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Technology Application in Social Funding for Agriculture: A Compressive Structured Review

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ABSTRACT

The incorporation of technology holds enormous potential to revolutionize farming techniques and enhance overall production in the continually changing field of agriculture. This comprehensive structured review delves into the realm of “Technology Application in Agriculture Funding,” with the goal of shedding light on the present situation, challenges, and opportunities in leveraging technology for agricultural financing. The objective of this review is to critically assess the current state, challenges, and opportunities in applying technology to agricultural funding. This study used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) approach by analysing a comprehensive selection using advanced searching approached on Scopus and Web of Science database. It was found that final primary data (n = 27) was analysed employing keywords such as funding, agricultural financing, waqf, agriculture, technology, and digital. Expect validation is divided into four themes: agricultural business and reorganisation, technology adoption and evaluation, policy and subsidies, and climate and environmental factors. The expected results anticipate uncovering innovative funding mechanisms, identifying successful technology applications, and outlining potential areas for improvement. In conclusion, the review aims to offer valuable insights, guiding policymakers, researchers, and stakeholders towards effective and sustainable technology-driven solutions in agriculture funding.

Keywords:
Social funding; Agricultural financing; Waqf; Agriculture; Technology; Digital

1. Introduction

In the rapidly evolving landscape of the agriculture industry, the fusion of technology and social funding is catalysing a paradigm shift, ushering in an era of empowerment and inclusivity. The symbiotic relationship between technology application and social funding has become a linchpin in revolutionising the way agricultural projects are financed and sustained. This article embarks on a comprehensive exploration of "Technology Application in Social Funding of the Agriculture Industry," unravelling the intricate tapestry of innovations that are reshaping the funding dynamics while fostering social inclusivity [1-3].

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At the heart of this transformative journey lies the intersection of digital technologies and social finance models. As traditional funding channels often fall short in meeting the diverse and dynamic needs of the agricultural sector, technology-driven social funding emerges as a potent force for change. Crowdfunding platforms, impact investing, and social impact bonds are creating avenues for individuals, communities, and organisations to actively participate in supporting agricultural initiatives that align with social and environmental goals.

The integration of technology amplifies the impact of social funding by enhancing transparency, accountability, and engagement. Blockchain technology, for instance, ensures traceability and immutability in financial transactions, providing donors and investors with real-time visibility into the utilisation of funds [4-6]. Smart contracts automate and streamline payment processes, reducing administrative overhead and ensuring that financial resources reach the intended beneficiaries swiftly. One of the pivotal aspects explored in this article is the role of digital platforms in fostering a sense of community and collaboration within the agricultural sector. Social media, online forums, and dedicated platforms connect farmers, investors, and enthusiasts, fostering a network where information exchange and collaborative funding efforts flourish. This interconnected ecosystem not only democratises access to funding but also nurtures a collective consciousness that transcends geographical boundaries.

Exploration into the dynamics of technology application in social funding for agriculture reveals an article that investigates the potential ripple effects on sustainable farming practices, rural development, and the overall resilience of agricultural communities [7-10]. Moreover, it sheds light on the role of technology in democratising access to funding, ensuring that smallholder farmers and marginalised communities have equal opportunities to thrive in the rapidly evolving agricultural landscape.

2. Literature Review

The application of technology in the social funding of the agriculture industry has gained significant attention in recent years. This section provides a literature review of previous studies on the topic, focusing on the use of blockchain, Internet of Things (IoT) technologies in the agricultural sector and Artificial Intelligence (AI) Technology in Agriculture.

