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Farming in the digital age: Unleashing the power of farming as a service (FaaS)

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Abstract

Farming as a Service (FaaS) is a modern agricultural approach that uses advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and precision farming to achieve optimal crop yields, enhance sustainability, and address global food security challenges. Fundamental components of FaaS include precision agriculture, IoT integration, livestock monitoring, and supply chain optimization. These components use technologies like satellite imagery, GPS, sensor networks, and blockchain to improve efficiency in agricultural supply chains and promote sustainable farming practices. Satellite imagery and blockchain improve decision-making processes, while precision agriculture and IoT integration enable real-time monitoring and management. FaaS offers many benefits, including heightened productivity, increased resource efficiency, and equitable access to advanced farming technologies. It particularly benefits small-scale farmers who may lack the financial means to invest in expensive equipment. However, FaaS adoption faces challenges such as initial investment barriers, concerns about data security, the imperative for technological literacy, and the necessity for customized ICT strategies tailored to diverse farming communities. Looking towards the future, FaaS will continue to evolve by incorporating technologies like blockchain for transparent supply chains, 5G connectivity for real-time data transfer, and further integration of IoT devices. This future trajectory is expected to be supported by Decision Support Systems (DSS) and Information and Communication Technology (ICT), crucial in bridging the digital divide and fostering sustainable agriculture practices. Ultimately, FaaS is positioned as a transformative force poised to bring about efficiency, sustainability, and inclusivity in modern agriculture.

Keywords: Decision support systems, FaaS, IOT, precision agriculture

1. Introduction

Farming as a Service (FaaS) is a concept similar to smart farming, focusing on precision agriculture through data collection and management for optimal growth environments. FaaS technology is essential for farm cloud services, offering pest management, growth management, and resource management based on analysis from IoT devices (Singh *et al*., 2022) [16]. Developing a cloud-based precision agriculture management system aims to overcome information imbalances, resolve price barriers, and establish environmentally friendly practices and revenue models.

Traditional farming practices, such as agroforestry, intercropping, crop rotation, cover cropping, and organic composting, have been crucial for centuries, promoting sustainable food production and environmental conservation (Hua *et al*., 2023) [9]. These practices enhance soil fertility, sequester carbon, optimise resource use, maintain biodiversity, and ensure sustainability (Bilotta *et al*., 2023) [5]. Despite facing challenges like slash-and-burn farming and pesticide use, which have negative environmental impacts, traditional agricultural knowledge persists and is passed down, enhancing farming system resilience. Future efforts should focus on innovative strategies to promote sustainable agriculture, address the challenges of feeding a growing population, and mitigate climate change (Pechlivani *et al*., 2023) [15].

Farming as a Service (FaaS) is a concept from Agriculture 4.0, using digital technologies to optimise crop yields and sustainability (Singh *et al*., 2022) [16]. It relies on real-time data from remote sensing and digital tools for decision-making, enabling precision farming. FaaS integrates AI algorithms and user-friendly interfaces for proactive pest and nutrient management, offering new opportunities for sustainable farming (Gebresenbet *et al*., 2023) [8].

Technological integration in modern agriculture, including IoT, smart sensors,image processing, data analytics, artificial intelligence, and machine learning, addresses challenges like water scarcity and pests while improving productivity (Bretas *et al*., 2023) [6]. These technologies enable intelligent agriculture systems, aiding in crop monitoring, animal production, food safety, and farm management. ICT in agriculture facilitates data compilation and knowledge exchange, while integrating robotics, geospatial systems, and AI enhances production efficiency and decision support (Aleluia *et al*., 2023) [3]. This integration enables on-demand production and distribution, digitising rural industries, and transforming rural areas. Motivations for farming as a service stem from economic factors, environmental concerns, and addressing global food security (Akudugu *et al*., 2023) [2]. Farmers are driven by cooperative services offering opportunities for improvement, market guarantees, and agency rules.

Adopting sustainable intensification practices offers personal satisfaction, eco-diversity, and eco-efficiency. Technology-enabled services enhance economic sustainability, food security, and data-driven decision-making (Menon *et al*., 2023) [13]. The Chinese socialised agricultural service system has notably boosted production efficiency and met food needs (Myalo *et al*., 2023) [14]. Overall, motivations for farming as a service emphasise efficiency, cost-effectiveness, sustainability, and global food security (Singh *et al*., 2022) [16].

