# HUMAN COMPUTER INTERACTION: SNIPPETS FROM NIGERIA'S AGRICULTURAL SECTOR

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## ABSTRACT

*The goal of human-computer interaction (HCI) is to design systems that minimize the barrier between the human's cognitive model of what they want to accomplish and the computer's understanding of the user's task. The application of HCI systems (modern, innovative, and sustainable digital technology) in agriculture enhances precision farming by providing data-driven decisions for sustainable agricultural production. Also, the use of HCI systems in agriculture improves yields, reduces resource wastage, boosts farmers' income, simplifies operations, and provides farmers with recommendations and insights designed for specific needs or local conditions. Agriculture plays a critical role in Nigeria's economy, employing about 70 % of the labour force and contributing approximately 25 % to GDP. However, most Nigerian farmers depend on crude implements, reflecting that HCI has not significantly impacted Nigeria's agricultural sector. Nonetheless, it is important to point out that the adoption of HCI in Nigeria's agriculture is changing, with many farmers expressing willingness to pay for technology adoption. Therefore, this review provides snippets of human-computer interaction from Nigeria's agricultural sector.*

**Keywords:** Precision Agriculture, Machine learning, Artificial Intelligence, computer interaction, Sustainability, Nigeria

## INTRODUCTION

The emergence of personal computing in the late 1970s disruptively changed the perspective that only humans who interacted with computers were information technology professionals and dedicated hobbyists. Personal computing, including both personal software (productivity applications, such as text editors and spreadsheets, and interactive computer games) and personal computer platforms (operating systems, programming languages, and hardware), made everyone in the world a potential computer user, and vividly highlighted the deficiencies of computers with respect to usability for those who wanted to use computers as tools (Andurkar & Andurkar, 2015). Human Computer Interaction (HCI) as a research and practice emerged within the early 1980s, initially as a speciality area in computing embracing science and human factors engineering, but has rapidly extended steadily over 3 decades, attracting professionals from many other disciplines and incorporating diverse concepts and approaches. Sometimes, HCI is also referred to as man—machine interaction (MMI) or computer—human interaction (CHI). HCI is a multidisciplinary field (e.g., engineering, psychology, ergonomics, design) that deals with the theory, design, implementation, and evaluation of the ways that humans use and interact with computing devices (Kim, 2015).

HCI is the study of how people communicate with computers and to what extent computers are developed for effective human interaction (Saini *et al.,* 2020). Furthermore, we can define HCI as the area of study where only the approaches, principles, and techniques are applied to build a user-friendly interface between people and computers (Jyoti & Kaur, 2023). Therefore, HCI as a design aims to create a fit between the user, the machine, and the necessary services in order to achieve certain performance in terms of the quality and efficiency of the services.

The use of HCI systems in agriculture improves yields, reduces resource wastage (Adediran et al., 2024), boosts farmers' income, and provides farmers with specific recommendations and insights designed for specific needs or local conditions (Asolo et al., 2024; Avasthi et al., 2025). Some of the applications and initiatives of HCI in agriculture are crop pest and disease detection, crop management practices (Adediran et al., 2024; Chowdhury et al., 2025; Hillary et al., 2025; Miller et al., 2025; Patil et al., 2023); soil quality monitoring such as soil nutrient analysis, soil microbial analysis, soil pollution, assessment of soil moisture (Folorunso et al., 2023; Jay et al., 2021; Larson et al., 2023; Pace et al., 2025; Reza et al., 2025); soil mapping and land use planning (Chattaraj et al., 2025; Louzada et al., 2025; Pham, & Nguyen, 2024); mobile applications and platforms that link farmers, policymakers, and researchers to offer digital extension tools and/or advisory services on weather patterns, market prices, and government policies (Dissanayake & Jayasinghe, 2025; Soni et al., 2025); livestock diet formulation (Saxena & Parasher, 2019), prediction of genetic merit, animal welfare/health management- early warning signals for prevention and control of highly infectious diseases, commercial dairy (De Vries et al., 2022; Oseni, 2024).

Agriculture plays a critical role in Nigeria's economy, employing about 70 % of the labour force and contributing approximately 25 % to GDP (Adenekan et al., 2019; Oxford Business Group, 2025). However, most Nigerian farmers (70 % of the farmers) depend on crude implements, reflecting that modern, innovative, and sustainable digital technology (HCI) has not significantly impacted Nigeria's agricultural sector (Onomu & Aliber, 2024; Samaila,2025). Nonetheless, it is important to point out that the adoption of HCI in Nigeria's agriculture is changing, with many farmers expressing willingness to pay for technology adoption. Therefore, this review provides snippets of human-computer interaction from Nigeria's agricultural sector.