Blockchain technology has been explored as a potential solution to address the limitations of centralised online social networks (OSNs) in the agriculture industry [11]. A systematic literature review of papers covering the application of blockchain technology in social media found that previous studies have focused mainly on blocking fake news and enhancing data privacy [12]. The review also discussed several challenges in applying blockchain technologies in social media contexts and proposed alternative ideas for future implementation and research [12]. Blockchain technology is a cutting-edge instrument that has the potential to revolutionize a number of industries, including agriculture [13]. Blockchain technology has the potential to improve the efficiency, traceability, and transparency of the supply chain for agriculture [14-17]. The management of supply chains, traceability and transparency, smart contracts, cooperatives, and agricultural communities are a few possible uses of blockchain technology in agriculture [18-21]. Moreover, the agriculture sector can be modernized through creative solutions provided by the Internet of Things (IoT), a promising technology [22]. According to a comprehensive review of the literature of IoT technologies and their present implementation in various agricultural application domains, scientists and researchers are constantly working to develop IoT-based products and solutions that address various agricultural domains [22]. Farooq *et al.*, provided an IoT agricultural framework that contextualizes the depiction of a wide variety of existing solutions in the area of agriculture. The review also included the primary issues and obstacles being researched in the area of agriculture. IoT sensors can be applied in agriculture to track a variety of physical parameters, including temperature, humidity, and soil moisture. This data can be utilized to analyse artificial intelligence (AI) systems [23]. IoT sensors for agriculture include those that measure soil moisture, the weather, crop health, animal monitoring, and water quality [24]. Recent advancements include the monitoring and controlling of water pumping systems using IoT for agricultural purposes. By programming NodeMCU boards for cloud connectivity using Arduino software, data collection and monitoring via ThingSpeak Cloud is made possible [25]. This allows for the monitoring of soil moisture, temperature, and humidity as well as the control of water pumps via a smartphone, showcasing the effective real-world uses of IoT in agricultural resource management [25]. In conclusion, agricultural precision, innovative farming, and environmentally friendly agriculture are only a few of the possible uses for IoT sensors in the agriculture industry. By leveraging IoT devices, farmers can make informed decisions about crop management, optimise their operations, and ensure the traceability and transparency of agricultural products throughout the supply chain.

With applications in predictive analytics, agricultural robots, and soil and crop monitoring, the use of artificial intelligence (AI) is currently a major technological advancement in the agricultural industry [26]. Researchers have successfully used AI applications in data collecting employing sensors, smart robotics, and monitoring systems for crops and livestock, according to a thorough literature assessment of the field's uses in agriculture [26]. The review also discussed the challenges and opportunities in the adoption of AI technology in the agriculture industry [26]. In conclusion, the application of technology in the social funding of the agriculture industry has been explored through various studies, focusing on the use of blockchain, IoT, and AI technologies. These technologies have the potential to address the limitations of centralised systems, improve data privacy, and enhance the efficiency and productivity of the agricultural sector. The AI technology can be used to improve crop yield in several ways. One way is through soil and crop monitoring, where AI can be used to analyse data collected from sensors and soil sampling to make informed decisions about crop management, irrigation, and fertilisation [22,27]. The AI can also be used to develop predictive models that can forecast crop yields, weather patterns, and market trends [28]. This can help farmers to optimise their operations and make informed decisions about planting, harvesting, and marketing their crops. In other related technological applications, the creation of an IoT-enabled fluid viscosity measuring device shows the adaptability of IoT in a variety of industries, including agriculture [29,30]. Sensors and controllers are used to monitor and display viscosity measurements through an LCD and a website. Moreover, the prospective uses of 3D printing technology in the agricultural industry have been examined [31]. While highlighting the advantages of 3D printing, including mass customization, design freedom, and waste reduction, Kumaresan *et al.,* also drew attention to the production qualities and material restrictions that need to be solved before the technology is widely used in the agricultural and other industries.

In summary, a number of studies have examined how technology might be applied to the agricultural sector for social funding, with a particular emphasis on blockchain, IoT, and AI applications. These innovations have the ability to increase data privacy, alleviate the drawbacks of centralized systems, and raise the productivity and efficiency of the agriculture industry. Farmers may optimize their operations, make well-informed decisions regarding crop management, and guarantee the traceability and transparency of agricultural products across the supply chain by utilizing these technologies.

3. Methodology
3.1 Identification

To choose a significant number of relevant papers for this inquiry, three key stages of the systematic review technique were used. Keywords are chosen in the initial stage, and related terms are sought using thesaurus, dictionaries, encyclopaedias, and previous research. All relevant terms were picked after creating search strings for the Scopus and Web of Science, (see Table 1). During the initial step of the systematic review approach, 1968 papers were successfully retrieved for the current study project from both databases.

