



Beyond the Farmgate to Table: Transformation of Root Crop Supply Chains and Impact on National Development

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Abstract

Root and tuber crops, such as cassava, yam, sweetpotato, potato, cocoyam and ginger are essential food and cash crops for millions of people in developing countries. However, their potential as contributors to national development, food security, and poverty reduction is often limited by inefficient supply chains, low productivity, and poor market linkages. This paper examines the challenges and opportunities in transforming root and tuber crop supply chains for sustainable development, drawing on case studies from Nigeria. The paper provides policy recommendations for creating an enabling policy environment, investing in research and development, improving infrastructure and market access, building capacity and knowledge transfer, and promoting inclusivity and gender sensitivity. The impacts of root and tuber crop supply chain transformation are also discussed, including increased agricultural productivity, improved food security and nutrition, enhanced employment opportunities, reduced poverty, and increased inclusivity. By addressing the challenges and implementing the suggested strategies, root and tuber crops can reach their full potential as contributors to sustainable and inclusive development.

Keywords: *Root and tuber crops (RTCs), Smallholder farmers, Food security, Nutritional value, Supply chain challenges, Production practices, Post-harvest handling, Market linkages and Sustainable business models*

1.0 Introduction

The National Root Crops Research Institute (NRCRI) in Umudike is celebrating its centennial anniversary. Over the past 100 years, the institute has played a significant role in developing root and tuber crops (RTCs) in Nigeria. RTCs such as cassava, yam, sweetpotato, potato, ginger and cocoyam are vital for food security, nutrition, and rural development. Nigeria ranks first as the highest producer of cassava, yam and cocoyam in the world but with declining yields (Table 1) in the past decade (FAO, 2021a).

However, the RTC supply chains face several challenges that hinder their growth and development.

Beyond the farm gate, several approaches can indeed help mitigate the transaction costs of market participation and supply for RTCs, particularly due to the challenges associated with their bulky and perishable nature. Approaches focus on integrating various actors along the value chain, from farmers to consumers, and aim to streamline processes and reduce inefficiencies.

By promoting value addition and processing of RTCs, such as converting them into flour, chips, or other processed forms, their bulkiness can be reduced. Processed products have a longer shelf life and are easier to transport, making it more cost-effective for

farmers to participate in markets beyond their immediate vicinity (Fig. 1). Table 2 shows the quantity of cassava processed into various products ranging from 74% to 80% from 2012 to 2021 (FAOSTAT, 2021b) respectively indicating enormous prospects for food security, and job opportunities within the value chain.

Aggregation and collective action by the formation of farmer groups or cooperatives enable collective action in the transportation and marketing of RTCs. By aggregating their produce, farmers can achieve economies of scale and negotiate better transportation rates or even establish their transportation systems. Investing in infrastructure such as rural roads, storage facilities, and market centres. Improved infrastructure reduces transportation costs, minimizes post-harvest losses, and enhances market access for RTCs. Information and communication technologies facilitate market linkages and reduce transaction costs. Online platforms, mobile applications, and SMS services can connect farmers with potential buyers, provide real-time market information, and facilitate the logistics of transportation. Value chain actors, entrepreneurs in the Agriculture and food landscape, have been addressing this issue through cooperative activities, leveraging on digital platforms for visibility and sales, and direct referrals for market linkages (Omosho, 2022). Collaboration between public and private stakeholders can help address transportation challenges. Governments can partner with private logistics companies or provide subsidies for transportation costs, while private sector actors can invest in transportation infrastructure and logistics services. By implementing these approaches, the transaction costs associated with transporting RTCs can be mitigated, enabling farmers to access larger markets and improve their profitability. This, in turn, contributes to the overall development and sustainability of the RTC value chains.

This paper aims to discuss the transformation of root crop supply chains and their impact on national development, food security, job creation, economic growth, poverty reduction, and inclusivity.

2.0 RTCs and their Importance

RTCs are a significant source of carbohydrates and other essential nutrients. They are also important for smallholder farmers as they provide income and employment, and contribute to rural development. They are essential for food security in Nigeria, as they are consumed by millions of people daily. The nutritional value and socioeconomic importance of root crops make them crucial for national development.

RTCs are essential food and cash crops for millions of people in developing countries, particularly in sub-Saharan Africa. These crops are resilient to drought and other environmental stresses and are rich in nutrients, making them important for food security and nutrition. They also have significant economic potential, as they can be processed into a range of products, including flour, starch, and chips, and are used in industries such as

animal feed, textiles, and pharmaceuticals, as well as other numerous food forms.