As the global population continues to grow, innovative strategies that blend traditional practices with modern technological solutions are essential. The future of sustainable agriculture lies in addressing the dual challenges of feeding the world and mitigating climate change impacts. Farming as a Service offers a promising pathway by providing scalable, cost-effective solutions that emphasize environmental care and resource management. This synergy not only enhances agricultural productivity but also ensures sustainability and resilience in food systems worldwide. The objective of the current study is to critically examine the following objective.

To critically examine the role and impact of farming as a service in the context of digital agriculture.

Materials and Methods

The study relies primarily on secondary sources of data. Data from secondary sources include journal articles, books, reports, and research works.

The genesis of farming as a service (Faas)

Farming as a Service (FaaS) has emerged as a means to ensure sustainability and improve productivity in agriculture. FaaS combines technology-driven innovations with best farming practices to enhance food security and eliminate poverty and hunger (Singh *et al*., 2022) [16]. It involves using relevant technology-enabled services to enable data-driven decision-making by various stakeholders such as farmers, agri-businesses, and agri-tech start-ups. Smart Farming, a critical component of FaaS, utilizes integrated technologies to increase feed and food production, predict diseases, and monitor plant growth cycles. Artificial intelligence (AI) and remote-sensing technologies, including drones, are crucial in implementing FaaS and improving agriculture efficiency. Using edge computing and service offloading techniques further optimizes the performance of real-time controls and overall edge services in smart Farming (Myalo *et al*., 2023) [14]. The concept of FaaS also extends to the maintenance and repair of agricultural machinery, aiming to improve efficiency and reduce costs.

Critical components of FaaS

Farming as a Service (FaaS) encompasses various key precision farming components. Satellite imagery provides valuable information about crop health, soil moisture, and vegetation indices, enabling farmers to monitor and manage their fields more effectively. GPS technology allows for precise positioning and mapping, facilitating accurate field measurements and targeted application of inputs. Sensor networks collect real-time data on soil moisture, temperature, and other environmental factors, providing farmers with insights to optimize irrigation and nutrient management (Ingle *et al*., 2023) [11]. These components of precision farming contribute to the digitization of agriculture and enable farmers to make informed decisions for sustainable and efficient farming practices (Tejaswi *et al*., 2023) [18].

Precision agriculture

Precision agriculture is a management approach that uses technology to optimize crop production and improve efficiency. It involves the use of satellite and computer technologies, the Internet of Things (IoT), and wireless sensor networks (WSN) to gather real-time information about environmental aspects, crop development, soil quality, and nutrient content. This information is analyzed using predictive analytics to make informed decisions about irrigation, pest management, fertilizer application, and crop yield optimization (Ingle *et al*., 2023) [11]. Precision agriculture techniques include irrigation, crop monitoring, crop protection, soil monitoring, and reduced labour costs. The implementation of precision agriculture has shown significant advancements, resulting in the development of precision agriculture apps that allow farmers to monitor and manage their crops remotely. Overall, precision agriculture plays a crucial role in enhancing crop yields, cutting expenses, and increasing productivity in the agricultural industry.

Iot integration

Technological integration in Farming Farming involves the core technologies of IoT, AI, robotics, and data analytics. These technologies are applied in various aspects of Farming to enhance productivity and efficiency. For example, in the agricultural field, IoT and AI are used for intelligent Farming, where smart sensors with AI capabilities offer sensor-based devices and equipment for crop monitoring and management (Kumar *et al*., 2022) [12]. Data analytics is used to analyze and control water consumption, temperature, humidity, and soil conditions to improve plant growth. Additionally, the integration of IoT, big data, and cloud computing plays a vital role in agriculture by facilitating connectivity, availability of data, and catering to various user needs (Bhanumurthy *et al*., 2022) [4]. The integration of these technologies enables resource optimization, decision-making support, and awareness of crop, land, weather, and market conditions for farmers.

Livestock monitoring and management

FAAS technologies, such as precision livestock farming (PLF) and the Internet of Things (IoT), are being applied to livestock farming to improve monitoring and management. PLF techniques, including machine learning, remote sensing, and precision agriculture technologies, automate data collection and support on-farm decision-making. IoT-based systems using sensors and devices collect data on environmental conditions, animal behaviour, and crop health, then process and transmit to a cloud-based platform for analysis (Castagnolo *et al*., 2023) [7]. These technologies offer benefits such as improved animal welfare, early detection of health issues, increased productivity, and reduced costs. However, there are challenges to implementing FAAS in livestock management, including the need for reliable reference data, variability in datasets, battery life of devices, and computational costs. Overcoming these challenges requires collaboration between farmers and researchers, software development, and further research and development.

