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Hybrid Agricultural Development Support Communication Model (DSC) by Integrating Traditional Practices with ICT-Based and AI-Driven Innovations: A Review Study

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ABSTRACT

Aim of the Study: This study aims to develop a communication strategy that integrates traditional methods, ICT-based technologies, and AI tools. An integrated communication strategy will increase the inclusive and efficient dissemination of agricultural knowledge.

Methodology: For analyzing contemporary communication techniques and their integration with old methods, a review of peer-reviewed articles was conducted using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which promote a transparent and systematic approach to identifying, screening and selecting relevant studies. The PRISMA guidelines were carefully followed to reduce bias, which guaranteed that the findings were consistent and reliable.

Findings: Findings suggest that integration of modern technologies and old communication methods can be used to develop a hybrid communication model for the development of the agricultural sector. These strategies can assist farmers in gradually adopting AI models. To enhance the engagement of farmers by providing timely and tailored information, ICT-based tools such as mobile applications, SMS and interactive voice response (IVR) systems were found to be relevant.

Conclusion: In conclusion, better adoption of modern means of communication and information dissemination can be facilitated by an integrated approach where farmers' feedback is a part of creating solutions. This study also emphasizes the importance of DSC frameworks' implementation for legislators and extension programs. Agricultural support systems can become more sustainable, efficient, and inclusive by matching real-life knowledge with AI's analytical attributes.

Keywords: Agricultural Development Support Communication, ICT in Agriculture, Artificial Intelligence, Hybrid Communication Model, Traditional Farming Knowledge, Precision Agriculture.

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1. INTRODUCTION

Agriculture is the backbone of many economies around the globe for long. The agricultural industry not only provide billions of people their livelihood and sustenance but also put food on the tables of billions of people across the globe, its role is undeniable (FAO, 2021). Despite the major role Agriculture sector perform in world economy, this sector face multiple challenges that include water scarcity, salinity, climate change and increase in global food demand (World Bank, 2020).

Development Support Communication (DSC) has played a vital role to address these challenges by timely information sharing with farmers and agricultural stake holders about advanced practices and technological innovations (Servaes & Malikhao, 2016). DSC fosters sustainable agricultural development by bridging the gap between emerging innovations in agriculture sector and traditional practices. Relevant information about farming techniques, timely weather updates, disease and pest control and information about government policies, due to effective communication techniques, enhance the efficiency of farmers and improve crop yield (Kumar & Roy, 2018). The diffusion of DSC enable the farmers to make informed decisions and adopt latest techniques while reducing environmental impact for increased productivity (Pretty et al., 2018).

It is observed that in most developing countries, agricultural communities often have low literacy rates, and this becomes a hurdle for the diffusion of the latest technologies to improve agricultural growth. Development Support Communication (DSC) has an important role in fostering an environment that is inclusive of learning, collaboration and innovation. Conventional methods like pamphlets, brochures, and farmer-to-farmer meetings still remain relevant due to the trust factor they uphold. These old techniques are important in the exchange of indigenous knowledge, context-based solutions and experiences (Chowdhury et al., 2019). Farmers learn from each other through these collaborative platforms in their unique circumstances and nurture flexibility and sustainability. (Leeuwis, 2020).

For analyzing contemporary communication techniques and their integration with old methods, a review of peer-reviewed articles was conducted using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which promote a transparent and systematic approach to identifying, screening and selecting relevant studies. The PRISMA guidelines were systematically followed to reduce bias, which guaranteed that the findings were valid and reliable. The study suggests an integrated approach of conventional techniques and contemporary technologies to develop a hybrid communication model for the development of the agricultural industry. These strategies can assist farmers in gradually adopting AI models, to enhance the capabilities of farmers by providing timely and personalized information. ICT-based tools such as mobile applications, SMS and interactive voice response (IVR) systems were found relevant in this regard.