## METHODOLOGY

A narrative literature review was employed in this study using Google Scholar and Scopus search engines, as well as tools like CORE, BASE, and ResearchGate. Our search strategy included the use of Boolean operators (AND, OR, and NOT) with keywords such as precision agriculture, machine learning, artificial intelligence, human-computer interaction, sustainability, Nigeria, wireless sensor networks (WSN), internet of things (IoT), deep learning, and robotics. The authors did not limit the literature to the year of publication. The literature reviewed was an overview of human-computer interaction, human-computer interaction in Nigeria's agricultural sector, and challenges with human-computer interaction.

## OVERVIEW OF HUMAN COMPUTER INTERACTION

Human-computer interaction researchers observe the ways humans interact with computers, and they design technologies that let humans interact with computers in novel ways (Saini *et al.,* 2020). HCI focuses not only on enhancing the usability, reliability, and functionality of present-day interfaces but also on the development of novel, innovative interfaces that can be used in natural, lifelike ways (Chakraborty *et al.,* 2018).

The most significant benefit of implementing human-computer interaction is the creation of more user-friendly applications - computers and systems are made more responsive to the user's needs, resulting in a better user experience (Saini *et al.,* 2020). More cost-effective and reliable HCI-based systems are increasingly appearing and becoming part of our everyday lives. The advancement in HCI has made it possible to interact with computers using voice commands, touchscreen, eye movement, and hand gestures (Hasan & Yu, 2017).

Some of the latest developments in hardware and software for HCI in various areas include specialized input/output devices, virtual or augmented reality, and wearable technology. The HCI industry is evolving rapidly and is so fascinating that it has contributed to the development of some of our most cherished creations, like virtual reality, self-driving cars, personal digital assistants, biometric authentication, and touch screen technologies (Hasan & Yu, 2017; Jyoti & Kaur, 2023). In the desktop computing HCI, many areas, e.g., real-time translation of one natural language into another, object recognition from images, low-cost virtual studio, On the other hand, for mobile computing, e.g., eye movement tracking, hand gesture recognition, obtaining heart rate by putting a finger on the touchscreen for some time, starting a vehicle remotely, feedback on driving behaviour, augmented reality headset for vehicle e.g., engine maintenance, fully autonomous car, etc. (Hasan & Yu, 2017). For people with disabilities, such systems will increasingly be able to provide a full life in the future, significantly improving their quality of life (Katona, 2021). Other achievements in HCI include:

- Systems based on gesture control or eye movement tracking may allow some functions of the mouse or keyboard to be triggered or replaced (Sziladi et al., 2017).
- The use of an armband called Myo by visually impaired people can use this device as a kind of support tool in their everyday lives (Csapo et al., 2016).
- Self-developed system for replacing computer input peripherals (keyboard and mouse) using eye path tracking (Zsolt et al., 2012).

- Examining eye movement parameters in the context of the acquisition of IT skills (Ujbanyi et al., 2016). The results obtained show that differences in gaze movement can be detected in students with different levels of knowledge, from which conclusions can be stated and related to effectiveness, success or failure of learning.

Jyoti and Kaur (2023) outlined the following as applications of HCI: *multimodal systems for people with disabilities; multimodal systems for emotion recognition; multimodal applications based on maps; and medicine with multi-modal HCI.* Gesture recognition is an important area for development in HCI systems (Chakraborty *et al.,* 2018). These systems can be broadly classified based on their number of channels as unimodal or multimodal. *Unimodal systems* can be: a) vision-based (e.g., body movement tracking, facial expression recognition, gaze detection, and gesture recognition; b) audio-based (e.g., auditory emotion recognition, speaker recognition, and speech recognition); or c) other types of sensors.

*Multimodal interfaces* can be set up using combinations of inputs, such as gesture and speech or facial pose and speech (Oviatt, 2007; Jiang et al., 2010). A multimodal interface offers a promising solution by allowing users to interact with programming tools using multiple sensory and input channels—such as speech, gestures, touch, audio, and haptic cues. By integrating these modalities, learning becomes inclusive and adaptable to the needs of diverse learners. A multimodal interface can be designed to facilitate programming education for people with disabilities. It examines accessibility challenges, design considerations, and implementation strategies for inclusive programming environments.

