MOTIVATIONAL FACTORS FOR SUSTAINABLE IRISH POTATO PRODUCTION: LEVERAGING EMERGING TECHNOLOGIES TO ENHANCE FARMERS' ACCESS TO INFORMATION NEEDS IN PLATEAU STATE, NIGERIA

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Abstract
Irish potato is a key contributor to global food and nutrition security. Sustainability in Irish potato production focuses on meeting current cultivation needs while preserving and enhancing resources for future use, thus promoting long-term food security. Access to information needs is vital for farmers, enabling them to obtain the necessary information to satisfy their agricultural needs. It is essential for improving farm practices, maximising profits, and enhancing livelihoods. Effective information access is especially crucial for sustainable Irish potato production, helping farmers use sustainable techniques, manage resources efficiently, and ensure healthy crop production over generations. The objectives of this study include to: identify the motivational factors that influence farmers to adopt sustainable Irish potato production in Plateau State, Nigeria; examine the role of emerging technologies (such as precision agriculture, social media, and mobile apps) in enhancing farmers' access to information needs and improving their productivity and to identify the key information needs of Irish potato farmers in Plateau State, Nigeria, and how these needs can be met through emerging technologies such as access to real-time information on best practices, weather forecasts, market prices, and pest management strategies, which are crucial for optimizing productivity and minimizing environmental impact. The study will adopt a literature review and make recommendations on strategies to integrate emerging technologies to enhance farmers' access to information needed to boost sustainable irish potato production in Plateau State Nigeria to improve food security and job opportunities.

Keywords: Access to information needs, emerging technology, farmers information needs, motivational factors and sustainable irish potato production

Introduction

The Irish potato (Solanum tuberosum) is a key contributor to global food and nutrition security, ranking fourth in human consumption after maize, wheat, and rice (F.A.O, 2023). Today, Plateau State account for over eighty per cent (80%) of Nigeria's Irish potato production. (Obi-Egbedi and Gulak, 2020). Irish potatoes offer numerous benefits, including serving as a staple food, a source of income when cultivated commercially (cash crops), and creating job opportunities. Nutritionally, they are rich in antioxidants, vitamins (B1, B2, B3, B6 which are very useful in maintaining brain and nervous system health, and C to repair the wear and tear

of the body cells), minerals (potassium, calcium, iron, magnesium, phosphorus, and sodium), and fibre, making them valuable for maintaining health, lowering blood pressure, and reducing cholesterol levels (Akinfewa, 2021).

However, Irish potato production in Plateau State faces challenges such as climate variability, pest and disease management, access to quality inputs, knowledge gaps, infrastructure, market access, financial constraints, and limited technological advancements (Adama, 2023).

Sustainability in agriculture, particularly in Irish potato production, involves using farming techniques that ensure healthy crop production for future generations while minimizing negative impacts on environmental, economic, and social aspects. Sustainable practices are crucial for the long-term sustainability of Irish potato production, including conserving water, reducing pesticide use, promoting biodiversity, and preventing soil erosion (Tijjani & Khairulmazmi, 2020).

Access to accurate and timely information is essential for achieving sustainability, and farmers can access information through extension workers, libraries, radio, television, and information and communication technologies (Ogbonna and Anunobi, 2022). Addressing challenges and adopting sustainable practices will ensure the long-term sustainability of Irish potato production in Plateau State and promote food security. The difficulty experienced by farmers in accessing relevant information hinders sustainability, leading to reduced productivity and output. Information is a vital resource for sustainable Irish potato production, alongside land, labour, capital, and skills. Farmers need agricultural information to improve farming practices, make informed decisions, and increase farm income. Effective access to information is crucial for sustainable Irish potato production, helping farmers use sustainable techniques, manage resources efficiently, and ensure healthy crop production over generations. For instance, information on soil care, irrigation management, and crop rotation is essential for maintaining soil health and conserving water (Garrido & Wyber, 2019).