Table 1
Search strings

Scopus	TITLE-ABS-KEY (((“fund" OR "subsidy”) OR (waq*) AND (agriculture AND cultivation OR husbandry OR crop) AND (technology OR digital))) AND (LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2024)) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j"))l
WoS	((“fund" OR "subsidy”) OR (waq*) AND (agriculture AND cultivation OR husbandry OR crop) AND (technology OR digital)) (Topic) and 2024 or 2023 or 2022 (Publication Years) and Article (Document Types) and English (Languages)

3.2 Screening

During the screening process, the collection of potentially pertinent research items is reviewed for content that aligns with the predetermined research topic or questions. One of the most common content-related screening criteria is the selection of research items according to how technology is applied in the agriculture industry's social funding. This stage involves eliminating all duplicate documents from the list of papers that were searched. 1968 publications were eliminated in the first screening step, and 83 papers were reviewed in the second stage of the screening process using various inclusion and exclusion criteria from this study (refer to Table 2). Since research articles are the main source of useful recommendations, this criterion was applied before any other.

In addition, it contains material not found in the most recent study, such as book series, conference proceedings, reviews, meta-synthesis, and meta-analyses. Moreover, the review was limited to English-language publications. It is imperative to remember that the strategy was limited to the years 2022–2024. Due to duplication criterion, two papers were rejected in total.

Table 2
The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2022-2024	<2022
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press

3.3 Eligibility

The third step is known as eligibility, where a total of 82 articles have been prepared. The titles and key contents of all articles underwent a thorough review at this stage to ensure that the inclusion requirements were fulfilled and fit in the present study and its research aims. Therefore, 55 reports were excluded due to their unrelated fields, lack of significant tittles, abstracts unrelated to the study’s objectives, or the articles were without full text access, as supported by empirical evidence. Finally, 27 articles were available for review (refer to Figure 1).

3.4 Data Abstraction and Analysis

An integrative analysis was used as one of the assessment strategies in this study to examine and synthesize a variety of research designs (quantitative methods). The objective of this rigorous investigation was to pinpoint pertinent topics and subtopics within the scope of the study. The initial phase of data collection marked the foundational step towards theme development. Figure 1 illustrates the meticulous examination conducted by the authors on a compilation of 27 publications to extract assertions or materials relevant to the study's focal areas. Subsequently, the authors critically evaluated the significant studies pertaining to the technology application in social funding within the agriculture industry. The methodology utilized across all studies, along with the research outcomes, underwent thorough scrutiny. Subsequent to this, collaborative efforts among the authors were initiated to delineate themes based on the evidence contextualized within this study. A log was meticulously maintained throughout the data analysis process to document analyses, perspectives, uncertainties, or any other pertinent thoughts related to data interpretation. Following this, a comparison of results was conducted to identify any discrepancies in the thematic framework. It is noteworthy that any disparities in concepts led to discussions among the authors for resolution. Furthermore, the findings were cross-referenced to address any inconsistencies in the theme development process. Any emerging inconsistencies within the themes prompted collaborative discussion among the authors for resolution. Finally, the refined themes underwent adjustments to ensure coherence. To bolster the validity of the findings, evaluations were subjected to scrutiny by two experts, one specializing in Islamic economics and the other in technology. The expert review phase facilitated the validation of each sub-theme in terms of clarity, significance, and adequacy, thereby establishing domain validity. Adjustments were made based on the author's discretion, considering feedback and comments provided by the expert.