3.0 Challenges in Root and Tuber Crop Supply Chains

The inefficient supply chains of root and tuber crops are a major challenge to their sustainable development. The challenges can be grouped into three categories: *production, processing, and marketing*.

3.1 Production challenges include low productivity, limited input access, and poor agricultural practices. These can have significant impacts on the efficiency and sustainability of agricultural systems.

- a. Low Productivity:** Low productivity in agriculture can be caused by various factors such as inadequate irrigation, lack of mechanization, poor crop management practices, and limited access to improved seeds and fertilizers. This results in lower yields and reduced profitability for farmers. To address this challenge, interventions like adopting improved agricultural techniques, providing access to modern farming equipment, and promoting the use of high-quality inputs can help enhance productivity.
- b. Limited Access to Inputs:** Limited access to inputs like seeds, fertilizers, pesticides, and machinery can hinder agricultural production. This challenge is often faced by small-scale farmers in developing countries due to factors such as high costs, lack of availability, and inadequate distribution networks. Improving access to inputs through initiatives like subsidies, credit facilities, farmer cooperatives, and strengthening supply chains can help overcome this challenge.
- c. Poor Agricultural Practices:** Poor agricultural practices, including improper land management, overuse of chemical inputs, inadequate crop rotation, and insufficient pest and disease control, can lead to soil degradation, reduced yields, and negative environmental impacts. Promoting sustainable agricultural practices like conservation agriculture, integrated pest management, and organic farming can help address these challenges and ensure long-term productivity.

3.2 Processing challenges include post-harvest losses, poor quality control, and limited processing technologies. Processing challenges can have significant impacts on the quality, shelf life, and marketability of agricultural products.

- a. Post-Harvest Losses:** This can occur due to various factors such as inadequate storage facilities, improper handling, lack of proper transportation infrastructure, and pest and disease infestation. Post-harvest losses not only result in economic losses for farmers but also contribute to food insecurity and waste. Implementing proper post-harvest

management practices such as improved storage facilities, cold chain systems, and efficient transportation can help reduce these losses.

- b. **Poor Quality Control:** Poor quality control can lead to the production of agricultural products that do not meet market standards or consumer expectations. Factors contributing to poor quality control include inadequate quality control measures, lack of standardized grading and sorting systems, and insufficient quality assurance practices. Implementing quality control measures such as quality testing, grading, sorting, and certification can help ensure that agricultural products meet the required quality standards.
- c. **Limited Processing Technologies:** Limited access to modern processing technologies can hinder the value addition and diversification of agricultural products. Outdated or inadequate processing technologies can result in low product quality, low processing efficiency, and limited product range. Promoting the adoption of improved processing technologies, providing training and technical support, and facilitating access to processing equipment can help overcome this challenge and enhance the value-added processing of agricultural products.

3.3 Marketing challenges include limited market access, low prices, and inadequate market information. These can significantly impact farmers' ability to sell their products, access markets, and obtain fair prices.

- a. **Limited Market Access:** Limited market access refers to the inability of farmers to reach potential buyers or markets for their agricultural products. Factors contributing to limited market access include inadequate transportation infrastructure, lack of market linkages, and distance from major markets. Improving market access can be achieved through initiatives such as developing rural infrastructure, establishing market networks, facilitating market information dissemination, and promoting farmer-producer organizations.
- b. **Low Prices:** Low prices for agricultural products can negatively affect farmers' incomes and livelihoods. Factors contributing to low prices include market volatility, lack of market competition, and asymmetry in bargaining power between farmers and buyers. Strengthening farmers' bargaining power, promoting fair trade practices, encouraging value addition and diversification, and supporting market information systems can help address this challenge and enable farmers to obtain better prices for their products.
- c. **Inadequate Market Information:** Lack of timely and accurate market information can hinder farmers' decision-making processes, leading to suboptimal production and

marketing strategies. Farmers need information on market demand, prices, trends, and consumer preferences to make informed decisions about what to produce when to sell, and where to sell their products. Establishing market information systems, providing training on market intelligence, and promoting the use of digital platforms can help address this challenge and improve farmers' access to market information.

The potential of root and tuber crops is often limited by these challenges. Smallholder farmers, who often rely on these crops for their livelihoods, face challenges such as limited access to credit, inputs, and markets, as well as poor infrastructure and inadequate extension services. These challenges contribute to low yields, post-harvest losses, and low prices, reducing the income and food security of smallholder farmers and limiting the contribution of root and tuber crops to national development. Transforming root and tuber crop supply chains can address these challenges and unlock the potential of these crops for sustainable development.

