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Technology Adoption and Its Impact on Rural Women's Entrepreneurial Activities in the Cassava Value Chain: A Review

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Abstract
The study was a review of technology adoption and its impact on rural women's entrepreneurial activities within the Cassava Value Chain. It provided conceptual clarifications on key terms such as, technology adoption, cassava value chain, and rural entrepreneurship, and also emphasized interconnectivity among these concepts. Furthermore, the review examined the various activities involved in the cassava value chain, highlighting the critical roles played by rural women in enhancing the value of cassava products. The study identified and discussed the challenges these rural women face, including limited access to technology, inadequate training, and socio-cultural barriers that hinder their entrepreneurial efforts. Through a synthesis of existing literature and empirical evidence, the paper offered recommendations aimed at fostering technology adoption among rural women, thereby enhancing their entrepreneurial capabilities and contributing to the overall development of the cassava value chain, especially at the grassroots level. The findings underscore the need for targeted interventions that support rural women in overcoming barriers and leveraging technology for sustainable entrepreneurship.
Keywords: Adoption, technology, rural women, cassava, value-chain.

Introduction

The adoption of technology in the cassava value chain has emerged as a critical factor in enhancing productivity and fostering entrepreneurship, particularly among rural women. In Nigeria, the cassava value chain presents significant opportunities for economic empowerment and food security. Cassava (Manihot esculenta) is a staple crop that contributes to the livelihoods of millions and serves as a vital source of income for rural households (Nwafor, Igbokwe, and Nwachukwu, 2018). However, despite its potential, the full benefits of cassava production are often hindered by traditional practices and limited access to modern technology (Ogunniyi, 2020). Studies of Abali and Ifenkwe (2014); Doss (2018); Mogues and Benin (2020) have shown that rural women play a pivotal role in the agricultural sector, yet they face unique challenges that impact their ability to adopt innovative technologies (Aker et al., 2016). Factors such as limited access to information, financial resources, and training opportunities can impede their entrepreneurial efforts in the cassava value chain (Mogaji et al., 2021). Consequently, understanding the dynamics of technology adoption among rural women is essential for developing targeted interventions that enhance their entrepreneurial capacities and overall contributions to the agricultural economy.

Previous studies of Doss (2018), Mogues and Benin (2020), Kumar and Singh (2022) have highlighted the importance of integrating gender perspectives in agricultural technology adoption frameworks. Research indicates that empowering women through technology can lead to improved productivity and increased

income levels, thereby promoting sustainable development (Kabeer, 2016). In the context of rural communities in Nigeria, exploring how technological innovations are adopted by women entrepreneurs in the cassava value chain provides valuable insights into the barriers they face, and the strategies needed to overcome them. Thus, this study aimed to give some conceptual clarification on technology adoption, entrepreneurship, the cassava value chain, and their interconnectivities. Furthermore, factors influencing technology adoption among rural women entrepreneurs on the cassava value chain were also reviewed. Conclusion and recommendations were made based on the findings.

Conceptual Clarifications

Rural entrepreneurship

Rural entrepreneurship refers to the process of creating and managing small businesses in rural areas, which are often characterized by limited resources, lower population densities, and unique socio-economic challenges. It is as a means to stimulate economic development, reduce poverty, and enhance the quality of life in rural communities. It refers to the creation and management of businesses in non-urban regions that primarily serve local needs and utilize local resources (Brouard and Larue, 2021). The authors further stated that rural entrepreneurship is characterized by its reliance on local resources, social networks, and community engagement. Entrepreneurs in rural settings often face distinct challenges compared to their urban counterparts, including limited access to capital, markets, and infrastructure (Morrison, 2008). It plays a critical role in job creation, income generation, and the overall economic vitality of rural areas. According to Bosworth (2015), rural entrepreneurship plays a crucial role in diversifying local economies, thereby reducing reliance on traditional sectors such as agriculture and mining. The author further stated that diversification is essential for building resilience against economic downturns. Moreover, rural entrepreneurship can lead to social benefits, including enhanced community cohesion and empowerment. As highlighted by Kauffman (2010), successful rural entrepreneurs frequently participate in community development activities, thereby fostering a sense of belonging and shared purpose among rural residents.

