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The Role of Information and Communication Technology (ICT) in Managing Post-Harvest Losses in Tomato Production in Adamawa State, Nigeria

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ABSTRACT

In Nigeria today, particularly in Adamawa State, tomato production continuously faces significant challenges of post-harvest losses, affecting the farmers and tomato sellers and the consumer. This study explores how Information and Communication Technology (ICT) can effectively manage these losses. Through utilizing ICT tools and technologies such as weather forecasting applications, real-time market information, and other ICT aided processing and storage techniques, farmers can make informed decisions throughout the production and distribution process. These technologies empower farmers to adopt best practices in handling their produce, improve storage conditions, and access timely market information, thereby reducing losses and increasing profitability. However, challenges such as access to technology, infrastructure, and digital literacy remain critical barriers. Addressing these issues is essential for maximizing the potential of ICT in transforming tomato production in Adamawa State, to ensure a sustainable agricultural practices and economic growth in the Adamawa and Nigeria as a whole.

Keywords: ICT, Tomato Production, Post-Harvest Losses, Adamawa, Nigeria

INTRODUCTION

Tomato (*Solanum lycopersicum L.*) is one of the most common used vegetable fruit produced and highly consumed staple food globally (Grandillo et al. 1999). Tomato has a diverse ways of consuming it, it can be sliced raw in in salads or as a major ingredient in many dishes, and cocktail drinks (Alam et al. 2007). Tomatoes are rich in nutrients and health benefits. Tomatoes are consumed almost everywhere in the world thus, it constitutes an essential part of our daily diet. According to World Tomato Processing Council data, global industrial tomato production has reached an estimated 44.19 million tons (Pauline, 2024), the second-highest ever recorded, close to the 2009 record of 44.51 million tons (Pauline, 2024). Tomato production can serve as one of the primary means of livelihood and source of income for most rural and semi-urban vegetable farmers.

Despite all these benefits, there are multitude of challenges from tomato farming and value chain services, the biggest challenge is post-harvest losses as tomatoes has a very short shelve life and can easily rot due to its perishable nature and lots of pests. The major challenges faced by tomato value chain key stakeholders include pest and disease control during production, post-harvest losses, marketing or a combination of any of them. This paper is to look at the post-harvest challenges and losses and recommend some low cost intermediate ICT strategies to manage and reduce the huge losses in tomato production. Addressing these losses is crucial not only for ensuring food availability but also for enhancing farmers' livelihoods and contributing to the overall economy.

Information and Communication Technology (ICT) has emerged as a pivotal tool in tackling post-harvest losses in agriculture. By leveraging on ICT solutions, stakeholders

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in tomatoes production can improve efficiencies in harvesting, storage, transportation, and market access. In the context of tomato production in Adamawa State, ICT interventions offer promising avenues to mitigate losses and enhance profitability for farmers. This study explores the role of ICT in managing post-harvest losses specifically in tomato production within Adamawa State, Nigeria. By examining current practices, challenges, and the impact of ICT solutions, this research aims to provide insights into how technology can be effectively harnessed to optimize the tomato value chain. Moreover, it seeks to contribute to the broader discourse on sustainable agriculture and food security in developing regions.

Key ICT strategies such as mobile applications for real-time market information, remote sensing technologies for monitoring crop health and storage conditions, and block-chain-based traceability systems for supply chain transparency are gaining traction globally (Kausar et al. 2023). However, their adoption and adaptation in local contexts like Adamawa State necessitate a nuanced understanding of socio-economic factors, infrastructure limitations, and user acceptance. Through a case study approach, this research endeavors to highlight successful ICT interventions, identify barriers to implementation, and propose recommendations for policy-makers, practitioners, and farmers alike. The paper aims to underscore the transformative potential of ICT in reducing post-harvest losses, enhancing productivity, and ultimately contributing to sustainable sufficiency and profitability in Nigeria's tomato sector.

CHALLENGES IN TOMATO PRODUCTION AND POST-HARVEST LOSSES

Production of tomatoes in Adamawa State is plagued by several challenges that affects the growing, harvesting and post-harvest stages (FAO, 2020). The following is the outlined the key challenges of tomatoes production.

Pest and Disease Management

Tomatoes farmers generally struggle with identifying and effectively managing pests and diseases in tomato crops. This significantly poses the risk and likelihood of poor yield and quality of tomatoes, this affects farmer incomes, availability of tomatoes in the market and food security in general. According to reports, pests like tomato fruit-worm and diseases such as bacterial wilt are prevalent in the region, requiring better pest surveillance and management practices (FAO, 2020).