Accessibility gaps can be filled using digital resources, especially in areas which lack basic infrastructure for communication. AI can convert a diverse and vast range of data into practical applications that can assist farmers in agricultural practices. User-friendly designs and alignment with local knowledge ensure good application of these strategies. While ICT platforms increase reach and AI tools improve accuracy and efficacy, the hybrid model merges the conventional practices with these technologies, which will boost trust and knowledge. (Ozor et al, 2024). Major challenges in this regard are low digital literacy, lack of infrastructure, and opposition to change. In conclusion, Better adoption of modern means of communication and information dissemination can be facilitated by an integrated approach where farmers' feedback is a part of creating solutions. This study also emphasizes the importance of DSC frameworks' implementation for legislators and extension programs. Agricultural support systems can become more sustainable, efficient, and inclusive by matching real-life knowledge with AI's analytical attributes.

The study provides a hybrid model for disseminating and integrating traditional agricultural strategies with AI-driven innovations and ICT-based strategies.

1.1 Problem Statement

Even with the advent of AI, communication technologies have taken a giant leap, but still in agricultural communities, especially in developing countries, there are difficulties in obtaining timely information. Conventional techniques lack efficiency and contextual personalization, while contemporary technologies like IoT and AI face the challenges of adoption due to a lack of literacy, infrastructure and trust. This review aim to fill the gap that exist between conventional techniques and contemporary innovations in the world of technology by merging both practices for maximum growth and sustainable development.

1.2 Research Questions

RQ_1. How can Development Support Communication (DSC) enhance community engagement for the growth and sustainability of agriculture?

RQ_2. How can DSC be utilized to connect traditional knowledge and communication methods with modern technologies to promote sustainable agricultural practices?

RQ_3. What are the key communication challenges and prospects in facilitating the adoption of innovative practices and technologies in agriculture through DSC interventions?

RQ_4. How are technical advancements like AI, Internet of Things (Iot) and Digital tools benefiting sustainable agricultural development?

2. REVIEW OF SELECTED LITERATURE

The cornerstone in the growth of a nation is agriculture; it not only guarantees food self-sufficiency but also generates jobs for a sizable population related to the sector. To grasp the present scene of Agriculture Development Support Communication (DSC), researchers in this review have used a methodical approach of choosing the pertinent literature.

Information and communication technology in agriculture studies awareness, preparedness, and acceptance of ICT in that field. It points up challenges such digital literacy and poor infrastructure that prevent the acceptance of the newest technologies. It underlines how much better ICT knowledge is needed. Its resources and integration will help to raise agricultural sustainability and output (Al-Ammary et al, 2022).

In agriculture, conventional DSC techniques are hampered in various ways that reduce their efficiency. Conventional approaches in (DSC) have a limited approach of one-size-fits-all approach, hence the contextual demands of farmers are not satisfied (Rivera & Qamar, 2019). Particularly in remote and underprivileged places where infrastructure constraints and digital divides impede the flow of information, these approaches can also suffer from accessibility problems (Davis & Sulaiman, 2021). AI in precision agriculture technologies for sustainable farming practices evaluates the part of artificial intelligence technologies in maintaining sustainable farming practices. It looks at many artificial intelligence uses in improving crop management, raising yield prediction, and lowering resource consumption including remote sensing, machine learning, and data analytics. Solutions driven by artificial intelligence can improve farming output, lower environmental impact, and enhance decision-making. It also covers difficulties in implementation, including high prices and technological constraints, and provides ideas for fostering AI acceptance in agriculture (Adebunmi et al., 2022).

Precision agriculture uses automation and artificial intelligence to raise crop output. It combines the cutting-edge technologies supporting the optimisation of agricultural activities like fertilisation, irrigation, and pest control. Integration of artificial intelligence is great if one wants to increase efficiency, lower resource waste, and raise crop output. There is also the necessity to solve issues and constraints like high application costs, technical difficulties, and the demand of trained workers. Precision agricultural automation and artificial intelligence have enormous potential to support environmentally friendly farming methods (Hoque, 2024).