Technology adoption

Technology adoption is the process by which individuals or organizations integrate new tools, techniques, or practices to improve their productivity and efficiency (Brouard and Larue, 2021). The authors further observed that integrating technology and innovation into rural businesses can help overcome some of the inherent limitations faced by rural entrepreneurs. In agriculture, technology adoption can include the use of improved seed varieties, mechanization, irrigation systems, and information and communication technologies (ICTs) (Aker, 2015). The adoption of modern agricultural technologies is essential for increasing crop yields, reducing labor costs, and ensuring sustainable farming practices (Davis et al., 2012). Technology adoption facilitates value addition in the cassava value chain through the production of various processed products such as flour, chips, and ethanol. The introduction of innovative processing technologies can lead to higher-quality products that meet market demands. As noted by Otegbayo et al. (2019), value-added products from cassava can fetch higher prices in local and international markets, thereby increasing farmers' profitability

Cassava value chain

The cassava value chain encompasses all activities involved in the production, processing, distribution, and marketing of cassava products (Nwafor et al., 2018). Cassava (Manihot esculenta) is a major staple food crop in Nigeria and serves as a vital source of income for millions of rural households (Ogunniyi, 2020). The cassava value chain involves multiple participants, such as farmers, processors, traders, and consumers. Each segment of the chain presents opportunities for entrepreneurship and innovation as seen in Fig 1. The potential for value addition in the cassava value chain is significant. Processing cassava into products such as flour, chips, and starch can enhance income generation for rural women entrepreneurs (Adebayo et al., 2019). The economic value of cassava is further enhanced by its versatility. It can be processed into various products such as flour, chips, and starch, which are in high demand both locally and internationally. As noted by Otegbayo et al. (2019), the global market for cassava products has expanded, providing farmers

with opportunities to increase their income through value addition. Processing is a critical stage in the cassava value chain that significantly enhances its market value. The transformation of fresh cassava roots into processed products not only reduces post-harvest losses but also increases profitability for farmers. Afolabi et al. (2018) emphasize that improved processing techniques, such as mechanized peeling and drying, can reduce waste and enhance product quality. Value addition through processing enables the creation of diverse products, including cassava flour, which is recognized as a gluten-free alternative for baking and cooking, and has become increasingly popular in both local and international markets (Maziya-Dixon et al., 2006; Adeyemi, 2022). Cassava Chips are used as snacks that can be produced with minimal investment and have a growing market demand (Nwosu, 2019). Cassava starch is extensively utilized in the food industry for thickening and stabilizing purposes, and it is also employed in various non-food applications, including textiles and paper (Ogunniyi et al., 2018).

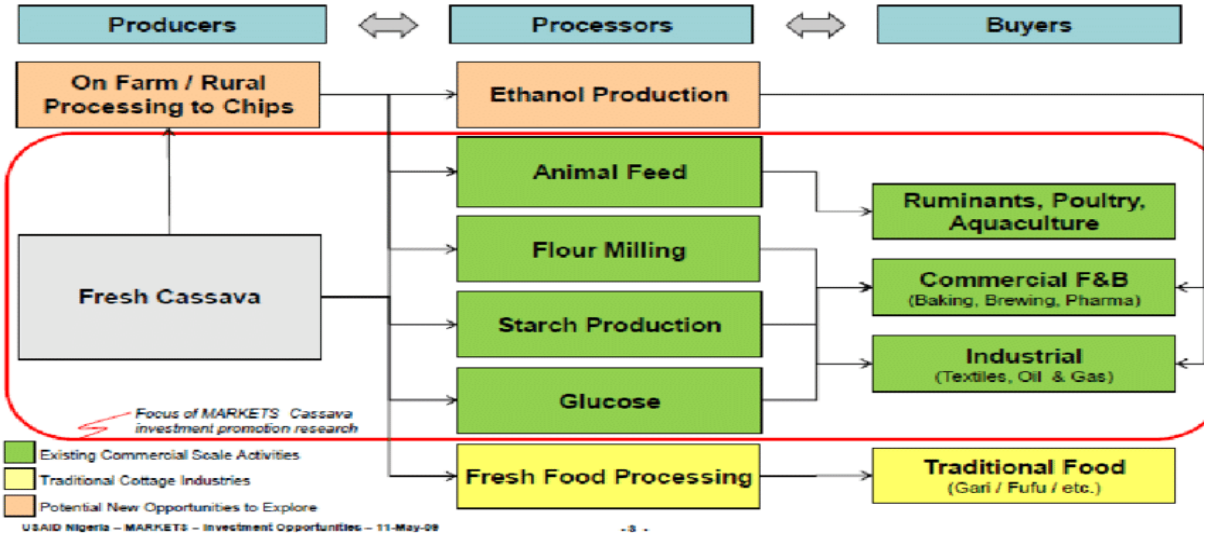

Fig. 1: Cassava value chain
Source: Onwualu, (2016)

