Digital Information Services and Commercialisation of Research Innovations in National Root Crop Research Institute for Sustainable Irish Potato Production in Nigeria

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Abstract

The commercialization of agricultural research innovations has become increasingly important for improving agricultural productivity, food security, rural livelihoods, and sustainable economic development in developing countries. However, the commercialization of these innovations depends ssignificantly on effective digital information services that facilitate timely access to research outputs by farmers, extension personnel, agribusinesses, policymakers, and other stakeholders. This study examined the of digital information services available for transforming research outputs into accessible and usable knowledge, their contributions to sustainable Irish potato production, their role in innovation commercialization, and the challenges limiting their effectiveness. The review identified institutional repositories, digital libraries, institutional websites, electronic databases, mobile agricultural information services, e-extension platforms, social media, sensor technologies, Internet of Things applications, and virtual training platforms as important channels for agricultural knowledge dissemination and innovation development. These services support awareness creation, information dissemination and repackaging, farmer education, market linkages, technology transfer, stakeholder feedback, and innovation adoption and scaling. However, their effectiveness is constrained by inadequate digital infrastructure, poor connectivity, unreliable electricity, limited digital literacy, affordability challenges, insufficient locally relevant content, and weak institutional investment. The study concludes that strengthening digital information services within NRCRI can enhance the visibility, accessibility, transfer, adoption, and commercialization of agricultural research innovations for sustainable Irish potato production in Nigeria.

Keywords: Digital information services, commercialization of research innovations, National Root Crops Research Institute, Irish potato, sustainable agriculture.

Introduction

The global quest for sustainable agriculture is becoming increasingly important in addressing the interlinked challenges of food insecurity, climate change, environmental degradation and rural poverty. Agriculture continues to be the main pillar of the Nigerian economy and makes a significant contribution to food security, employment, livelihoods, poverty reduction and national income. (Atang et al., 2025; Uche & Eunice, 2024). Irish potato (Solanum tuberosum) is an economically and nutritionally important crop that contributes to household food security, income generation, employment, and agricultural commercialisation. Its nutritional composition, including carbohydrates, vitamins, minerals, antioxidants, and dietary fibre, further enhances its importance in human nutrition (Devaux et al., 2021; Siamalube et al., 2024; Tumuramye et al., 2025; Rahman et al., 2025). Plateau State is a major Irish potato-producing region in Nigeria because of its favourable agro-ecological conditions and substantial contribution to national production and rural economic development (Musa, 2025; Udoh et al., 2025).

Despite this importance, the Irish potato industry is facing environmental, economic, technical and institutional constraints. Climate change, rising temperatures, erratic rainfall and land degradation are threatening agricultural productivity at a global level (Chen, 2025; Naik et al., 2025), while smallholder farmers in developing countries are particularly vulnerable because of limited access to productive resources and reliable information (Touch et al., 2024). In Plateau State, farmers experience drought, flooding, temperature fluctuations, pests and diseases, inadequate access to improved seed varieties, high input costs, limited credit, inadequate extension services, insufficient market information, weak rural infrastructure, poor post-harvest management, insecurity, and low technological adoption (Goni et al., 2024; Atang et al., 2025; Kolo & Balere, 2023; Adama, 2023).

In response, the National Root Crops Research Institute (NRCRI) and other stakeholders have implemented interventions such as improved seed varieties, training of farmers, market linkage, value-added, better access to inputs and sustainable production methods such as integrated pest control and climate smart farming (Udoh et al., 2025; Idi et al., 2024; Egesi, 2023; Eche et al., 2024). However, technical inefficiencies, high production costs, lack of access to clean seeds, climate variability, poor rural connectivity, limited staff for extension, low digital literacy, language barriers and weak institutional coordination continue to hamper the effective use of agricultural innovation (Salau et al., 2020; Udoh et al., 2025; Alegwu & Yustus, 2025; Osuji et al., 2025).

Digital information services, including institutional repositories, digital libraries, mobile applications, web portals, social media, e-extension services, geo-information systems and advisory systems powered by artificial intelligence, will improve the dissemination of agricultural knowledge and communication between researchers, extension staff, farmers, policy makers and agribusinesses (Porciello et al., 2022; MacPherson et al., 2022).