Development of intelligent systems is highly significant in the context of developing Intelligent Systems for Monitoring and Management of Agricultural Enterprises since it not only increases crop yield by optimising the use of resources, but also makes timely information possible by means of intelligent system integration with automated management. They also lower running expenses (Tupalo, 2024).

Sustainable farming has been highlighted as helping women to empower themselves by Ferto & Bojnec (2024). Women play a crucial part in sustainable agriculture, and the study emphasises the difficulties they have in wise decision-making and constrained resources. Gender-inclusive policies should be pushed to empower women in the agriculture industry who are equal in number to men but not as beneficiaries, therefore improving agricultural output and sustainable growth. The research supports women's leadership in agriculture by means of breaking gender stereotypes (Ferto & Bojnec, 2024).

Artificial intelligence (AI) within agriculture is driving the fresh developments and changes. Several artificial intelligence applications improve results: precision agriculture, predictive analytics, crop monitoring, and so forth. Analytical qualities of artificial intelligence (Ritambara and Shubham, 2024) can help with problems including climate change, pest control, in-time decision making, and best use of resources.

By means of the construction of a Decision Support System (DSS) for precision agriculture, the farmers can obtain real-time data about soil condition, weather conditions, and crop status. Mostly for smallholders, the DSS seeks to bridge the technological adoption gap (Bourgeois et al., 2015).

Modern technology in connectivity, big data analysis, high-performance sensors, and automatic machinery to raise the efficiency of the farm sector define smart agriculture. The development of smart agriculture in China emphasises on how sustainability in agriculture is achieved using technology such artificial intelligence, IoT, and big data. They also cover the restrictions including low literacy, inadequate infrastructure, and government non-consistent regulations. For a sustainable agricultural future, China must solve issues of food security and environmental problems (Wu et al., 2024).

By providing real-time recommendations based on data, the Decision Support System helps smallholder farmers in semi-arid agriculture increase their use of resources such water and fertilisers, therefore improving their crop output. To increase output and reduce hazards in semi-arid environments, this system alerts on soil conditions, weather and crop health. Its objectives are to increase crop yields, increase efficiency, and support sustainable farming practices, thus enabling farmers to make wise decisions and so boost their livelihoods (Chiri, 2013).

3. RESEARCH METHODOLOGY

3.1 Research Design

A review methodology was used to analyze the existing literature on Development Support Communication (DSC). This review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, and adherence to PRISMA guidelines ensured a transparent and systematic approach for selecting relevant studies. The meticulous screening process to evaluate the quality and relevance of each study reduced the bias, guaranteeing the reliability of the study.

Table 1: *Inclusion and Exclusion Criteria for Study Selection*

Criteria	Inclusion	Exclusion
Language	English-language studies	Non-English studies
Publication Year	Studies published between 2003 and 2024	Studies published before 2003
Study Type	Peer-reviewed journal articles with diverse paradigm models.	Non-peer-reviewed articles, editorials, opinion pieces, blogs, etc.
Interventions	AI-driven innovations, ICT tools, mobile apps, and traditional knowledge systems	Studies which do not focus on AI-driven innovations, ICT tools, mobile apps, and

	integrated with modern technology.	traditional knowledge systems integrated with modern technology.
Relevance	Studies relevant to agricultural Development Support Communication (DSC)that integrate traditional methods and new technologies	Studies not relevant to agricultural Development Support Communication (DSC)that integrate traditional methods and new technologies
Outcomes	Studies with clear outcomes.	Studies without clear outcomes related to DSC advancements.
Population	Studies related to the agricultural sector	Studies focusing on non-agriculture sectors

3.2 Eligibility Criteria

3.2.1 Inclusion Criteria

The study included papers on agricultural communication from peer-reviewed publications. The analysis included papers from 2003 to 2024, guaranteeing the inclusion of modern developments and trends as well as research, especially looking at agricultural communication methods and their impacts. Included in the research were studies looking at how artificial intelligence (AI) might affect agriculture sector development support communication (DSC).