Supply chain optimization

Farming as a Service (FaaS) is a concept that contributes to improving efficiency in agricultural supply chains. Using digital marketplaces, FaaS connects farmers with consumers, creating a direct and efficient channel for the exchange of agricultural products. For example, Tudouec, a potato e-commerce platform in Inner Mongolia, China, is a multi-functional platform that enhances supply chain capabilities by interacting information flow with capital and material flows (Huang and Lian (2024)) [10]. Additionally, blockchain technology in supply chain management (SCM) can optimize and reconfigure the agricultural supply chain. Blockchain-based digital twin solutions can promote the digitization and intelligence of SCM, resulting in time and energy savings. These advancements in supply chain optimization, such as FaaS and blockchain-based solutions, enable better coordination between farmers and service providers, leading to improved efficiency in agricultural supply chains.

Benefits of farming as a service (FAAS) (Abdullah *et al*., 2023) [1].

- It enables farmers to optimize their processes, leading to increased productivity. Precision farming and automation reduce resource wastage and human errors, allowing for more efficient use of land, water, and inputs.
- FaaS promotes sustainable farming practices by emphasizing resource efficiency and environmental conservation.
- Intelligent irrigation systems can significantly reduce water usage, while predictive analytics help minimize the use of pesticides and fertilizers.
- FaaS has the potential to democratize access to advanced farming technologies.
- Small and medium-sized farmers who may not have the financial means to invest in expensive equipment can benefit from FaaS on a subscription or pay-per-use basis, making technology more accessible.

Challenges in the adoption of FaaS

Adopting Farming as a Service (FaaS) in agriculture faces several challenges and considerations.

- The initial investment required for implementing advanced technologies can be a barrier for some farmers, and financial incentives and support from governments and private stakeholders are needed to encourage adoption (Menon *et al*., 2023) [13].
- Data collection and utilization in FaaS raises concerns about data security and privacy, highlighting the need for robust cyber security measures and ethical guidelines to protect sensitive agricultural information (Kumar *et al*., 2022) [12].
- Technological literacy is crucial for the success of FaaS, and initiatives for training and education are necessary to ensure that farmers can effectively use and maintain advanced technologies (Talero *et al*., 2023) [17].
- Additionally, interoperability, diversity in farming practices, and farmer capacitation are challenges to adopting Smart Farming solutions, which require customized ICT adoption strategies for different types of farmers.

The future of FaaS

Farming as a Service (FaaS) is a transformative approach in agriculture that aims to enhance efficiency, sustainability, and accessibility. With technological advancements, FaaS is expected to evolve further by incorporating innovations such as blockchain for transparent supply chains, 5G connectivity for real-time data transfer, and Internet of Things (IoT) device integration. Decision Support Systems (DSS) play a critical role in collecting and analyzing data for FaaS, utilizing real-time data from various digital and space-based technologies. These DSSs incorporate artificial intelligence algorithms and user-friendly interfaces to enable timely interventions and well-informed decision-making processes. (Pechlivani *et al*., 2023) [15] Information and communication technology (ICT) can also bridge the digital divide faced by smallholder farmers, promoting sustainable agriculture and supporting their adoption of agricultural socialized services. Agricultural social networks (ASNs) are also crucial in digitalizing the agricultural value chain, enabling an inclusive digital economy and contributing to sustainability.

Conclusion

Farming as a Service (FaaS) is a potent force in revolutionising agriculture through IoT, AI, and precision farming. It promises enhanced crop yields, sustainability, and food security. FaaS integrates precision agriculture, IoT, livestock monitoring, and supply chain optimisation, leveraging technologies like satellite imagery and blockchain. Despite challenges such as initial investments and data security, FaaS offers increased productivity and accessibility to advanced technologies. Future enhancements include blockchain transparency, and IoT integration, aided by decision support systems and ICT for sustainable agriculture.