In addition to dissemination, these services can support the commercialisation of research innovations by increasing the visibility, availability, transfer and market uptake of research results. Commercialization turns research findings into products, services, processes, or businesses that create economic and social value, without effective commercialisation, breakthrough ideas remain in the lab, and society misses out on improved quality of life, industry advancements, and economic prosperity (Järvinen, 2025; Organisation for Economic Co-operation and Development [OECD], 2023).

However, only limited empirical attention is paid to how digital information services facilitate the commercialisation, take-up and sustainable use of agricultural research innovations developed by NRCRI. Existing studies have focused to a large extent on technology adoption, extension services, seed systems and productivity, leaving little understanding of the strategic relationship between digital information services, the commercialisation of research and sustainable potato production in Ireland. This study therefore examines the types of digital information services and the commercialisation of agricultural research innovations, with a particular focus on the NRCRI and the sustainable production of Irish potatoes in Nigeria, their contributions, identifies the current challenges and strategies for enhancing digital information services to improve the commercialization and sustainable utilization of research innovations in Nigeria.

Types of Digital Information Services for Transforming Research Innovation

Digital information services have become fundamental components of contemporary agricultural research institutions because they facilitate knowledge organization, research dissemination, stakeholder communication, and technology transfer. The effectiveness of NRCRI research innovations, particularly those related to sustainable Irish potato production, depends largely on the availability of reliable digital platforms that enable timely access, interpretation, and utilization of agricultural information (Ayim et al., 2022; Porciello et al., 2022).

The digital information services include institutional repositories, digital libraries, electronic databases, organizational websites, e-extension platforms, mobile agricultural applications, social media platforms, virtual training systems, online market information systems, and research knowledge management platforms.

1. **Institutional repositories.** An institution's intellectual outputs, such as research articles, technical reports, conference proceedings, theses, datasets, extension publications, policy briefs, and documents pertaining to innovation, can be systematically gathered, preserved, managed, and freely distributed thru institutional repositories, which are digital platforms. For researchers, farmers, development organizations, and policymakers, they improve access to academic and agricultural information, increase institutional visibility, and preserve important research knowledge (Ghosh & Roy, 2022). By organizing and sharing pertinent agricultural knowledge, institutional repositories also aid in filling information gaps, especially in rural and underserved communities. This fosters cooperation, well-informed decision-making, and evidence-based policymaking (Bos & Munnichs, 2016). An institutional repository could serve as a centralized digital knowledge hub for the National Root Crops Research Institute (NRCRI) in order to store and distribute information on post-harvest technologies, climate-smart agriculture, pest and disease management, improved Irish potato varieties, and other research innovations. A repository like this would strengthen the connection between agricultural research, technology adoption, and the commercialization of research innovations by improving access to evidence-based information for farmers, extension agents, researchers, and commercial stakeholders (Oberhiri-Orumah & Baro, 2023).

2. **Digital libraries** are technology-enabled information platforms that provide users with seamless access to scholarly and agricultural information beyond geographical and physical limitations. Modern digital libraries are characterised by interoperability, cloud-based storage, and integrated access mechanisms that facilitate the retrieval of academic and research resources across multiple platforms (Mohammed & Teslim, 2023). Their integration with information and communication technologies, social media platforms, mobile applications,

and video-conferencing tools has further enhanced the timely dissemination and exchange of agricultural information between farmers, extension personnel, researchers, and other stakeholders. Through these platforms, farmers can access information on weather conditions, agricultural innovations, input costs, fertiliser application, production practices, and market opportunities, thereby supporting informed decision-making and knowledge sharing. Digital libraries also provide access to current information on improved crop varieties, disease management, irrigation, fertiliser application, and post-harvest technologies without geographical constraints (Mushi et al., 2022). Within NRCRI, digital library services can facilitate access to agricultural databases, scientific publications, crop production manuals, climate information, and specialised knowledge on root and tuber crops, thereby supporting research activities, strengthening staff capacity, and improving the development and dissemination of evidence-based extension materials to farmers.

3. **Institutional Websites:** Web portals are comprehensive platforms that aggregate agricultural information and extension services in one place (Rahman et al., 2021). These websites give farmers access to research papers, extension materials, videos, and e-learning modules on a range of agricultural topics. Web portals also offer interactive features such as discussion boards and live chat support, allowing farmers to interact with extension agents and agricultural experts. These platforms foster knowledge-sharing among farmers and empower them with the information they need to make informed decisions (Rahman et al., 2021). They provide official channels for disseminating information about institutional activities, research programmes, publications, technologies, training opportunities, and stakeholder engagement activities. Institutional websites are the most common digital communication platforms used by research organizations. Agricultural research institutions increasingly use websites to improve transparency, increase public awareness, and enhance access to research outputs (Ayim et al., 2022).