Interconnection of entrepreneurship, technology adoption, and the cassava value chain

The interplay as indicated in Fig 2, between entrepreneurship and technology adoption is particularly evident in the cassava value chain. Entrepreneurial women who adopt modern technologies can improve their production practices and processing methods. This not only increases their productivity but also enhances their competitiveness in local and regional markets (Davis et al., 2012). Furthermore, the integration of ICTs into the cassava value chain can facilitate access to information about market prices, best practices in cultivation and processing, and potential buyers (Aker, 2015). Such access empowers women entrepreneurs to make informed decisions that can lead to better economic outcomes. Thus, fostering entrepreneurship among rural women in the cassava value chain through technology adoption can significantly contribute to economic development and food security.

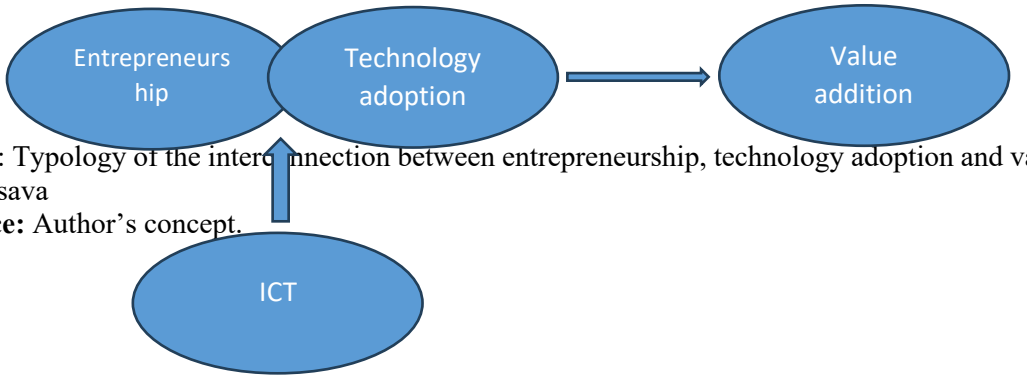

Fig. 2: Typology of the interconnection between entrepreneurship, technology adoption and value addition in cassava
Source: Author's concept.

Roles of rural women in cassava value addition and the technologies applied

The cassava value chain encompasses various activities crucial for the production, processing, and marketing of cassava. Rural women play a significant role in this value chain, engaging in activities that contribute to food security and economic development. According to Akinwumi and Adeyemo (2020), rural women are often involved in the cultivation of cassava. They participate in land preparation, planting, weeding, and harvesting. The authors further observed that their knowledge of local agricultural practices and varieties contributes significantly to the productivity of cassava farms. Following the harvest, women play significant roles in processing cassava into a variety of products, including gari, fufu, and tapioca. This processing not only adds value to the raw cassava but also creates employment opportunities for women (Osei and Osei-Agyemang, 2021). Women are essential to the marketing of cassava products. They often take on the responsibility of selling processed cassava in local markets, managing sales, and negotiating prices (Nwafor and Ogbodo, 2022).

From top left: Plate 1: hydraulic pressing machine; Plate 2: indigenous press; Plate 3: Automated garri sieve; Plate 4: Manual sieve; Plate 5: Automated garri frier; Plate 6: Manual frier

Source: Adeyemi, (2022)

Table 1: Processing activities and the technology application employed by rural women