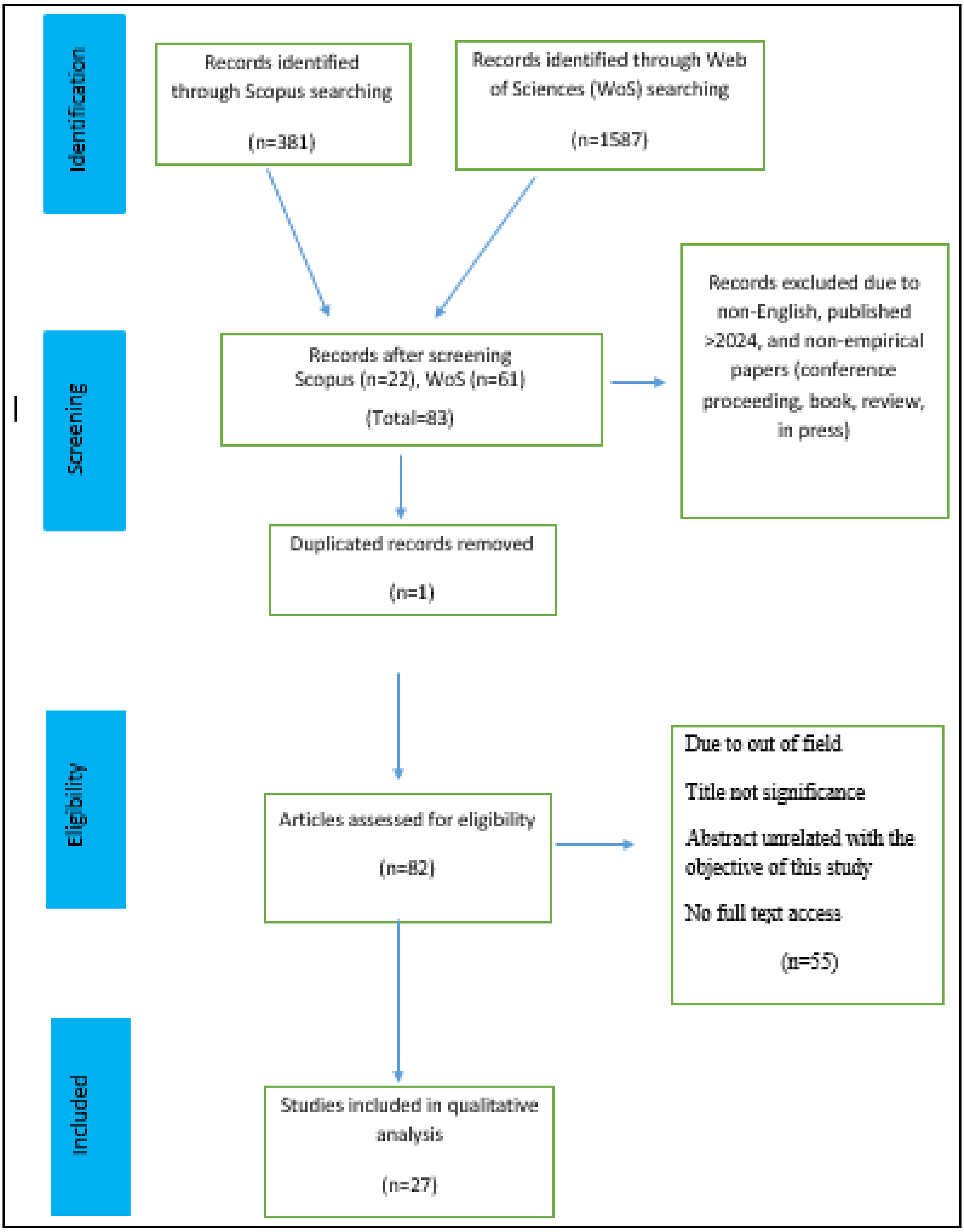

Fig. 1. Flow diagram of the proposed searching study [32]

3. Results and Finding

This section presents the research results based on the four themes identified (Theme 1: Agricultural Business and Reorganisation, Theme 2: Technology Adoption and Evaluation, Theme 3: Policy and Subsidies, and Theme 4: Climate and Environmental Factors).