   A well-developed NRCRI institutional websites function as digital technology showcases where research innovations can be displayed and promoted to potential users. Information about available technologies, licensing opportunities, seed multiplication programmes, and commercialization partnerships can be strategically presented to attract private-sector participation.

4. **Electronic Databases and Research Information Systems:** Agricultural research institutions depend on databases to support literature review, technology development, policy formulation, and decision-making. According to Mohammed et al. (2021), databases are digitised information (such as bibliographic records, abstracts, full-text documents, directory entries, images, statistics, etc.). These databases are made up of uniformly formatted records that are managed by a database management system (DBMS) software and arranged for ease and speed of search and retrieval. They include full-text current and historical electronic information resources, including e-books, journal articles, and digitised items. The agricultural online databases are Access to Global Online Research in Agriculture (AGORA), The Essential Electronic Agriculture Library (TEEAL), Health Internetwork Access to Research Initiative (HINARI), Agricultural Online Access (AGRICOLA), Agricultural Database (AGRIS), and many others (Mohammed et al., 2021). These databases provide researchers with access to global agricultural knowledge resources. These platforms enable NRCRI researchers to access current scientific findings, compare production technologies, identify research gaps, and develop innovations that respond to emerging agricultural challenges. Databases containing patent information, technology profiles, market intelligence, and innovation case studies help

researchers identify commercialization opportunities and avoid infringement of existing intellectual property rights. Access to patent databases further encourages originality and supports the development of commercially competitive technologies (World Intellectual Property Organization [WIPO], 2023).

For NRCRI, strengthening access to both open-access and subscription-based agricultural databases would significantly improve research productivity, innovation development, technology commercialization, and evidence-based extension services.

5. **Mobile Agricultural Information Services:** Mobile platforms provide farmers with direct access to agricultural information through applications, SMS services, voice-based advisory systems, and mobile-based extension platforms (Ayim et al., 2022). Mobile applications such as agriBORA and ViaziSoko connect farmers to markets, weather advisories, input suppliers, credit, and crop insurance services, enhancing decision-making and productivity (Barungi et al., 2025). ViaziSoko enables farmers to access certified seeds, fertilisers, agrochemicals, mechanisation, soil testing, marketing, and extension services through its web portal, app, and USSD code. agriBORA offers agro-input lending, transaction management, and real-time crop monitoring via the web, mobile apps, and USSD. Similarly, platforms like Kisan Call Centre and mKisan provide tailored agricultural information, expert advice, and market prices, while Skymet and IMD Mausam deliver localised weather forecasts and advisories through apps and SMS. These ICT tools support smart farming by promoting best practices, reducing crop losses through real-time alerts, and aiding seasonal planning and risk management. Farmers can also use smartphones to send images of diseased plants to experts for quick diagnosis and advice (Priya et al., 2025)

   For Irish potato farmers, mobile information services can provide recommendations on seed selection, planting schedules, fertilizer application, disease identification, weather conditions, and market prices. Mobile applications can also support interactive communication between farmers and researchers by allowing users to submit questions, receive expert advice, and report production challenges. The advantage of mobile services lies in their ability to reach farmers who may have limited access to physical extension services.

6. **Electronic Extension (E-extension) Platforms:** E-extension combines digital communication technologies with traditional extension approaches to provide farmers with timely, interactive, and accessible advisory services. These platforms include online training modules, video demonstrations, virtual consultations, webinars, and digital advisory systems (Porciello et al., 2022). For NRCRI, e-extension platforms can strengthen the dissemination of Irish potato production technologies by providing farmers with practical learning resources. Video demonstrations showing improved planting methods, disease management techniques, harvesting procedures, and storage practices can improve farmers' understanding and adoption of recommended practices. E-extension also enhances feedback mechanisms between researchers and farmers. Through digital communication channels, farmers can communicate production challenges, enabling researchers to modify technologies according to farmers' realities.
7. **Social Media Platforms:** Social media platforms tools such as Facebook, Twitter, WhatsApp and Instagram provide interactive spaces where farmers can pose questions, discuss production challenges and access real-time updates on weather, prices and pest outbreaks (Ngwenya et al., 2020). Visual and audio-visual content (infographics, instructional videos) helps simplify complex technical concepts, improving comprehension among diverse user groups (Pallavi et