Processing activities	Indigenous Technology	Improved Technology
a. **GARRI**	Knife made of bamboo, flint, or metal	Mechanical peeler, Motorized
1. Peeling		peeler, Hand peeler, hand rasper
2. Washing	Local Calabash bowl	Aluminum tank
3. Grating	Rough Stone, prickly trunk of palms, sheet/tin iron pierced with nail on one side	Mechanized Grater, Motorised Grater, Hammer mill, disk grater, hand grater.
4. Fermentation	Heavy stone on a heavy-weighted cloth or nylon	Batch fermentation in an

	bag	aluminum tank, locally made, hydraulic or mechanical
5.Dewatering Pressing	Heavy stone on heavy-weighted nylon bag (for several days)	Hydraulic jack press, screw press, parallel board press, upgraded trad. Press for a few minutes.
6. Sieving	Woven baskets, suspended cloth pieces holding mash	Improved pulverizer e.g. drum sieve, rotating sieve
Frying / Recasting	Cast Iron pan over a wood fire	Upgraded roaster, solar dryer, kiln-type dryer
8. Sifting	Woven basket	Improved pulverizer and sifter
B. **LAFUN**	Knife made of bamboo, flint, or metal	Mechanical peeler,
1. Peeling		motorized peeler, hand rapper
2. Soaking	Local Calabash	Aluminum tank
3. Pulverizing	Woven basket	Improved pulverizer
4. Dewatering	Heavy stone on heavy-weighted cloth or nylon bag	Hydraulic press, Mechanical press
5. Drying	Cast iron pan over wood fire	Drum dryer, solar dryer
C. STARCH	Knife made of bamboo	Mechanical, peeler, cassava filter,
1. Peeling		Motorized peeler
2. Washing	Calabash bowl	Aluminum tank
3. Grating	Sheet or tin iron pierced with nail on one side	Power grater, motorized grater, Disc grater
4. Dewatering	Heavy stone on heavy weighed cloth or nylon bag	Hydraulic press, screw press
5. Drying	Cast iron pan over wood fire	Engraved fryer, solar dryer
6. Packaging	Local jute bag	Scaled polythene bags
D. FUFU		
1. Peeling	Local Knife	Hand peeler – (mechanized)
2. Washing	Local Calabash bowl	Aluminum tank
3. Grating	Rough Stone	Motorized grater, Rotary grater
4. Dewatering	Heavy Stone on heavy-weight cloth	Mechanized press, Hydraulic press
5. Packaging	Local Jute bag	Hydraulic polythene bag

Source: Author' concept

The Table 1 showed various processing activities and the technologies both Indigenous and Improved) application employed by rural women in the cassava value chain.

Empirical Review

In her investigation of the processing technologies utilized by cassava processors and the array of products that can be derived from cassava processing, Mgbakor (2015) found that respondents employed various modern equipment in their operations. The study revealed that a significant majority (98.2%) of the surveyed cassava processors used cast-iron frying pots for frying. Additionally, other commonly used processing equipment included drying on platforms, tarpaulins, or mats (77.9%); aluminum or plastic basket sieves (73.8%); grating machines (72.9%); and hydraulic presses (71.5%). In contrast, milling machines were utilized by only 34.1% of the processors.

Notably, a substantial proportion of cassava producers and processors reported never having used several mechanical devices: 92.3% had never employed a mechanical peeler, 98.2% had not used a washing machine, 99.1% had no experience with steep tanks, 99.4% had never used sieving machines, and 100% reported never using motorized fryers or electric sealers. Furthermore, 99.7% had not used hammer mills, and 97.1% had never employed pulverizing machines. Furthermore, the author attributed this lack of usage to the prohibitive costs of these processing technologies, which are often beyond the financial reach of local

processors and noted that many cassava processors operate on a small scale and therefore cannot afford advanced processing equipment. Consequently, cassava processing in the study area faces significant challenges due to low productivity and limited technological applications.

Mgbakor (2015) also highlighted that while a majority of processors (77.4%) employed upgraded technology, 22.6% still relied on conventional methods. This suggests that most rural women farmers are utilizing improved technologies, though not uniformly across all operations. The coexistence of both advanced and traditional techniques can be described as "mixed technology," representing a progressive shift away from traditional cassava processing practices.