In augmented reality (AR) and virtual reality (VR), multimodal interaction is essential for creating immersive environments, e.g. VR/AR systems leverage speech, gestures, and eye-tracking to allow users to navigate virtual spaces seamlessly and interact naturally with digital objects (Dritsas et al., 2025). Brain-computer interfaces (BCIs) are becoming integral to future multimodal systems, which offer the potential to capture neural activity directly from the brain, creating a new modality that allows users to control systems using thought alone (Dritsas et al., 2025). For example, BCIs could enhance accessibility for individuals with severe physical disabilities, allowing them to control devices or communicate through a combination of brain signals and other multimodal inputs (Kim et al., 2021; Tang et al., 2023; Wen et al., 2020; Won et al., 2020).

Studies (Sargsyan, 2024; Ren et al., 2025; Ricci et al., 2025; Tzimos et al., 2025) have explored the field of orientation and mobility training, technologies with haptic interaction to assist individuals with visual impairments in learning how to navigate safely and effectively using the sense of touch. Chandler et al (2022) worked on Brain Computer Interfaces and Communication Disabilities.

## SNIPPETS OF HUMAN COMPUTER INTERACTION FROM NIGERIA'S AGRICULTURAL SECTOR

The snippets of human-computer interaction from Nigeria's agricultural sector is presented in Table 1. Ozor et al. (2024) used artificial intelligence and IoT technology to enhance the production, management and marketing of crops such as the Nsukka Yellow Pepper (*Capsicum Chinense Nsukkadrilus*). Similarly, Usip et al. (2022) developed a machine learning-based mobile chatbot for crop farmers to obtain valuable answers to questions, advice and recommendations on specific farming practices. On the other hand, Danis et al. (2011) developed a mobile phone service that assists Nigerian Farmers on what crops to plant, management practices for their crops, as well as the market for their produce.

James et al. (2022) implemented IoT technology in agricultural processes. Likewise, Lawal et al. (2025) used artificial intelligence in the food processing industry to optimize operations across the value chain - from raw material sourcing to final distribution. Emmanuel et al. (2024) reported the use of artificial intelligence, big data, drones, and robots to enhance productivity and profitability in animal husbandry and crop production. The implementation of robotics, Global Position System (GPS) Technology, the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain technology in agricultural production systems in Nigeria were suggested in the review of Olajide et al. (2025).

The study of Augustine et al. (2020) pointed out the use of drones for soil management, aerial planting, and crop management, like irrigation, spraying, and crop health monitoring in Nigeria. Mba et al. (2024) applied advanced machine learning and deep learning models for the prediction of soil physico-chemical characteristics. In the livestock sector, Oseni et al. (2025) used sensor nodes on a commercial broiler farm to monitor key health and welfare parameters by tracking ambient factors. Also, Olaniyi et al. (2019) implemented a remote monitoring and control system for poultry feed dispensing in a deep litter poultry farm.

**Table 1: Snippets of Human-Computer Interaction from Nigeria's Agricultural Sector**

| S/N | Author(s) | HCI Implementation in Nigeria's Agricultural Sector |
|---|---|---|
| 1 | Augustine et al., 2020 | The use of drones for soil management, aerial planting, and crop management like irrigation, spraying, and crop health monitoring. |
| 2 | Danis et al., 2011 | A mobile phone service that assists Nigerian Farmers on what crops to plant, management practices for their crops as well as market for their produce. |
| 3 | Emmanuel et al., 2024 | The use of artificial intelligence, big data, drones, and robots to enhance productivity and profitability in animal husbandry and crop production. |
| 4 | James et al., 2022 | IoT technology in agricultural processes |
| 5 | Lawal et al., 2025 | The use of artificial intelligence in food processing industry to optimize operations across value chain - from raw material sourcing to final distribution. |
| 6 | Mba et al., 2024 | Application of advanced machine learning and deep learning models for prediction of soil physico-chemical characteristics. |
| 7 | Olajide et al., 2025 | Robotics, Global Position System (GPS) Technology, the Internet of Things (IoT), Artificial and Intelligence (AI), and block chain technology in agricultural production systems |
| 8 | Olaniyi et al., 2019 | Remote monitoring and control system for poultry feed dispensing in a deep litter poultry farm. |
| 9 | Oseni et al., 2025 | The use of sensor nodes on commercial broiler farm to monitor key health and welfare parameters by tracking ambient factors. |
| 10 | Ozor et al., 2024 | The use of artificial intelligence and IoT technology to enhance the production, management and marketing of Nsukka Yellow Pepper – NYP (*Capsicum Chinense Nsukkadrilus*). This included collection of datasets for early disease detection, soil nutrient monitoring, enhance water conservation through smart irrigation, and provision of extension services to farmers. |
| 11 | Usip et al., 2022 | Development of machine learning-based mobile chatbot for crop farmers to obtain valuable answers to questions, advice and recommendations on specific farming practices. |