3.2.2 Exclusion Criteria

Non-English publications that failed to meet the language requirements for inclusion, opinion articles, blogs, and other non-peer-reviewed materials that do not meet the academic standards were excluded. Research that lacked methodological clarity and provided insufficient details to evaluate the validity and reliability of their findings was also excluded.

3.3 STAGE I

3.3.1 Data Sources and Search Strategy

The literature search was conducted across four databases.

a. Elsevier
b. Google Scholar
c. Agricultural journals
d. Springer Nature

3.3.2 Search Keywords

These keywords were used to search for relevant research articles for analysis.
“Development support communication in agriculture”
“Agricultural extension and communication”
“AI in agricultural communication”
“ICT for rural development”
“Machine learning and AI in agricultural advisory”

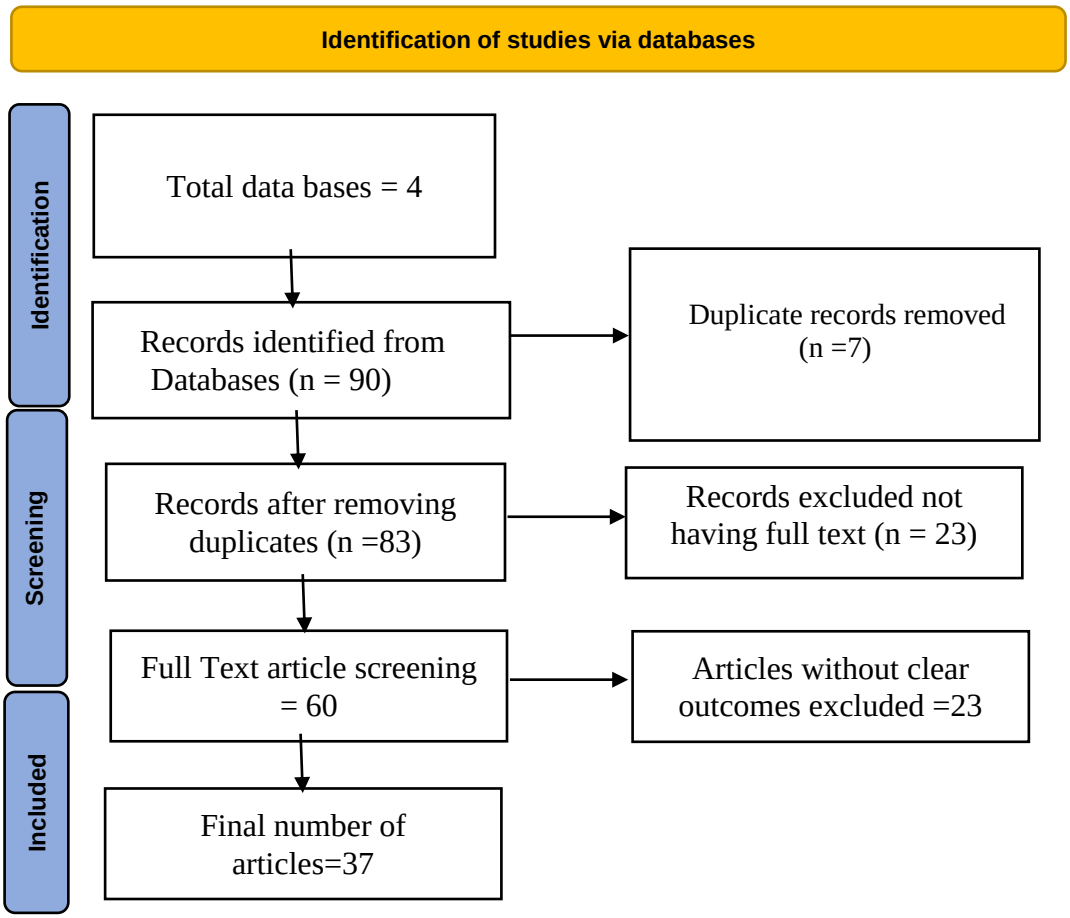
3.4 STAGE II

3.4.1 Study Selection Process

The selection process included three steps. Title and abstract screening was done by initial filtering of articles based on relevance. Studies available with full-text were selected for detailed analysis. Relevant information such as methodology, findings, and technological interventions in DSC data extraction and synthesis, was used. Studies measuring the impact, effectiveness, adoption, or challenges of AI-driven DSC innovations were selected for study. Studies related to farmers, agricultural extension officers, and