al., 2023). Social media platforms help farmers and other agricultural stakeholders exchange information, network, and share expertise. The platform connecting farmers with researchers and extension agents to shared information for problem-solving. These platforms foster an open and inclusive environment, allowing farmers to ask questions, discuss challenges, and access real-time information from a diverse community of users Ngwenya et al., 2020).
NRCRI can utilize social media platforms to increase awareness of Irish potato innovations, promote training activities, advertise improved varieties, and communicate market opportunities. Social media also provides opportunities for building communities of practice where farmers, researchers, extension agents, and agribusiness actors exchange experiences and knowledge.

8. **Sensor Technologies and Internet of Things (IoT):** Precision farming, sustainable resource management, and data-driven decision-making are made possible by the digital library platform. These technologies offer real-time monitoring and automation, revolutionising how farmers interact with their crops and livestock; Sensor technologies devices can collect and transmit data on various agricultural parameters. These sensors can measure soil moisture, temperature, humidity, pH levels, nutrient content, and even crop health Younis et al., (2021). Farmers can obtain comprehensive information about the state of their fields and make well-informed decisions for improved crop management by placing sensors throughout the land. The Internet of Things (IoT) connects physical devices, such as sensors and actuators, to the Internet so they may communicate data and carry out tasks without direct human intervention. In agriculture, IoT-enabled devices enable seamless data collection and communication between various components of the farming system (Kamble et al.,2022) These devices form a network of interconnected elements that continuously monitor and transmit data, providing farmers with real-time information to optimise their agricultural practices; Precision farming and resource management, Sensor technologies and IoT, monitoring soil and crop conditions in real-time. Farmers can implement site-specific management strategies, applying the right inputs at the right time and in the right quantity (Singh et al., 2020). This precision method maximises yields and Decision Support Systems (DSS), giving farmers recommendations and actionable insights while minimising resource waste and environmental impact. DSS utilises data analytics, machine learning, and artificial intelligence to process vast amounts of information and offer customised advice to farmers (Pallavi et al., 2023). These systems enhance farmers' ability to make evidence-based decisions, resulting in improved efficiency and productivity.

Digital Information Services Supporting Commercialization of Agricultural Research Innovations

The commercialization of agricultural research innovations requires more than the generation of scientific knowledge; it requires effective mechanisms for transforming research outputs into accessible, understandable, adoptable, and market-oriented technologies. Through digital platforms, research institutions can increase the visibility of innovations, reduce information barriers, facilitate technology transfer, strengthen stakeholder engagement, and create pathways for commercialization (Ayim et al., 2022; Porciello et al., 2022).

In agricultural research institutions such as the National Root Crops Research Institute (NRCRI), digital information services support this process by providing efficient channels for packaging, disseminating, and exchanging innovation-related information among researchers, farmers,

entrepreneurs, and policymakers. Consequently, digital information systems have become important components of agricultural innovation ecosystems and commercialization strategies (Mushi et al., 2022).

i. Awareness Creation and Visibility of Research Innovations

One of the primary contributions of digital information services to commercialization is the creation of awareness about agricultural research innovations. Many agricultural technologies fail to achieve widespread adoption because potential users are unaware of their availability, benefits, or application methods. Digital platforms address this challenge by increasing the visibility of innovations through institutional websites, digital repositories, social media platforms, online newsletters, mobile applications, and electronic extension systems.

For NRCRI, digital platforms can be used to promote improved Irish potato varieties, disease-resistant planting materials, climate-smart production technologies, improved storage techniques, and other research outputs. By providing detailed information about the characteristics, advantages, and availability of these innovations, digital services help farmers, seed producers, agro-dealers, and investors recognize opportunities for adoption and commercialization (Ayim et al., 2022). Digital awareness creation also expands the reach of research institutions beyond traditional extension boundaries. Conventional dissemination methods often depend on physical demonstrations, printed materials, and extension visits, which may be limited by financial and logistical constraints. Digital communication enables research institutions to reach larger and more geographically dispersed audiences at relatively lower costs (Porciello et al., 2022).

ii. Information Dissemination and Knowledge Accessibility

Effective commercialization depends on the availability of accurate, timely, and accessible information. Digital information services enhance the dissemination of agricultural knowledge by providing multiple channels through which stakeholders can obtain research-based information. These channels include digital libraries, institutional repositories, mobile advisory platforms, online databases, e-extension systems, and social media.