Table 3
Theme 1: Agricultural Business and Reorganisation

Author(s)	Title	Year	Journal	Methodology	Findings
Dmytriieva V.; Sviatets Y [2]	Agricultural Business in Independent Ukraine: Thirty-year Dynamics of The Reorganisation Process	2023	Agricultural and Resource Economics	Content analysis of legislative field, official statistical data study, regression, correlation analysis, Hodrick-Prescott method, quantitative analysis with GNU Octave software.	Legislative changes affected agriculture organisation and productivity. Two distinct stages in agriculture development identified. Overcoming economic challenges and external threats.
Mishra M [11]	Advancing Indo-Australia Agricultural Biotechnology Cooperation	2022	Asian Biotechnology and Development Review	Analysis of India-Australia cooperation in biotechnology, overview of Indo-Australian Career Boosting Gold Fellowships, and examination of first-hand research experience at La Trobe University, Melbourne.	Promotion of science diplomacy for greater collaboration with nations having advanced systems in biotechnology and agriculture sciences. Exploration of science & technology cooperation in multilateral formats such as G20 and Quad.
Haq E.U.; Pervaiz U.; Khan M.Z.; Khan A [8]	An Assessment of Off-Season Vegetables Production in District Peshawar, Khyber Pakhtunkhwa	2022	Sarhad Journal of Agriculture	Data collection from 60 sample respondents, analysis of problems faced by farmers, evaluation of yield and income, and examination of the role of extension workers through interviews.	Low frequency of extension worker visits, limited training on tunnel farming, higher costs in tunnel cultivation, and profitability variation between tomato and bitter gourd. Major constraints include high installation costs, unavailability of inputs, lack of technical knowledge, and marketing challenges.
Burch, K; Guthman, J; Gugganig, M; Bronson, K; Comi, M; Legun, K; Biltekoff, C; Broad, G; Brock, S; Freidberg, S; Baur, P; Mincyte, D [33]	Social science - STEM collaborations in agriculture, food and beyond: an STSFAN manifesto	2023	Agriculture and Human Values	Involves an intervention that is action-oriented and is based on the authors' experiences working in interdisciplinary research and technology collaborations in the field of agriculture and food as social scientists.	Highlights the contribution of social scientists, identifies barriers to collaboration, and proposes ways to overcome them

Table 4
Theme 2: Technology Adoption and Evaluation

Authors	Title	Year	Journal	Methodology	Findings
Chen X.; Shang J [1]	Analysis of Farmers' Willingness to Use Blockchain and Influencing Factors Based on the Binary Logit Model	2022	Wireless Communications and Mobile Computing	Application of the Binary Logit model, comprehensive data analysis, and model inspection.	Chinese farmers are not very willing to use blockchain. Farmers' decisions are influenced by age, education, training, money, subsidies, and technology use.
Poonia S.; Jat N.K.; Santra P.; Singh A.K.; Jain D.; Meena H.M [3]	Techno-economic evaluation of different agrivoltaics designs for the hot arid ecosystem India	2022	Renewable Energy	Techno-economic analysis of AVS designs, field performance assessment, comparison with PV-GM (photovoltaic ground-mounted) systems, and assessment of economic viability.	AVS provides additional land-based revenue. Net returns are highest with a one-row full density photovoltaic array with irrigated brinjal. Economic study demonstrates the safety and viability of investing in AVS.
Huber R.; Späti K.; Finger R [5].	A behavioural agent-based modelling approach for the ex-ante assessment of policies supporting precision agriculture	2023	Ecological Economics	Bio-economic optimisation model, choice experiment, survey, census data, and agent-based modelling framework.	Payment based on results is more economical than technology and area-based subsidies. Farmers' behavioural traits, such their resistance to change, affect how effective policies are.
Tende I.G.; Aburada K.; Yamaba H.; Katayama T.; Okazaki N [34]	Proposal for a blockchain based agricultural input voucher system	2022	Artificial Life and Robotics	Development of a blockchain-based agricultural input voucher system using Hyperledger Fabric. Evaluation of system effectiveness.	Tanzanian farmers can now get digital subsidy vouchers using an efficient and secure blockchain-based system.
Boni Y.; Suraya R.S [35]	The Influence of Village Fund Allocation in Improving Skills and Procuring Agriculture Facilities and Infrastructure on Increasing Rural Area Farmers' Income in Muna Regency, Indonesia	2023	Migration Letters	Utilizing primary and secondary data for multiple linear regression analysis.	Village Fund distributions increase the income of rural farmers by enhancing agricultural infrastructure and skill levels.
Taimour H.; Farhadian H.; Saadvandi M [36]	Farmers' Agreement to Apply and Willingness to Pay for Climate-Smart Agricultural Technologies at the Farm Level	2022	Journal of Agricultural Science and Technology	Probit models that incorporate data from surveys, censuses, and choice experiments.	Low-cost solutions with immediate benefits are preferred by farmers. Adoption of Community Supported Agriculture (CSA) is impacted by government extension services, farmer field schools, subsidies, energy access, and perceptions of climate shocks.