rural communities had relevance to the study. Four databases were searched out of which a total of 90 studies were selected, 7 duplicates were removed using Mendeley reference manager. 23 records without full-text and 23records with unclear outcomes were removed leaving 37 studies, which were used for analysis.

Fig 1: PRISMA Flow Chart



4. RESULTS AND DISCUSSION

4.1 Paradigm Models

This review provides a dynamic study of many approaches as the studies included used distinct paradigm models. Whereas quantitative investigations made their conclusions generalisable and valid, qualitative research enhanced the review with theoretical viewpoints and in-depth analysis. Mixed-method approaches, review studies and other modern techniques guaranteed our results and debates were more dependable.

Table 2: *Paradigm Models of Selected Studies*

Paradigm Model	**Qualitative**	**Quantitative**	**Mixed Method**	**Review Study**	**Other Methods**	**Total**
Number of Studies	3	5	8	13	8	37
Percentage	8.1%	13.5%	21.6%	35.1%	21.6%	100%

4.2 Evaluation of Current DSC Approaches

Current DSC approaches combine conventional methods with ICT-based solutions and artificial intelligence driven developments. Here, researchers have covered both conventional and new technologies as well as their part in agricultural development to provide a comprehensive picture of the present DSC scenario in agriculture.

4.2.1 Conventional Approaches

Development Support Communication (DSC) approaches consists of face-to-face interaction and community participation. The main ideas are spreading agricultural knowledge and encouraging local involvement.

The Agricultural Extension staff connects rural communities' practical application with research. They provide farmers pertinent knowledge on several subjects, including soil health, crop management, irrigation methods, and insect control. Extension agents help farmers in applying techniques using field demonstrations, training courses and individual consultations. Local radio stations provide timely and pertinent information, even in far-off areas and enable farmers to increase output, make wise choices, and remain linked to more general agricultural networks.

Face-to-face meetings, including field days and seminars, provide hands-on instruction to farmers on contemporary tactics, technology, and sustainable ways, therefore encouraging practical learning and use of new approaches. Through posters, booklets, newsletters, and brochures, farmers are informed with fresh ideas on advances, agricultural methods, and government initiatives. At community meetings, farmers exchange information and group problem-solving by sharing experiences, talking about challenges, and getting advice from local officials or extension staff.

Community radio stations help farmers improve productivity, make informed decisions, and stay connected to broader agricultural networks by offering timely and relevant advice, even in remote locations. Hands-on training to farmers on modern strategies, technology, and sustainable methods, promoting practical learning and implementation of new techniques, is provided through face-toface meetings, like field days and workshops. Important information on innovations, farming practices, and government programs is distributed to farmers and updates them with new techniques through posters, pamphlets, newsletters and brochures. Farmers share experiences, discuss issues, and receive guidance from local leaders or extension officers, disseminating knowledge and collective problem-solving at community meetings.