For Irish potato production, digital dissemination can provide farmers with information on improved varieties, seed certification requirements, planting techniques, pest and disease management, fertilizer recommendations, irrigation practices, harvesting methods, and storage technologies. Access to such information improves farmers' ability to adopt innovations correctly and achieve expected productivity outcomes. Digital dissemination also supports commercialization by reducing knowledge gaps between research institutions and agricultural enterprises. Private-sector actors such as seed companies, processors, and agro-input suppliers can access information about available technologies and establish partnerships for scaling innovations. Therefore, digital information services function as bridges connecting research outputs with commercial opportunities (Porciello et al., 2022).

iii. Information Packaging and Repackaging for Different User Groups

A major challenge in agricultural research communication is that scientific information is often produced in technical formats that may not be easily understood by farmers and other non-specialist users. According to kadikikansimba et al. (2025), Information repackaging involves reprocessing and reshaping content to make it more practical and usable for specific audiences. For smallholder farmers, this is particularly important, as they often struggle with the technical language and abstract ideas presented in agricultural research. Given their generally low and

diverse levels of formal education, simplifying complex information is essential for effective communication between researchers, extension officers, and farmers (Mushi et al., 2022). Digital information services support commercialization by enabling information packaging and repackaging according to the needs, literacy levels, and technological abilities of different audiences.

Information repackaging involves transforming complex research findings into user-friendly formats such as farmer manuals, instructional videos, infographics, podcasts, mobile messages, frequently asked questions (FAQs), and local-language materials. This process improves comprehension and increases the likelihood that users will apply recommended technologies effectively.

For NRCRI, research information on Irish potato innovations can be repackaged into practical digital resources showing farmers how to select quality seed, manage diseases, apply fertilizers, conserve soil moisture, and improve storage. Such user-oriented information products increase the usability and commercial value of research outputs because they make innovations easier to understand and adopt (Ghosh & Roy, 2022).

iv. Farmer Education and Capacity Building

Digital information services provide innovative approaches for strengthening farmers' knowledge and technical capacity. Sustainable commercialization requires users to possess the skills necessary to implement new technologies successfully. Without adequate training, even high-quality innovations may experience low adoption rates. Digital training platforms, online courses, webinars, video demonstrations, mobile learning applications, and virtual farmer field schools provide flexible opportunities for agricultural education. These approaches overcome geographical barriers and allow farmers to access training materials repeatedly according to their learning needs.

In Irish potato production, digital education can improve farmers' understanding of sustainable production practices, including integrated pest management, climate adaptation strategies, seed management, soil fertility improvement, and post-harvest handling. Improved knowledge enhances confidence in adopting innovations and increases demand for commercially available technologies.

v. Market Linkages and Commercial Opportunities

Commercialization requires effective connections between technology producers and users. Digital information services support market linkage development by connecting farmers, researchers, agribusinesses, input suppliers, investors, and consumers. Digital marketplaces, agricultural information platforms, and online business networks provide opportunities for stakeholders to identify commercial opportunities and establish partnerships.

For NRCRI innovations, digital platforms can promote linkages between improved Irish potato seed producers, farmer cooperatives, agro-dealers, processors, and commercial buyers. Such connections enhance technology availability, improve supply-chain coordination, and encourage private-sector participation in agricultural innovation commercialization.

Digital market information services also help farmers make better production and marketing decisions by providing information on commodity prices, consumer demand, input availability, and market trends. Improved market intelligence increases profitability and encourages farmers to invest in improved production technologies (Ayim et al., 2022).

vi. Accelerating Technology Transfer

Technology transfer represents a critical stage in agricultural innovation commercialization. It involves the movement of technologies, knowledge, and skills from research institutions to end-users. Digital information services accelerate technology transfer by reducing communication barriers and enabling rapid dissemination of innovations.

Through digital platforms, NRCRI can share research findings, production guides, demonstration videos, and technology descriptions with farmers and extension organizations. Digital communication also allows researchers to provide technical support after technology adoption, increasing the probability of successful implementation.