## CHALLENGES WITH HUMAN COMPUTER INTERACTION

The design and implementation of efficient, reliable, understandable and manageable HCI-based systems requires understanding human behaviour, human limits, human needs, and human cognition (Torok, 2016; Katona, 2021). The implementation HCI in Nigerian agriculture is hindered by data quality issues, inadequate policy support, limited infrastructure- limited access to electricity and network/ connectivity challenges (Olajide et al., 2025; Lawal et al., 2025), economic feasibility/resource scarcity and inadequate technical expertise (Emmanuel et al., 2024; James et al., 2022), lack of awareness, data privacy/security concerns, ethical considerations and legal problems (Ade-Ibijola & Okonkwo, 2023; James et al., 2022; Olagunju, 2024; Lawal et al., 2025).

Generally, Tencent (2025) outlined the following as challenges and problems of human-computer interaction:

***Understanding User Needs***: One of the primary challenges is accurately understanding and predicting user needs and behaviours. This requires extensive user research and testing. Example: Designing a new smartphone interface might require understanding how users currently interact with their devices and predicting how they might want to use new features.

***Accessibility:*** Ensuring that technology is accessible to all users, including those with disabilities, is a significant challenge. Example: Developing a website that is accessible to visually impaired users involves using proper contrast ratios, alt text for images, and screen reader compatibility.

***Complexity:*** As technology becomes more advanced, it can become increasingly complex, making it difficult for users to understand and use. Example: Setting up a home automation system can be complex for users who are not tech-savvy.

***Security and Privacy***: Balancing the convenience of technology with the need to protect user data and privacy is a constant challenge. Example: Implementing two-factor authentication adds a layer of security but can also be seen as an inconvenience by some users.

***Interoperability:*** Ensuring that different systems and devices can communicate and work together seamlessly is a challenge. Example: Integrating various smart home devices from different manufacturers can be difficult due to differing protocols and standards.

***User Experience (UX) Design***: Creating an interface that is both functional and enjoyable to use requires a deep understanding of design principles and user psychology. Example: Designing a mobile app that is intuitive and provides a seamless user experience involves careful planning and iteration.

***Feedback and Iteration:*** Gathering user feedback and continuously iterating on designs is crucial, but can be time-consuming and resource-intensive.

On the other hand, Hasan and Yu (2017) reported that the increasing influence of HCI has led to ethical considerations, which include:

*Bias and Fairness*: As AI and machine learning play a larger role in HCI, it is crucial to ensure that AI-driven interactions are fair and unbiased.

*Privacy and Confidentiality*: Researchers must protect the privacy of participants, especially when collecting personal data or using pervasive sensing technologies. This involves transparent data practices and obtaining informed consent.

*Harm and Welfare*: Research must maximize benefits while minimizing potential risks of physical, psychological, or social harm to participants, including vulnerable populations.

*Transparency and Trust*: For technologies like AI, researchers need to design transparent systems and interaction models that build and maintain user trust.

## CONCLUSION

This study revealed that HCI is a multidisciplinary field that deals with the theory, design, implementation, and evaluation of the ways that humans use and interact with computing devices. HCI aims to produce a world in which interacting with computers is easier and richer. The snippets of human computer interaction from Nigeria's agricultural sector show that artificial intelligence, IoT technology are used to enhance the production, management and marketing of crops; a machine learning-based mobile chatbot is used in Nigeria for farmers' crop advisory/management. Likewise, artificial intelligence is used for the food processing industry to optimize operations across the value chain - from raw material sourcing to final distribution. Furthermore, artificial intelligence, big data, drones, and robots are used to enhance productivity and profitability in animal husbandry and crop production.

Drones are currently used for soil management, aerial planting, and crop management, like irrigation, spraying, and crop health monitoring. Machine learning and deep learning models are used for the prediction of soil physicochemical characteristics. In the livestock sector, sensor nodes are used in commercial broiler farms to monitor key health and welfare parameters by tracking ambient factors. Nonetheless, the implementation of HCI in Nigerian agriculture is hindered by data quality issues, inadequate policy support, limited infrastructure, limited access to electricity and network/ connectivity challenges, economic feasibility/resource scarcity and inadequate technical expertise, lack of awareness, data privacy/security concerns, ethical considerations and legal problems.

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