4.1.2 Limitation of Conventional DSC Approaches

Standardised communication approaches fail to adequately meet the various demands of farmers, hence conventional DSC techniques in agriculture run major challenges (Rivera & Qamar, 2019). Lack of the required infrastructure, digital resources, and accessibility problems in distant rural locations adds to their further hindrance (Davis & Sulaiman, 2021). These challenges cause limited uptake of agricultural advances, usually coming from communication gaps between farmers, extension agents, and researchers, thereby producing either irrelevant or insufficiently customised information (Rogers, 2003). Furthermore restricted their efficacy are extension services' poor capacity marked by inadequate skills, resources, and participatory approaches (Christoplos, 2018). Conventional DSC approaches of high resource needs and dependence on outside financial assistance further create scalability and long-term sustainability problems (Swanson & Rajalahti, 2010; Anderson & Feder, 2007). Notwithstanding digital tools like mobile phones and social media offering possible alternatives for more personalised and timely communication, problems including limited access, low digital literacy and unreliable connectivity among farmers, particularly in developing regions, continue to limit their effectiveness (Aker & Mbiti, 2010; Baumüller, 2018).

4.1.3 ICT-Based Approaches

Mobile applications and online platforms among other ICT tools provide farmers real-time access to vital data like pest alerts, market pricing, and weather predictions. These technologies provide customised guidance and fast updates, hence boosting output. By providing correct, current knowledge, they assist to overcome obstacles such limited extension services and geographical inaccessibility. ICT technologies help farmers to drive operations and lower risks, therefore enhancing sustainability and profitability in agriculture (Bahumuller, 2018).

Interactive systems include forums, social media, and chatbots improve real-time communication and feedback in agriculture. By means of these platforms, farmers may immediately get guidance, solutions, and peer support, thereby enabling their direct interaction with experts, extension workers, and other farmers. Farmers create a cooperative climate for knowledge sharing at venues by sharing experiences, asking questions and engaging in conversations Leeuwis (2020). While it offers a larger venue for community involvement, social media helps farmers to track agricultural trends, market updates, and expert opinions (Wolfert et al., 2017). Chatbots save the time needed to acquire important data and provide 24/7 service. Farmers get quick and automatic answers for their questions Wolfert et al. (2017).

4.1.4 Challenges in Executing Novel DSC Techniques

Particularly in rural or underdeveloped areas, limited internet access, inadequate connection and infrastructure impede the acceptance of ICT-based DSC solutions. Digital gap in access to cellphones, internet, and digital literacy might impede farmers from fully using contemporary communication platforms. Limited economic resources are also a main hurdle in the implementation of DSC techniques. As far as artificial intelligence and ICT extensive infrastructures are concerned, their integration with conventional methods is a great challenge. DSC activities depend critically on sustainable program financing, training materials, and resources.

Local languages, traditions, and agricultural techniques could all call for the use of traditional communication tools. Moreover difficult for including farmers, especially in undeveloped areas, in the framework of ICT and artificial intelligence technologies are education and literacy

4.1.5 Novel DSC AI-Driven Innovations

Digital technologies and artificial intelligence (AI) are changing agricultural communication and offering fresh ideas to raise farmer involvement, accuracy, and efficiency (Wolfert et al., 2017).

Table 4: *Studies Regarding AI-Driven Innovations*

Name of Study	**Date of Publication**	**Author(s)**	**Key points Discussed Regarding AI-Based Innovation in Agriculture DSC**
Transforming Crop Management Through Advanced AI and Machine Learning: Insight into Innovation Strategies for Sustainable Agriculture	October 3,2024	Danish Gul et al.	The study discussed the role of AI and Machine Learning (ML) for acquiring accurate information on pest control, agricultural productivity, weather updates and timely decision making by agricultural communities.
A Decision Support System for Enhancing	August 2013	Ayubu Jacob Churi, et al.	This study explore the decision support systems of smallholder farmers to reduce climate risks and increase crop productivity. The study discuss the