4.0 Transformation of Root and Tuber Crop Supply Chains

To address the challenges in root and tuber crop supply chains, the following strategies can be adopted:

4.1 Enhanced Production Practices and Technology Adoption:

Promoting the adoption of improved agricultural practices and technologies can enhance productivity, reduce post-harvest losses, and improve the quality of root and tuber crops. Extension services, farmer training programs, and the use of innovative technologies can be employed. Extension services can provide farmers with information on best practices for planting, harvesting, and storage of root and tuber crops. This can include information on soil management, pest and disease control, and irrigation techniques. Farmer training programs can provide hands-on training and demonstrations to farmers. Innovative technologies can also be used to enhance production practices and technology adoption. For example, precision agriculture technologies such as GPS mapping and remote sensing can help farmers optimize their use of inputs such as fertilizer and water and identify areas of their fields that may require additional attention. Mobile phone apps can also be used to provide farmers with real-time information on weather patterns, market prices, and crop management practices. In addition to promoting the adoption of improved practices and technologies, it is important to ensure that farmers have access to the necessary inputs and infrastructure to implement these changes. This may include access to high-quality seeds, fertilizers, and irrigation systems, as well as storage facilities and transportation networks to bring crops to market.

4.2 Improving Post-Harvest Handling and Processing Techniques: Efficient post-harvest handling and processing techniques are crucial for reducing losses

and adding value to root and tuber crops. Improved storage facilities, processing technologies, and quality control measures can be employed. This is essential for reducing losses and maximizing the value of root and tuber crops.

- a. **Improved storage facilities:** Proper storage facilities are crucial for preserving the quality of RTCs after harvest. This can include the use of well-ventilated storage structures, such as warehouses or silos that protect against pests, diseases, and environmental factors like temperature and humidity. Implementing proper storage practices, such as regular inspection and maintenance, can help extend the shelf life of the crops and reduce post-harvest losses.
- b. **Processing technologies:** This can add value and extend their shelf life. Technologies such as drying, milling, and grinding can be used to produce value-added products like flour, starch, or chips. Processing techniques can also enhance the nutritional value of the crops, making them more appealing to consumers. Training programs and workshops can be conducted to educate farmers on the use of these technologies and to promote their adoption.
- c. **Quality control measures:** Quality control measures implementation throughout the post-harvest handling and processing stages is crucial for ensuring the production of high-quality RTCs. This can involve regular monitoring and testing of the crops for factors such as moisture content, presence of contaminants, and overall quality. By implementing quality control measures, farmers and processors can identify and address any issues that may affect the quality and marketability of the crops.
- d. **Value addition and market linkages:** Adding value to RTCs through processing techniques can open up new market opportunities. Farmers can explore partnerships with food processing companies or establish their processing units to produce value-added products. Additionally, creating market linkages with wholesalers, retailers, and consumers can help ensure a steady demand for processed products.

4.3 Strengthening Market Linkages and Access for Smallholder Farmers: Creating robust market linkages and improving access to markets for smallholder farmers is essential for enhancing their incomes and ensuring the sustainability of root and tuber crop supply chains. Strategies such as market information systems, farmer cooperatives, and public-private partnerships can be employed. This is crucial for their economic empowerment and the sustainability of RTC supply chains.

- a. **Market information systems:** Establishing market information systems can provide

farmers with real-time information on market prices, demand trends, and consumer preferences. This enables farmers to make informed decisions about what to produce, when to sell, and at what price. Market information systems can be set up through mobile phone apps, SMS services, or physical market information centres.

- b. **Farmer cooperatives:** Farmer groups and clusters can help smallholder farmers pool their resources and collectively market their produce. Cooperatives can negotiate better prices, access credit facilities, and engage in bulk selling, which increases their bargaining power in the market. Additionally, cooperatives can facilitate the collective purchasing of inputs and the sharing production and marketing knowledge among members.
- c. **Public-private partnerships:** Collaborations between the public and private sectors can help facilitate market linkages for smallholder farmers. Governments can work with private companies to develop procurement systems that ensure fair prices for farmers' produce. Public-private partnerships can also support the establishment of processing facilities, storage infrastructure, and transportation networks, which can improve market access for smallholder farmers.
- d. **Value chain development:** Strengthening the entire value chain, from production to consumption, can enhance market linkages for smallholder farmers. This involves improving infrastructure, such as roads and cold storage facilities, to facilitate the movement of crops from farms to markets. It also includes promoting the adoption of quality and safety standards to meet market requirements. Value chain development efforts can be supported through capacity-building programs, technical assistance, and investment in infrastructure.
- e. **Market diversification and product differentiation:** Smallholder farmers can explore opportunities for market diversification by identifying niche markets or value-added products. This can involve targeting specific consumer segments, such as organic or specialty markets, and producing unique varieties or processed products. Product differentiation can help farmers command higher prices and reduce their dependence on traditional commodity markets.