References

1. Abdullah FY, Yaseen MT, Sheet YS. Smart Eco-Friendly and Low-Cost Farming Control System. In: Proceedings of the 5th International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA); c2023. p. 1-5.
2. Akudugu MA, Nkegbe PK, Wongnaa CA, Millar KK. Technology adoption behaviors of farmers during crises: What are the key factors to consider? J Agric Food Res. 2023;14:100694. https://doi.org/10.1016/j.jafr.2023.100694.
3. Aleluia VM, Soares VN, Caldeira JM, Gaspar PD. Livestock Monitoring Prototype Implementation and Validation. Rev Inform Teor Aplicada. 2023;30(1):53-65.
4. Bhanumurthy Y, Haq SE, Anne K, Melingi SB. Integration of Artificial Intelligence and IoT on

Agricultural Applications. In: Proceedings of the Intelligent Systems for Social Good: Theory and Practice. Singapore: Springer Nature Singapore; 2022. p. 29-38.
5. Bilotta G, Genovese E, Citroni R, Cotroneo F, Meduri GM, Barrile V. Integration of an Innovative Atmospheric Forecasting Simulator and Remote Sensing Data into a Geographical Information System in the Frame of agriculture 4.0 Concept. Agri. Engineering. 2023;5(3):1280-1301. http://dx.doi.org/10.3390/agriengineering5030081.
6. Bretas IL, Dubeux Jr JC, Cruz PJ, Oduor KT, Queiroz LD, Valente DS. Precision livestock farming applied to grazing land monitoring and management–a review. Agron J. 2023;24:1638–1662.
7. Castagnolo G, Mancuso D, Porto SM. Cow Behavioural Activities in Extensive Farms: Challenges of Adopting Automatic Monitoring Systems. Sensors. 2023;23(8):3828.
8. Gebresenbet G, Bosona T, Patterson D, Persson H, Fischer B, Mandaluniz N, *et al*. A concept for applying integrated digital technologies to enhance future innovative agricultural systems. Smart Agric Technol. 2023;5:100255.
9. Hua J, Wang H, Kang M, Wang X, Guo S, Chang F, *et al*. The design and implementation of a distributed agricultural service system for smallholder farmers in China. Int. J Agric Sustainability. 2023;21(1):2221108.
10. Huang M, Lian J. Research on the optimization of the path of the agricultural logistics industry under the innovative mode of “blockchain + supply chain finance”. Apply Math Nonlinear Sci. 2024;9(1). https://doi.org/10.2478/amns.2023.1.00265.
11. Ingle A, Gupta P, Gaikwad N, Bhatye S. Precision Agriculture Application using Machine Learning. Int. J Adv. Res Sci. Commun Technol. 2023;3(7):1–8. DOI: 10.48175/jars-9463.
12. Kumar A, Gupta DN, Kumar R. Integration Aspects of AI, IoT, Big Data, and Blockchain in Healthcare Industry. In: Transformation in Healthcare with Emerging Technologies. 2022. p. 81–104.
13. Menon K, Umrani FA, Baqai A, Syed ZS. A Review Based On Comparative Analysis of Techniques Used in Precision Agriculture. In: Proceedings of the 4th International Conference on Computing, Mathematics and Engineering Technologies (iCoMET); c2023. p. 1–7.
14. Myalo OV, Prokopov SP, Myalo VV, Maltseva EI. Concept for the formation of technical service of agricultural machinery in Western Siberia. In: E3S Web of Conferences. 2023;392:01044.
15. Pechlivani EM, Gkogkos G, Giakoumoglou N, Hadjigeorgiou I, Tzovaras D. Towards Sustainable Farming: A Robust Decision Support System’s Architecture for Agriculture 4.0. In: Proceedings of the 2023 24th International Conference on Digital Signal Processing (DSP); c2023. p. 1–5.
16. Singh C, Khilari SH, Nair AN. Farming-as-a-service (FAAS) for a sustainable agricultural ecosystem in India: design of an innovative farm management system 4.0. In: Digital Transformation and Internationalization Strategies in Organizations; c2022. p. 85–123.
17. Talero L, Parra-Sanchez D, Lamos D. Opportunities and Barriers of Smart Farming Adoption by Farmers Based on a Systematic Literature Review. In: Proceedings of the International Conference on Innovation, Documentation and Education; 2023. p. 53-64. DOI:10.4995/INN2022.2022.15746.
18. Tejaswi K, Jyothi BN, Jabbar MA, Vasavi B, Begum R. An insight into applications of IoT in the Agricultural Sector. In: Emerging Trends, Techniques, and Applications in Geospatial Data Science. IGI Global; 2023. p. 96-112. https://www.igi-global.com/chapter/an-insight-into-applications-of-iot-in-the-agricultural-sector/322476.