In a related study, Achem (2017) explored the mechanization of cassava processing operations in Kwara State. The author found that nearly all peeling, washing, drying, frying, and chipping tasks were performed manually. However, he noted significant advancements in the mechanization of grating and milling processes, which were powered by diesel engines in 90.1% and 87.4% of cases, respectively. Despite these advancements, the majority of cassava processing tasks remain labor-intensive and time-consuming due to their manual execution. The dependence on manual methods presents significant challenges for rural women entrepreneurs engaged in cassava value addition, particularly at the grassroots level. In a study conducted by Odebode et al. (2019), the authors examined the adoption of improved cassava processing technologies among women processors in Nigeria. They found that only 35% of respondents had adopted advanced processing technologies, such as mechanized graters and hydraulic presses, despite the potential for increased efficiency and productivity. The study highlighted that barriers to adoption included inadequate access to credit facilities, lack of training on new technologies, and cultural resistance to changing traditional practices. This finding aligns with Mgbakor's (2015) observation of limited technological applications among cassava processors and underscores the need for targeted interventions to enhance technology adoption. Lastly, a study by Nwafor et al. (2020) investigated the impact of mechanization on the productivity of cassava processors in Southeast Nigeria. The researchers reported that processors who utilized mechanized equipment for tasks such as grating and milling experienced a 40% increase in output compared to those relying solely on manual methods. The study also revealed that while 60% of the surveyed processors had access to some form of mechanization, many still faced challenges related to maintenance costs and the availability of spare parts. This finding supports Achem (2017) conclusion about the labor-intensive nature of cassava processing and emphasizes the potential benefits of mechanization in improving productivity.

Factors Affecting Technology Adoption among Rural Women Entrepreneurs in the Cassava Value Chain

Analyzing the challenges faced by cassava processors and the adoption of improved processing technologies, Ewebiyi et al (2020) discovered that significant majority of respondents identified several key constraints such as insufficient cash (91.5%), lack of technical knowledge (88.6%), inadequate information (84.1%), high purchasing costs (83.0%), and a shortage of qualified engineers (80.1%) as major barriers to the implementation of enhanced processing technologies. Additionally, political instability, natural disasters, and low levels of computer literacy were noted as minor obstacles by 64.2% and 60.8% of respondents, respectively. This underscores that the limitations experienced by respondents represent substantial impediments to their ability to adopt and utilize advanced processing technologies.

In another study, Awoyemi et al. (2020) discovered that the significant expenses associated with machinery (2.98) and maintenance (2.97) were the primary barriers preventing the adoption of cassava processing technology in the region. This suggests that most surveyed individuals were unable to afford the necessary machinery for cassava processing, and those who could often struggle with maintenance expenses. The study also noted that intermittent power supply (1.79) posed a challenge to the utilization of these technologies. Although, as noted by the authors, its impact was not deemed significant.

Additionally, in her analysis of women's participation in cassava production and processing, Onyemauwa (2012) identified and ranked the key obstacles that limit women's engagement in cassava cultivation, processing, and the adoption of technological innovations. These barriers included the lack of land

ownership among women, their engagement in domestic responsibilities, insufficient farm size, and the high cost of technological cassava processing machines.
In a study carried out by Emokaro and Ogbebor (2020) on gender dynamics in agricultural technology adoption, it was discovered that cultural expectations and traditional gender roles often restrict women's participation in technology adoption processes. Studies have shown that societal norms can limit women's mobility and decision-making power, impacting their ability to engage with new technologies. In another study on infrastructure and technology adoption in rural Nigeria, implications for women in cassava value chains by Ibrahim et al (2021); it was discovered that inadequate infrastructure, such as poor roads and lack of electricity, poses significant challenges for rural women in adopting value-added technologies for cassava.

Conclusion and Recommendations

In conclusion, the intersection of technology adoption and rural women entrepreneurship within the cassava value chain presents a multifaceted landscape with significant implications for agricultural development and gender empowerment. This study highlighted the critical role that women play in the value addition process of cassava, where their involvement not only enhances productivity but also contributes to economic resilience especially in rural communities. Women serve as key actors in processing, marketing, and distributing cassava products, thus driving local economies and improving food security.
However, the findings underscored the fact that rural women face numerous challenges that hinder their full participation in the cassava value chain. Barriers such as limited access to improved processing technologies, financial constraints, inadequate technical knowledge, and socio-cultural norms restrict their entrepreneurial potential. Based on these findings, the following recommendations were made;

1. The need for targeted interventions that supports women's active involvement in cassava value addition and technology adoption should be prioritized by government at all levels and other private service providers;
2. Establishment of financial support mechanisms tailored to the needs of rural women entrepreneurs in the cassava sector. This can involve creating microfinance options, grants, or subsidized loans that specifically target women-led businesses. Additionally, training programs on financial literacy and business management should be implemented to empower women in making informed financial decisions and managing their enterprises effectively.
3. Social-cultural laws preventing women from land ownership and access to technological machines should be amended through appropriate legislation and policies implementation.

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