Tanti P.C.; Jena P.R.; Aryal J.P.; Rahut D.B [37]	Role of institutional factors in climate-smart technology adoption in agriculture: Evidence from an Eastern Indian state	2022	Environmental Challenges	Probit models using primary data collected from farm households.	Major factors influencing the implementation of Community Support Agriculture include government extension services, farmer field schools, subsidies, energy access, and perceptions of climate shocks.
Tenreiro T.R.; Avillez F.; Gómez J.A.; Penteado M.; Coelho J.C.; Fereres E [38]	Opportunities for variable rate application of nitrogen under spatial water variations in rainfed wheat systems—an economic analysis	2023	Precision Agriculture	Economic examination of VRA (Variable Rate Application) adoption scenarios, case study, and simulations.	Adoption of VRA (Variable Rate Application) is financially beneficial for farms whose yearly sown area exceeds 567 hectares year−1. With the present trends in energy prices and transportation costs, viability increases.
Rozenstein, O; Cohen, Y; Alchanatis, V; Behrendt, K; Bonfil, DJ; Eshel, G; Harari, A; Harris, WE; Klapp, I; Laor, Y; Linker, R; Paz-Kagan, T; Peets, S; Rutter, SM; Salzer, Y; Lowenberg-DeBoer, J [39]	Data-driven agriculture and sustainable farming: friends or foes?	2024	Precision Agriculture	Data collected by sensors and digested by artificial intelligence (AI)	Emphasises the significance of interdisciplinary research, precision agriculture techniques, and data-driven agricultural technologies.
Ahsan, MB; Leifeng, G; Azam, FMS; Xu, BB; Rayhan, SJ; Kaium, A; Wensheng, W [40]	Barriers, Challenges, and Requirements for ICT Usage among Sub-Assistant Agricultural Officers in Bangladesh: Toward Sustainability in Agriculture	2022	Sustainability	Using a semi-structured questionnaire for the survey	73.2% of extension officers have basic ICT knowledge; Field visits and training workshops are effective approaches; Challenges include technical obstacles, farmers' ignorance, and shortage of computers
Ali Azizan, N., Muhamat, A.A., Syed Alwi, S.F., Ali, H. and Abdullah, A.Q.C [41]	Revitalising Waqf (endowment) lands for agribusiness: potentials of the anchor company model	2022	Journal of Agribusiness in Developing and Emerging Economies	There were series of interviews that had been conducted with ten (10) key informants who are experts and practitioners in the areas of Shariah (Islamic law), farming, agribusiness, land management and waqf	the needs to secure market for the agribusiness produce and the potential role of anchor company in the agribusiness. It is pertinent that for agribusiness to thrive, selecting the right anchor company that has the capacity to address the challenges is necessary.

Azganin, H., Kassim, S. and Sa'ad, A.A. [42]	Proposed waqf crowdfunding models for small farmers and the required parameters for their application	2022	Islamic Economic Studies	The present study employed a qualitative method by analysing the relevant literature on crowdfunding, waqf cash, waqf and agriculture, together with the primary sources of the Ḥadīth.	crowdfunding can bring immense benefits to the agriculture sector and farmers if it is integrated with waqf. This system will enable underprivileged farmers to meet their necessities and participate in their country's economic development.