Recent advancements in artificial intelligence (AI), like the improved YOLOv5n model, offer better detection of tomato diseases and pests. This model improves detection accuracy while reducing computational complexity, making it more suitable for real-time application in agricultural settings (Hu et. Al, 2023).

Storage and Transportation

According to (FAO, 2020) approximately 40% of tomato harvests are lost due to improper storage and transportation conditions.

Inadequate storage facilities and poor transportation infrastructure are major causes of post-harvest losses. Tomatoes often suffer from mechanical damage during harvesting and handling, and lack of proper storage conditions leads to spoilage.

According to (FAO, 2020) approximately 40% of tomato harvests are lost due to improper storage and transportation conditions. The absence of cold chain infrastructure further exacerbates these issues, causing quality deterioration and significant economic losses for farmers.

Investments in post-harvest infrastructure and the adoption of digital solutions like Trace-X farm management software can help track and improve post-harvest handling,

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reducing losses and enhancing supply chain efficiency (Trace-X, 2024).

Market Access

Farmers often lack timely access to market information on prices and demand, this in turn lead to inefficiencies and income loss as well as missed opportunities to optimize sales (IFAD, 2021).

Seasonal farming constraints in Adamawa coupled with inadequate research and development (R&D), limit tomato production to specific times of the year. Improved seed varieties and sustainable farming practices are essential to enable year-round cultivation and mitigate seasonal price fluctuations. Enhanced market access and infrastructure would help farmers achieve better prices and reduce post-harvest losses (Okojie 2023).

RECENT DEVELOPMENTS AND SOLUTIONS

i. **Technological Interventions:** Efforts are being made to introduce pest-resistant tomato varieties and promote integrated pest management (IPM) practices.

ii. **Infrastructure Investments:** Projects are underway to upgrade storage facilities and improve road networks to facilitate better transportation of produce.

iii. **Market Linkages:** Organizations like the International Fund for Agricultural Development (IFAD) are supporting initiatives to enhance market information systems and establish farmer cooperatives to strengthen market access and bargaining power (IFAD, 2021).

In conclusion, addressing these challenges requires a multi-faceted approach involving ICT tools, innovation, infrastructure development, and improved market linkages to enhance tomato production and reduce post-harvest losses in Adamawa State.

THE ROLE OF ICT IN ENHANCING TOMATO PRODUCTION

Information and Communication Technology (ICT) has been increasingly recognized as a vital tool in managing post-harvest losses in tomato production (WFP, 2024) (Oluyi 2023). Post-harvest losses in tomatoes are significant, with developing countries often losing up to 40% of their produce due to inadequate storage and handling techniques. However, the integration of Information and Communication Technology (ICT) in tomato production has shown significant benefits, particularly in enhancing productivity and sustainability. The following are some key points and recent developments in ICT that will enhance productivity in tomato production:

i. **Precision Agriculture and Smart Farming**: ICT enables precision agriculture by using sensors, drones, and satellite imagery to monitor crop health, soil conditions, and weather patterns. For instance, advanced sensors and imaging technology help in identifying diseases like powdery mildew and tomato spotted wilt virus, which can improve timely intervention and reduce crop loss (Sørensen, et al. 2019) .

ii. **Automation and Robotics**: The use of robotic systems in tomato production, such as automated harvesting and disease detection, enhances efficiency and reduces labor costs. Robots equipped with machine vision can identify ripe tomatoes and detect pests or diseases, thus optimizing the harvesting process and minimizing crop damage (Sørensen, et al. 2019) .

iii. **Mobile Technology and Apps**: Mobile apps and SMS services provide farmers with real-time information on weather forecasts, pest outbreaks, and market prices. This timely data helps farmers make informed decisions about planting, irrigation, and harvesting, thereby increasing yields and reducing losses. ICT also facilitates better market access and price negotiations by

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connecting farmers directly with buyers (Beed, 2017) .

iv. **IoT and Big Data**: The Internet of Things (IoT) and big data analytics play a crucial role in managing large-scale tomato production. IoT devices collect data from various sources, which is then analyzed to optimize resource use (water, fertilizers) and improve crop management practices. This technology supports sustainable farming by minimizing waste and enhancing resource efficiency (Sørensen, et al. 2019) .

v. **Climate Resilience**: ICT tools help farmers adapt to climate change by providing critical insights into climate patterns and suggesting adaptive measures. This includes using data to select climate-resilient tomato varieties and adjusting planting schedules to avoid adverse weather conditions (Beed, 2017) .

vi. **Educational and Support Platforms**: ICT platforms offer training and support to farmers, helping them adopt best practices in tomato cultivation. These platforms provide access to agricultural extension services, expert advice, and peer learning opportunities, which can improve farming techniques and productivity (Beed, 2017) .

vii. Recent statistics and studies demonstrate that farms using ICT solutions have seen yield increases of 20-30%, and resource use efficiency improvements of 15-20%. These technologies are becoming more accessible and affordable, making it easier for smallholder farmers to benefit from digital innovations (Sørensen, et al. 2019) . (Ribeiro, et, al., 2023)

viii. Overall, the role of ICT in enhancing tomato production is pivotal for achieving higher productivity, sustainability, and economic viability for farmers.