4.4 Promoting Sustainable and Inclusive Business Models: Promoting sustainable and inclusive business models can contribute to the long-term viability of root and tuber crop supply chains. Approaches such as contract farming, value chain integration, and inclusive financing mechanisms can be employed. Promoting sustainable and inclusive business models is crucial for

the long-term viability of RTC supply chains.

- a. **Contract farming:** Involves formal agreements between farmers and buyers, where farmers commit to producing a certain quantity and quality of crops, and buyers agree to purchase the produce at a pre-agreed price. Contract farming can provide smallholder farmers with a guaranteed market for their produce, access to credit and inputs, and technical assistance. It also enables buyers to secure a reliable supply of quality produce.
- b. **Value chain integration:** Coordination of activities along the entire value chain, from production to consumption. This includes vertical integration, where companies control multiple stages of the value chain, or horizontal integration, where companies collaborate with other actors in the value chain. Value chain integration can improve efficiency, reduce transaction costs, and increase value addition.
- c. **Inclusive financing mechanisms:** Mechanisms, such as microfinance, can provide smallholder farmers with access to credit and other financial services. This can enable farmers to invest in their production activities, adopt new technologies, and improve their livelihoods. Inclusive financing mechanisms can also reduce the risk of default and increase the financial sustainability of the value chain.
- d. **Sustainable production practices:** Promoting sustainable production practices, such as conservation agriculture, can improve the environmental sustainability of RTC production. Reduction in the use of synthetic inputs, promoting crop diversification, improving soil health, and also enhancing the resilience of smallholder farmers to climate change and other environmental shocks.
- e. **Inclusive business models:** Aim to create shared value for all actors in the value chain, including smallholder farmers. This can involve the integration of smallholder farmers into the value chain as suppliers, partners, or shareholders. Also promote social and environmental sustainability by addressing issues such as gender equality, labour rights, and environmental conservation.

These strategies require collaboration between various stakeholders, including farmers, buyers, financial institutions, and development organizations, to create an enabling environment for sustainable and inclusive business models to thrive, thereby contributing to the overall development of the RTC sector.

5.0 Successful Transformations

The RTCs value chain in Nigeria has undergone significant transformation in recent years. This has involved the adoption of improved production practices, such as the use of disease-resistant varieties,

mechanization, post-harvest management techniques and the implementation of good agricultural practices. Development of value-added products, and several food forms, for the domestic and export market, the establishment of processing centers and the adoption of quality control measures. The value chain has also focused on the development of a branding strategy to increase RTC's market value, and promotion as a premium product, with a focus on its nutritional value and culinary versatility. These transformations have led to increased productivity, improved quality, and enhanced profitability for smallholder farmers. The adoption of improved production practices has led to higher yields and reduced post-harvest losses. The development of value-added products and branding strategies has also increased the market value of these crops, enabling farmers to command higher prices for their produce. The transformation of the RTC value chains in Nigeria has demonstrated the potential for smallholder farmers to benefit from value chain development. However, these transformations require sustained investment in research, extension services, and infrastructure to ensure their long-term viability.

5.1 Policy Recommendations for Sustainable Transformation

To ensure the sustained transformation of RTC supply chains, it is essential to adopt a multi-faceted approach that includes the following policy recommendations:

- a. **Creating an enabling policy environment:** Governments and other stakeholders should work together to create an enabling policy environment that supports the development of RTC supply chains. This can include policies that promote investment in the sector, improve access to credit and other financial services, and support research and development.
- b. **Investing in research and development:** Investment in research and development is crucial for improving production practices and technology adoption. This can include the development of high-yielding and disease-resistant varieties, the adoption of precision agriculture techniques, and the development of new processing technologies.
- c. **Developing infrastructure:** Developing infrastructure such as roads and markets is critical for reducing transaction costs of market participation, strengthening market linkages and access for smallholder farmers. This can include the development of transportation networks, the establishment of storage facilities, and the construction of marketplaces.
- d. **Providing capacity building and knowledge transfer:** Capacity building and knowledge transfer are essential for enhancing the skills of smallholder farmers and other stakeholders in the supply chain. This can include training programs on good agricultural practices, post-harvest management, and marketing and business skills.
- e. **Adopting inclusive and gender-sensitive**

approaches: Gender-sensitive approaches are crucial for ensuring that all stakeholders benefit from the transformation of root crop supply chains. This can include the integration of women and youth into the supply chain, the promotion of gender equality and empowerment, and the adoption of inclusive business models.