Table 5
Theme 3: Policy and Subsidies

Authors	Title	Year	Journal	Methodology	Findings
Ganbold N.; Fahad S.; Li H.; Gungaa T [4]	An evaluation of subsidy policy impacts, transient and persistent technical efficiency: A case of Mongolia	2022	Environment, Development and Sustainability	Approach to stochastic frontier analysis with four components. The primary inputs driving output increase are labour, seed, and wheat sown area. Overall technical efficiency is positively impacted by soft loans and cash incentives for inputs.	Subsidies affect the productivity of wheat production. Agriculture households need to increase their technical skills. Encourage the efficiency, technical advancement, and present policy of subsidies in wheat cultivation.
Lee D.; Kim K [10]	National Investment Framework for Revitalising the R&D Collaborative Ecosystem of Sustainable Smart Agriculture	2022	Sustainability (Switzerland)	5646 public R&D projects totalling USD 1408.5 million between 2015 and 2021 are examined. a suggested approach for tracking the status of R&D investments. An example of a case study is the cultivation of strawberries.	Smart agricultural R&D investment status examined. Proposed framework useful for promoting smart agriculture and establishing sustainable collaboration ecosystems.

Weerahewa J.; Dayananda D [43]	Land use changes and economic effects of alternative fertiliser policies: A simulation analysis with a bio-economic model for a Tank Village of Sri Lanka	2023	Agricultural Systems	Creation of a simulation and bioeconomic model for five different policy scenarios. Conventional farming, increased accessibility to organic fertilizers, elimination of chemical fertilizer subsidies, higher costs for produce free of chemical fertilizers, and a composite shock are some of the several scenarios.	Conventional agriculture scenario shows paddy and maize cultivation preferred for profit maximising farmers. Restriction on chemical fertilisers leads to abandonment of paddy and maize cultivation. Composite shock scenario with organic fertilisers, no chemical fertiliser subsidy, and premium prices yields maximum returns.

Table 6
Theme 4: Climate and Environmental Factors

Authors	Title	Year	Journal	Methodology	Findings
Rock J.S.; Schnurr M.A.; Kingiri A.; Ely A.; Glover D.; Stone G.D.; Fischer K [44]	The knowledge politics of genome editing in Africa	2023	Elementa	Interview with donors, scientists, and development specialists.	Excitement and anticipation for genome editing, but frustration over political-economic hurdles.
Khonje M.G.; Nyondo C.; Chilora L.; Mangisoni J.H.; Ricker-Gilbert J.; Burke W.J [9]	Exploring adoption effects of subsidies and soil fertility management in Malawi	2022	Journal of Agricultural Economics	Multinomial endogenous treatment effects models, multivariate probit, and dynamic random effects probit.	At least 12% of crop income and micronutrient consumption are increased with joint use.
Bomdzele E., Jr.; Molua E.L [7]	Assessment of the impact of climate and non-climatic parameters on cocoa production: a contextual analysis for Cameroon	2023	Frontiers in Climate	Trend analyses and Vector Error Correction Model (VECM).	Crop output increases with temperature, CO_2 emissions, land use, and pesticide quantity, but declines with rainfall.
Zhou X.; Liu M.; Ouyang A [45]	Which Scale Is Appropriate for the Sustainable Management of Paddy Field? A Case Study of Jiaxing, China	2023	Sustainability (Switzerland)	Stochastic frontier production function and binary logit approach.	Appropriate scale is 10–30 ha, influenced by land quality, farmer experience, loan accessibility, and age.