Compared with traditional technology transfer methods, digital approaches offer greater scalability because information can be distributed to thousands of users simultaneously. This capability is particularly valuable for expanding the reach of agricultural innovations across different regions of Nigeria.

vii. Feedback Mechanisms and Stakeholder Interaction

A major advantage of digital information services is their ability to support two-way communication between innovation developers and users. Traditional research dissemination often follows a linear model where researchers generate technologies and farmers receive information. Digital platforms transform this approach into interactive systems where farmers can provide feedback, report challenges, and participate in innovation improvement.

Feedback obtained through mobile applications, online discussion forums, social media, and digital surveys provides researchers with valuable information about farmers' experiences and technology performance. Such feedback supports adaptive research and ensures that innovations remain relevant to users' needs.

For NRCRI, digital interaction with Irish potato farmers can provide insights into production constraints, technology adoption challenges, seed quality issues, and market conditions. This information can guide future research priorities and improve commercialization strategies.

viii. Supporting Innovation Adoption and Scaling

The ultimate objective of commercialization is widespread adoption and scaling of beneficial innovations. Digital information services contribute to adoption by increasing awareness, improving understanding, reducing uncertainty, and providing continuous support after adoption. According to diffusion theory, access to reliable information influences users' perceptions of innovation advantages, compatibility, complexity, and applicability.

Digital platforms strengthen innovation diffusion by providing evidence of successful adoption through farmer testimonials, demonstration videos, performance data, and success stories. Such information increases trust and encourages other farmers and organizations to adopt similar technologies.

In the context of sustainable Irish potato production, digital information services can facilitate the scaling of improved varieties, climate-smart practices, disease management technologies, and post-harvest innovations developed by NRCRI.

The Role of Digital Information Services in sustainable irish potato production

Digital information services have become an increasingly important component of contemporary information and knowledge management, particularly in facilitating the generation, organisation, dissemination, and utilisation of knowledge through digital technologies (Ayim et al., 2020; Edwards, 2022).

The rapid advancement of information and communication technologies (ICTs), cloud computing, artificial intelligence (AI), big data analytics, mobile technologies, and internet-enabled platforms has fundamentally transformed how information is generated, organized, preserved, disseminated, and utilized. Consequently, digital information services have evolved from simple electronic information delivery mechanisms into strategic platforms that facilitate knowledge exchange, innovation diffusion, stakeholder engagement, and evidence-based decision-making. According to Umar and Ibrahim (2023) and Bosah et al. (2025) digital information services referred to the provision of access to information in a digital format, often through online platforms, allowing users to search, retrieve, and utilize data such as articles, documents, multimedia content, and databases for effective utilization of library resources. It is an information services provided in electronic medium to facilitate research and play a complementary role to print library resources

A. One of the major contributions of digital information services to Irish potato sustainability is improved access to agricultural extension information. Conventional extension systems in many developing countries face limitations associated with inadequate extension personnel, high operational costs, and difficulties reaching geographically dispersed farmers. Digital extension platforms complement traditional extension approaches by enabling researchers and extension agents to provide advisory services to larger numbers of farmers through mobile phones, online platforms, videos, and interactive communication channels. Evidence from low- and middle-income countries shows that digital agricultural services have primarily focused on advisory and extension functions, improving farmers' knowledge and encouraging changes in production practices (Porciello et al., 2022).

   For Irish potato farmers, digital extension services can support sustainable production by providing information on improved varieties, recommended planting dates, integrated pest and disease management, soil fertility practices, climate adaptation strategies, and post-harvest handling techniques. For example, farmers can receive digital alerts regarding disease outbreaks, weather conditions, and recommended management practices, allowing them to make timely decisions that reduce production losses. Such information improves farm resilience and contributes to sustainable intensification of potato production.

   Digital information services also enhance farmers' access to climate-smart agricultural knowledge. Climate change presents significant risks to Irish potato production through unpredictable rainfall patterns, temperature variations, drought stress, and increased pest and disease pressure. Digital climate information services provide farmers with weather forecasts, seasonal climate predictions, and risk management recommendations that support adaptation strategies. The integration of digital climate advisory services with agricultural extension can improve farmers' capacity to adjust production practices and minimize climate-related losses (Porciello et al., 2022).