The Objectives of the Study
The aim and objectives of this study is to enhance farmers' access to information needs for the sustainability of irish potato production through leveraging emerging technologies in Plateau State, Nigeria. The specific objectives are to:
1. identify the motivational factors that influence farmers to adopt sustainable Irish potato production in Plateau State, Nigeria;
2. examine the role of emerging technologies in enhancing farmers' access to information needs and improving their productivity;
3. identify the key information needs of Irish potato farmers in Plateau State, Nigeria, and how these needs can be met through emerging technologies and
4. strategies to improve farmers' access to information needs through integrating emerging technologies to boost sustainable irish potato production in Plateau State Nigeria.

Literature Review
Farmers' Motivational Factors for Adoption of Sustainable Irish Potatoes Production
Feliciano (2022) reported that, a wide range of agricultural practices that are considered sustainable consist of water conservation, input reduction, soil conservation, biodiversity conservation, adoption of renewable energy, organic farming and climate change mitigation and adaptation practices. The motivational factors that enable farmers to adopt these sustainable agricultural practices are economic factors (costs, technology, market demands);

institutional factors (regulations and land tenure); farmers' sources of information; farmers' perceptions on sustainability; farm characteristics and farmers' perceptions on climate change and climate change risks. Farmers adopt sustainable agricultural practices due to various factors, including economic, institutional, social, and environmental considerations (Feliciano, 2022; Piñeiro et al., 2020: Selahkwe et al., 2021).

Economic motivations include Cost reduction and efficiency; market demands and premium prices for sustainable products; access to technology, such as water re-utilisation and Combined Heat and Power (CHP); Increased profitability through minimized input costs and optimized resource allocation; Farm gate price and revenue. Also, the implementation of biodiversity conservation practices and their 'co-benefits' (Feliciano, 2022).

Institutional factors such as regulations and land tenure. Regulations are general rules or specific actions imposed by government agencies or private entities to enhance environmental and economic outcomes through improved practices (Piñeiro et al., 2020). Institutional factors influencing sustainable practice adoption include Regulations and land tenure; access to credits and extension services, training on farm records, fertilizer use and planting and weeding techniques. Having access to credits helps the farmers to conduct field operations on time because of being able to pay for agricultural services and inputs needed in potato production, government support and policies influence positively potato production.

Social factors motivating sustainable practice adoption include Farmers' sources of information; Access to relevant and reliable information is considered crucial for farmers' adoption of agronomic innovations including sustainable agricultural practices (Dessart et al., 2019). Informational sources and participation in knowledge networks on the adoption of sustainable agricultural practices; farmers' perceptions of sustainability and environmental consciousness; family size and availability of cheap labour; farmers' years of experience and educational level; access to information and knowledge networks. Dessart et al., (2019) found that farmers' awareness of water quality, soil erosion, and the impact of sustainable management practices on the environment often leads to the adoption of sustainable management. Environmental factors driving sustainable practice adoption include: Climate change and water scarcity; soil conservation and erosion prevention; biodiversity conservation and wildlife corridors. Overall, farmers' adoption of sustainable agricultural practices is influenced by a complex interplay of economic, institutional, social, and environmental factors. The extension services help to equip the farmers with improved technologies and innovations that improve production efficiency leading to high yields. The knowledge gained from extension agents led the farmers to adopt improved technologies and management practices which have resulted in improvements in potato yield and production. More so, Selahkwe et al,. (2021) highlighted the farmers' motivational factors as follows; number of follow-ups after training, farmers' years of experience positively and significantly motivate farmers to adopt improved technologies, farmers with higher educational levels adopt new technology quickly than those with low education level, information access channels, rural residents with higher education level are more likely to value the government information department and Internet, follow-up and access to extension facilities after training, years of potatoes farming experience, access to quality seeds and improved seed from Non-Governmental.