Impacts of Root and Tuber Crop Supply Chain Transformation

The transformation of the RTC supply chains can have significant impacts on various aspects of national development.

- a. **Increased agricultural productivity:** By improving production practices, adopting new technologies, and enhancing market linkages, the transformation of the RTC supply chains can lead to increased agricultural productivity. This, in turn, can contribute to higher yields, improved farm incomes, and overall agricultural development.
- b. **Improved food security and nutrition:** RTCs are often staple foods in many countries, particularly in regions where they are widely grown. Enhancing the supply chains can ensure a more reliable and efficient availability of these nutritious crops, thereby improving food security and nutrition for both rural and urban populations.
- c. **Enhanced employment opportunities:** RTC supply chain transformation can generate employment opportunities along the entire value chain, from production to processing, distribution, and marketing. This can lead to increased rural employment, especially for smallholder farmers and rural communities, contributing to poverty reduction and economic growth.
- d. **Reduced poverty:** The transformation of RTC supply chains can have a positive impact on poverty reduction. By increasing agricultural productivity and creating employment opportunities, smallholder farmers and rural communities can improve their incomes and livelihoods, thereby reducing poverty levels.

- e. **Increased inclusivity:** RTC's supply chain transformation can promote inclusivity by ensuring that all stakeholders, including smallholder farmers, women, youth, and marginalized groups, have access to and benefit from the value chain. Inclusive approaches can address gender inequalities, empower marginalized groups, and promote equitable economic growth.
- f. **Economic growth:** The development of RTC supply chains can contribute to overall economic growth by stimulating rural development, increasing agricultural value-added, and fostering agribusiness development. This, in turn, can have positive spillover effects on other sectors of the economy.

Conclusion

The transformation of root crop supply chains is crucial for ensuring sustainable national development, food security, job creation, economic growth, poverty reduction, and inclusivity. The National Root Crops Research Institute has played a significant role in this transformation over the past 100 years and will continue to do so in the future. The policy recommendations and case studies presented in this paper provide a roadmap for the sustained transformation of root crop supply chains in Nigeria and other countries.

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Table 1: Root and Tuber Crops Yield (t/ha): 2012-2021

Year	Cassava	Yam	Cocoyam	Sweetpotato	Potatoes	Ginger
2012	7.96	7.20	5.14	2.70	3.60	4.04
2013	7.03	7.00	4.83	2.65	3.63	4.00
2014	7.66	8.19	5.11	2.48	3.70	3.54
2015	7.27	8.18	3.96	2.48	3.89	6.05
2016	9.08	9.16	3.75	2.65	3.68	9.08
2017	9.07	9.39	4.09	2.63	3.88	8.69
2018	9.40	10.20	3.93	2.59	3.82	8.03
2019	5.83	7.81	3.92	2.63	3.79	8.00
2020	8.10	8.07	3.98	2.62	3.83	8.47
2021	6.94	8.54	3.94	2.61	3.81	8.84

Source: FAOSTAT, 2021a



Fig. 1: Display of some NRCRI-added products at an exhibition
Source: Egesi, 2023

Table 2: Cassava production, processed and supply trend

Year	Production (t)	Processed form (t)	Food supply Fresh form (t)	Food supply fresh form (%)	Processed form (%)
2012	50950292	40760234	4477022	8.78	80.00
2013	47406770	38571429	4628463	9.76	81.36
2014	56328480	45062784	7026978	12.47	80.00
2015	57643271	46114617	7190998	12.47	80.00
2016	59565916	47652733	7430848	12.47	80.00
2017	55068732	44054986	6869824	12.47	80.00
2018	55795814	44636651	6960528	12.47	80.00
2019	59411510	47400000	7540794	12.69	79.78
2020	59063109	43179906	7368123	12.47	73.10
2021	63031377	46902655	7385600	11.72	74.41

Source: FAOSTAT, 2021b