B. Promotion of improved technology adoption. Agricultural research institutions such as the National Root Crops Research Institute (NRCRI) generate innovations including improved Irish potato varieties, disease-resistant planting materials, production manuals, fertilizer recommendations, and post-harvest technologies. However, the impact of these innovations

depends on effective dissemination mechanisms. Digital platforms increase the visibility and accessibility of research outputs by making technical information available to farmers, extension workers, seed companies, policymakers, and private-sector stakeholders. This reduces the knowledge gap between research institutions and agricultural communities (Ayim et al., 2022).

Digital repositories and institutional websites are particularly important for preserving and disseminating agricultural research outputs. Through these platforms, NRCRI can provide access to research publications, technical reports, training materials, extension guides, and innovation profiles related to Irish potato production. Such digital knowledge repositories enhance institutional visibility, support evidence-based farming, and create opportunities for research innovations to reach wider audiences. Open access to agricultural knowledge is increasingly recognized as a key requirement for accelerating innovation diffusion and sustainable agricultural development (Ghosh & Roy, 2022).

Digital information services also support sustainable Irish potato production through farmer education and capacity development. Many smallholder farmers require continuous training to improve their understanding of modern production practices. Digital learning platforms, online training programmes, video demonstrations, and mobile-based learning resources provide flexible opportunities for farmers to acquire new skills without the limitations of physical training sessions. These approaches are particularly valuable in rural communities where access to conventional training institutions is limited (Mushi et al., 2022).

C. Digital information services facilitate market access and commercialization opportunities for Irish potato farmers. Sustainable production requires not only increased productivity but also profitable market participation. Digital market platforms provide information about commodity prices, buyer requirements, input availability, and market trends. By improving market transparency, digital platforms reduce information asymmetry and enable farmers to make better production and marketing decisions. This connection between production information and market intelligence strengthens the commercialization potential of agricultural innovations (Porciello et al., 2022).

The role of digital information services extends beyond individual farmers to agricultural value-chain stakeholders. Seed producers, agro-input suppliers, processors, researchers, extension organizations, and policymakers can utilize digital platforms to coordinate activities, exchange information, and develop partnerships. In the case of NRCRI, digital information services can support stronger relationships between researchers, potato farmers, seed multipliers, extension agencies, and commercial enterprises, thereby creating an enabling environment for innovation commercialization.

Challenges Affecting Effective Digital Information Dissemination in Agricultural Research Institutions

Although digital information services provide significant opportunities for improving agricultural knowledge dissemination, innovation transfer, and commercialization, their effectiveness within agricultural research institutions is influenced by several technological, institutional, socioeconomic, and policy-related challenges. In developing countries such as Nigeria, the adoption of digital information services within agricultural systems remains uneven due to limitations in infrastructure, human capacity, financial investment, institutional coordination, and user accessibility. These challenges influence the ability of research institutions such as the

National Root Crops Research Institute (NRCRI) to effectively disseminate research innovations and support sustainable Irish potato production: Inadequate ICT infrastructure, Poor internet connectivity and digital access inequality, Low digital literacy among farmers and extension personnel, Limited institutional funding and sustainability challenges, Weak institutional support and policy limitations, Poor information packaging and limited localized content, Language and cultural barriers, Data quality, Reliability, and trust issues, Cybersecurity and digital data management concerns, Limited integration between research, Extension, and commercialization system (Ayim et al., 2022; Porciello et al., 2022).

Conclusion and Recommendation

The study establishes that digital information services provide opportunities for improving access to information on improved varieties, seed quality, pest and disease management, soil fertility, climate adaptation, irrigation, post-harvest handling, and market opportunities for sustainable irish potato production, and can contribute significantly to the commercialization of agricultural research innovations generated by the National Root Crops Research Institute. Despite the benefits associated with digital information services, several challenges limit their contribution to sustainable Irish potato production in Nigeria. These include poor internet connectivity in rural areas, inadequate ICT infrastructure, unreliable electricity supply, limited digital literacy among farmers, high cost of digital devices, insufficient locally relevant digital content, and weak institutional investment in digital agricultural systems. These challenges create digital inequalities that may prevent some farmers from benefiting from emerging agricultural technologies.

Addressing these challenges requires a comprehensive digital agricultural strategy that combines technological development with human capacity building and institutional strengthening. Research institutions such as NRCRI should invest in user-centred digital platforms, develop farmer-friendly information materials, provide digital literacy training, integrate indigenous knowledge into digital content, and establish partnerships with telecommunications providers, extension organizations, and private-sector actors. Such strategies will improve accessibility, usability, and sustainability of digital information services for Irish potato farmers.

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