The Role of Emerging Technologies in Enhancing Farmers' Access to Information Needs
Precision agriculture (PA) is a modern technology to optimize agricultural practices, resulting in increased productivity while reducing costs and environmental impact. Khose et al. (2023) posited that PA is an application of principles and technologies such as data collection,

Precision farming starts with data collection, gathering information on soil characteristics, moisture levels, nutrient content, crop health, and weather patterns. This data is collected through various technologies, including soil sensors, drones, satellites, weather stations, and ground-based sensors; Data analysis, the collected data is processed and analysed using sophisticated AI-ML algorithms and advanced software. This analysis reveals patterns, trends, and correlations, enabling farmers to make data-driven decisions; Site-Specific management, based on the analysed data, farmers can adopt site-specific management practices, adjusting irrigation schedules, nutrient applications, and pest control measures according to their unique needs of each area; Automation and precision equipment, precision farming relies on advanced machinery and equipment equipped with GPS and other technologies. These tools enable precise navigation, planting, fertilization, and harvesting, reducing human error and optimizing resource utilization. It is an innovative technology that comprises the application of several Hi-tech tools like Geographical Information System (GIS), Global Positioning System, Remote Sensing, Variable Rate Technology, Decision Support System, and Farmer (Nithinkumar *et al.*, 2023).

Remote sensing; Satellite imagery and aerial drones provide real-time data on crop health, growth, and stress levels. Multispectral, thermal, and hyperspectral imaging can detect early signs of pest infestations, diseases, and nutrient deficiencies, and help to identify water-stressed areas, enabling prompt action (Caballero *et al.*, 2019).

Global positioning system (GPS); GPS technology enables precise mapping of agricultural fields and provides accurate location information for agricultural machinery. This facilitates controlled traffic farming, where the same paths are followed repeatedly, minimizing soil compaction.

Geographic information systems (GIS); GIS integrates various data layers, including satellite imagery, weather data, soil maps, and yield maps. By visualizing this data spatially, farmers gain valuable insights into field variability and can make informed decisions accordingly.

Sensors and Internet of Things (IoT); Soil moisture sensors, water quality sensors, weather stations, and crop monitoring devices continuously collect data on environmental conditions. This information aids in optimizing irrigation schedules, predicting optimal planting times, and adjusting nutrient applications. The information collected from these sensors will help to develop different prediction models, which helps farm management preciously.

Machine Learning and Artificial Intelligence (AI)
Precision farming, leveraging AI, ML, and IoT technologies, optimizes agricultural practices by enhancing water management through soil moisture monitoring and efficient irrigation systems (Khose *et al.*, 2023), improving nutrient management through soil testing and real-time sensing (Shekhar *et al.*, 2021a; 2021b), revolutionizing pest and disease management through remote sensing and targeted interventions (Khose *et al.*, 2023), and promoting crop monitoring and yield prediction through satellite imagery and advanced models (Ahmad *et al.*, 2020), ultimately leading to reduced chemical usage, soil conservation, biodiversity preservation, water conservation, and lower greenhouse gas emissions (Mekonnen *et al.*, 2019). **Smart agriculture** employs methods that differ from traditional ones, such as controlled irrigation and targeted, accurate application of herbicides and fertilizers, to increase production, decrease environmental impact, and enhance efficiency and profitability (Dhanaraju *et al.*, 2022). Artificial intelligence, big data, cloud and edge computing, smart sensors, Internet of

Things (IoT) technology, robots, drones, and artificial intelligence are the primary digital technologies enabling the development and implementation of smart agricultural systems.

Cell phones and smart mobile phones are becoming the most important tools for farmers to access agricultural-related information. Smartphones provide easy access to weather information and market data, removing technological barriers and offering user-friendly applications for operating hardware, accessing sensor data, real-time IoT solutions, cloud services, and farm management applications at affordable prices. These applications and websites can aid small-scale farmers in communication, information access, expense tracking, yield management, and farm management, ultimately leading to better decision-making, increased productivity, and higher profitability (Dhillon & Moncur, 2023).