CHALLENGES AND CONSIDERATIONS IN ADOPTION OF ICT

Despite the benefits, adoption of ICT in agriculture specifically in tomato production has several significant challenges that impact its effectiveness and widespread implementation, the following are some of the identified challenges:

Infrastructure Challenges: Availability and reliability of infrastructure and connectivity is a great challenge towards the adoption and implementation of ICT, this challenge is characterized by:

i. **Limited Connectivity:** Rural areas often lack reliable internet connectivity, which hinders farmers' ability to access and utilize ICT tools effectively.

ii. **Inadequate Electricity Supply**: Inadequate electricity infrastructure further complicates ICT adoption, as many ICT tools require consistent power supply.

According to the World Bank, around 50% of rural populations in developing countries Adamawa state inclusive, lack access to reliable internet connectivity, posing a major barrier to ICT adoption in agriculture (World Bank, 2012).

Awareness and Training Needs: Lack of awareness and technical knowhow is another challenge hampering the adoption of ICT in mitigating tomatoes post-harvest losses, this can be overcome through:

i. **Continuous Support:** Farmers require ongoing training and technical support to understand and utilize ICT tools such as mobile apps, weather forecasting systems, and market information platforms.

ii. **Capacity Building:** Training programs need to be tailored to the local context and the specific needs of farmers to ensure they can effectively integrate ICT into their farming practices.

Sustainability Challenges: Long-term sustainability of initiatives is another challenge to consider in adoption and implementation of ICT in managing post-harvest losses and in agricultural practices in general, to ensure sustainability the following measures need to be taken:

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i. **Policy Support:** Long-term sustainability of ICT initiatives in agriculture requires supportive policies that prioritize rural infrastructure development, including internet connectivity and electricity access.

ii. **Investment**: Adequate investment in ICT infrastructure and supportive frameworks is essential to ensure that ICT solutions remain viable and accessible to farmers over time.

iii. **Statistics**: The International Telecommunication Union (ITU) emphasizes the importance of policy frameworks and investment in ICT infrastructure to enhance agricultural productivity and resilience (ITU, 2020).

Recent Developments and Solutions: Recent developments represent a concerted effort to address the barriers to ICT adoption in agriculture. The following efforts aim to bridge the digital divide and empower farmers with the tools and knowledge needed to improve agricultural productivity and sustainability.

i. **Public-Private Partnerships:** Collaborative efforts between governments, private sector entities, and development organizations are being promoted to improve rural connectivity and infrastructure.

ii. **Training Programs:** Initiatives focusing on capacity building and technical training for farmers are being expanded to enhance their ICT literacy and adoption rates.

iii. **Policy Interventions:** Governments are increasingly recognizing the importance of ICT in agriculture and are implementing policies to support infrastructure development and ICT adoption among rural communities.

CONCLUSION

In conclusion, Information and Communication Technology (ICT) plays a crucial role in enhancing tomato production and reducing post-harvest losses in Adamawa State, Nigeria. By addressing challenges related to pest management, storage, and market access, ICT interventions empower farmers, improve productivity, and contribute to sustainable agricultural practices. Despite the findings that ICT holds immense potential to transform agriculture, including tomato production, overcoming infrastructure limitations, enhancing awareness and training, and ensuring sustainability through supportive policies and investments are critical for realizing these benefits in Adamawa State which is largely rural.

However, there is need for continued investment in ICT infrastructure, farmer education, and policy support is essential to realize the full potential of ICT in transforming agriculture in Adamawa State and Nigeria as a whole.

Direction for Future Studies

Post-harvest losses are a significant challenge in tomato production, affecting both the quality and quantity of the produce. Developing an ICT-based platform or framework to manage these losses can offer innovative solutions to monitor, control, and minimize post-harvest losses. However, developing the ICT-based platform for managing post-harvest losses in tomato production presents a promising direction for future research. Such a platform has the potential to transform how farmers manage their produce, ultimately reducing waste, improving quality, and enhancing profitability. Future studies should focus on designing, testing, and refining this platform, with a strong emphasis on user-friendliness, integration with existing systems, and scalability.

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