Bacci M.; Idrissa O.A.; Zini C.; Burrone S.; Sitta A.A.; Tarchiani V [46]	Effectiveness of agrometeorological services for smallholder farmers: The case study in the regions of Dosso and Tillabéri in Niger	2023	Climate Services	Case study with interviews, roving seminars, and media communication.	Access to CS alone does not guarantee positive impacts; training of farmers is crucial.
Su X.; Shi J.; Wang T.; Shen Q.; Niu W.; Xu Z [47]	More Income, Less Pollution? How Income Expectation Affects Pesticide Application	2022	International Journal of Environmental Research and Public Health	Ordered logistic regression model.	Healthy crop growing technology is the most enticing; revenue development is a major factor.
Zamanialaei M.; Brown M.E.; McCarty J.L.; Fain J.J [48]	Weather or not? The role of international sanctions and climate on food prices in Iran	2023	Frontiers in Sustainable Food Systems	Econometric measures and CHIRPS precipitation data.	International sanctions have a significant impact on food prices, overshadowing weather disturbances.
El Fartassi I.; Milne A.E.; El Alami R.; Rafiqi M.; Hassall K.L.; Waine T.W.; Zawadzka J.; Diarra A.; Corstanje R [49]	Evidence of collaborative opportunities to ensure long-term sustainability in African farming	2023	Journal of Cleaner Production	Surveys and log-linear modelling.	Environmental factors, agricultural traits, the availability of water, and subsidies all have an impact on decisions.

4. Discussion and Conclusion

4.1 Agricultural Business and Reorganisation

Legislative changes have significantly impacted the organisation and productivity of agriculture, delineating two distinct development stages. Overcoming economic challenges and external threats necessitates strategic approaches for agricultural resilience. The promotion of science diplomacy is recommended to foster greater collaboration, particularly with nations advanced in biotechnology and agriculture sciences. There is an exploration of science and technology cooperation in global forums, such as G20 and Quad. Challenges in tunnel farming, including low-frequency extension worker visits, limited training, higher costs, and profitability variations between crops such as tomato and bitter gourd, underscore the need for targeted interventions. Major constraints encompass high installation costs, input unavailability, lack of technical knowledge, and marketing challenges. Additionally, the findings emphasise the vital contribution of social scientists in interdisciplinary collaborations, identifying barriers and proposing solutions for fostering effective partnerships in agricultural business and reorganisation.

4.2 Technology Adoption and Evaluation

China's farmers are hesitant to adopt blockchain technology due to factors such as age, education, income, and technology use. Agrovoltaic systems (AVS) offer additional income, but farmers' reluctance to change has affected the policy effectiveness. Tanzania proposed a secure blockchain system for digital subsidy vouchers, while Climate-Smart Agriculture (CSA) adoption is influenced by government extension services, farmer field school participation, and energy access. Variable Rate Application (VRA) is economically advantageous for farms with large sown areas. Challenges include technical difficulties, farmer ignorance, and computer shortages.

4.3 Policy and Subsidies

Subsidies play a crucial role in influencing wheat production efficiency, and there is a need to enhance the technical skills of farm households. The recommendation is to promote the current subsidy policy while focusing on improving efficiency and technical upgrading in wheat farming. The status of smart agricultural R&D investment is analysed, and a proposed framework is found to be effective for boosting smart agriculture and fostering long-term cooperative ecosystems. In the context of conventional agriculture scenarios, profit-maximising farmers prefer paddy and maize cultivation. However, restrictions on chemical fertilisers result in the abandonment of these crops. In a composite shock scenario involving organic fertilisers, no chemical fertiliser subsidy, and premium prices, the cultivation strategy would yield maximum returns. These findings collectively highlight the significance of subsidies in shaping agricultural efficiency, the need for skill enhancement, and the potential for smart agricultural policies to foster sustainable collaboration ecosystems.

4.4 Climate and Environmental Factors

The findings within the climate and environmental factor's theme offer a nuanced perspective on the challenges and prospects in agriculture. While genome editing generates excitement, the frustration over political-economic hurdles in African agriculture underscores the complexities faced. The combination of subsidy and soil fertility management emerges as a potential technique for increasing crop income and nutrient consumption. Crop output is influenced by climate variables such as temperature, carbon dioxide (CO2) releases, use of land, and pesticide amount, with rainfall having a significant negative impact. Identifying an appropriate scale for paddy field cultivation in Jiaxing underscores the need for tailored approaches. The significance of training farmers, the appeal of healthy crop growth technology, and the impact of international sanctions on food prices collectively emphasise the intricate interplay of factors shaping agricultural decisions. In conclusion, these insights guide policymakers, and practitioners in navigating the multifaceted landscape of sustainable and climate-resilient agriculture.

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