Mobile applications according to Kamal and Bablu (2023) offer enhanced access to information, market linkages, financial services, resource management, and extension services, which collectively empower smallholder farmers and catalyse agricultural growth. Increased Access to Information such as access to real-time weather updates, up-to-date crop prices, best farming practices, and pest and disease management. Leveraging mobile applications on a smartphone with an internet connection provides access to real-time weather updates. The provision of real-time weather updates is one of the most crucial features of agricultural mobile applications, weather plays a crucial role in farming, determining the timing of planting, irrigation schedules, and the overall health of crops. Accurate forecasts enable farmers to plan planting, irrigation, and harvesting, mitigating climate-related risks; mobile applications furnish farmers with up-to-date crop prices from various markets, empowering them to make informed decisions about when and where to sell their produce. Farmers access market rates, negotiate fair deals, and maximize earnings, enhancing economic stability; The best farming practices and innovative techniques are now readily accessible through these mobile applications. Best farming practices, interactive tutorials, videos, and expert insights promote sustainable, efficient, and environmentally friendly methodologies; Pest and disease management is a constant challenge for smallholder farmers, as outbreaks can devastate entire harvests. Mobile applications have addressed this concern by providing farmers with timely and accurate information on pest identification, prevention, and control measures. Timely information on identification, prevention, and control measures protects crops and minimizes losses, farmers can make well-informed decisions to enhance productivity and achieve better crop yields. These advancements not only drive economic growth for farmers but also contribute to sustainable and resilient agriculture, supporting food security and economic development in rural communities (Maginga et al., 2022).

Financial Inclusion such as mobile banking and digital payment solutions, access to credit for essential inputs, increased financial security and stability, reduction of transaction costs; Resource Management such as farm management and resource tracking tools, optimal resource allocation and efficiency, reduced resource wastage and environmental impact, higher productivity and reduced expenses; and Extension Services for dissemination of information via text, audio, and video content, remote support and guidance for farmers, adoption of sustainable farming practices, improved productivity and income levels.

Farmers Information Needs
Irish potato farmers need access to various types of information to improve their farming practices and increase productivity as mentioned by Begna (2022): Kumar et al. (2023) and Indira et al. (2023) these include: farmers needs information on variety selection, Participatory Variety Selection (PVS) for improved crop adoption and food security; Sustainable agriculture,

farmers need information on key principles and practices for environmental stewardship, social responsibility, and economic viability; Quality seeds, farmers need information on how to access high-quality, disease-resistant seeds for better crop performance and higher productivity; Pest and disease management or monitoring to reduce crops loss, accurate information for early detection and ecological-based management; Soil health and fertility management, farmer need soil health data to manage fertilization and irrigation effectivity, information on how to maintaining soil health through testing, nutrient management, and conservation agriculture; Post-harvest handling and storage information, storage technologies and management practices to reduce losses; Climate change and weather information to forecasts planting and harvest, adaptation strategies using accurate climate data and seasonal forecasts; Market information and access to understand pricing trends and sell produce at the best rate, timely market information for informed decision-making and improved market performance.

Strategies to Improve Farmers' Access to Information Needs with Emerging Technologies.

The following are strategies to improve farmers' access to information needs through emerging technologies these include:

➢ Stakeholders in agriculture should research to identify farmers' information needs and equip them with timely information on the best internet tools to adopt for sustainable farming and agriculture information delivery.

➢ Educating and training farmers on modern agricultural technologies is crucial; this includes teaching them how to utilize mobile apps, websites, and digital tools, and developing user-friendly interfaces with follow-up support to ensure effective and sustainable adoption.

➢ Organizing ICT and agricultural information literacy training for farmers will equip them to harness the potential of internet-based information services.

➢ Providing online agricultural advisory and consultancy services in libraries and information services centres offers a valuable platform to reach farmers.

➢ The government should prioritize infrastructure investment, such as improved internet connectivity, to enhance access to internet-based services.

➢ The government should formulate policies offering incentives for technology adoption in agriculture, including providing low-cost smartphones/tablets to farmers and establishing public-access telecenters where farmers can access information at a low-cost.

➢ Developing local digital platforms, apps, and services for farmers and fostering partnerships between government, telecom providers, agri-tech companies, and non-governmental organizations can facilitate the distribution of agricultural knowledge.

Conclusion

Sustainable Irish potato production relies on access to quality, timely, accurate, and relevant agricultural information. Farmers are motivated to adopt sustainable farming practices when they see a clear economic benefit from their production efforts, as well as support from systems such as government incentives and extension services. Additionally, sustainable practices like soil health management, pest control, and efficient water use, along with the use of modern technologies and improved disease-resistant potato seed varieties, also encourage adoption.

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