Crop Productivity of Smallholder Farmers in Semi-Arid Agriculture			importance of farm-level decisions and knowledge sharing for better productivity.
Towards Sustainable Agriculture: The Opportunities and Challenges of Artificial Intelligence in Agriculture Advisory Services	2024	Moses Z Sithole, et al.	This study explores the potential of AI in Agriculture Advisory Services (AASs), which can be considered a form of DSC. It talks about how AI can provide the most optimized pest control, soil health and moisture monitoring and analysis of data for farmers,
AI in precision agriculture: A review of technologies for sustainable farming practices	2024	Adebunmi et al.	This study review the role of integrated AI-driven technologies to attain sustainability in farming practices. It also discussed the role of Machine Learning (ML) for predictive analytics.
Frontiers of Artificial Intelligence in Agriculture Sector: Trends and Transformations	October 21, 2024	Ritambara et al.	This study examines AI-related applications like pest control, crop monitoring, precision farming and soil health evaluation, emphasizing how AI enables data-driven decision making.
Fostering Agriculture Transformation through AI: An Open-Source AI Architecture Exploiting the MLOps Paradigm	January 25,2024	Antonio Carlos et al.	The study suggested an open-source AI architecture design that integrate certain strategies with data-driven technologies for development. It is not specifically focused on AI but give a base for development of AI-driven decision-making tools.
Enhancing Africa's agriculture and food systems through responsible and gender inclusive AI innovation: insight from AI4AFS networks	January 23, 2025	Nicholas Ozor, et al.	This work investigates AI-driven solutions for several agricultural problems, including insect identification and crop monitoring in Sub-Saharan Africa. It underlines how these are linked to local settings' ethical norms
Internet of Things and Machine Learning Applications for Smart Precision Agriculture	2021	R. Siyakumar, et al.	The book, Ubiquitous Computing discussed the role of Machine Learning (ML) for predictive analytics, and how Machine Learning (ML) and IoT are important to formulate effective strategies for farm management systems.
Automation and AI in Precision	October 9,2024	Azmirul Hoque et al.	This review discusses the role of AI-driven predictive analytics for crop management. It enables

Agriculture: Innovations for Enhanced Crop Mangement and Sustainbility		farmers to make data-driven decisions for maximum use of resources and climate impacts.

The table gives a comprehensive picture of AI-based advancements in Data-Driven Smart Agriculture (DSC) strategies. It clearly describes the breakthroughs achieved with AI innovations that are at the core of data-driven smart agriculture. Avast range of AI applications is used for crop monitoring, disease identification, pest control, weather updates and predictive analytics.

4.1.6 AI's Contribution to the Overcoming of DSC Challenges

Artificial intelligence technology can be used to overcome restrictions in infrastructure. DSC providers face a significant challenge when it comes to physically reaching individuals who live in rural places. This digital divide can be narrowed through the use of voice-based artificial intelligence and chatbots, which make information available to farmers who are both low-tech and illiterate. Extension agents can receive real-time assistance, prediction warnings (weather/pests), and intelligent instruction from chatbots powered by artificial intelligence. Through the ability to forecast market trends and anticipated yields, artificial intelligence helps to enhance crop planning, soil health, supply chains, and policy choices. Artificial intelligence improves DSC by increasing the accuracy of agricultural decision-making.

4.1.7 The Impact of Artificial Intelligence on the Progression of Agricultural Communication

Artificial intelligence technologies, such as machine learning and predictive analytics, are assisting farmers in making more informed decisions on the management of crops, the administration of pest control, and irrigation based on data collected in real time. AI has the ability to provide personalised communication by modifying information in order to satisfy the individual demands of a farmer, such as the local circumstances and the type of crop. This ensures that the advice provided is more relevant and practical. As a means of overcoming obstacles like as distance, time, and expertise, chatbots and virtual assistants powered by artificial intelligence deliver immediate responses to queries posed by farmers. AI is capable of doing data analysis, collecting data from a variety of sources (such as Internet of Things sensors and satellite weather reports), and transforming it into actionable insights.

4.1.8 Possibilities provided by AI in the DSC

Opportunities are improved with the use of AI in agriculture. The application of artificial intelligence (AI) offers answers for adaptation since it has a considerable potential to provide small-scale farmers with individualised recommendations. It is possible that AI-driven technologies, such as predictive climate models and precision farming, may revolutionise the agricultural industry.

4.1.9. Restrictions imposed by the Infrastructure

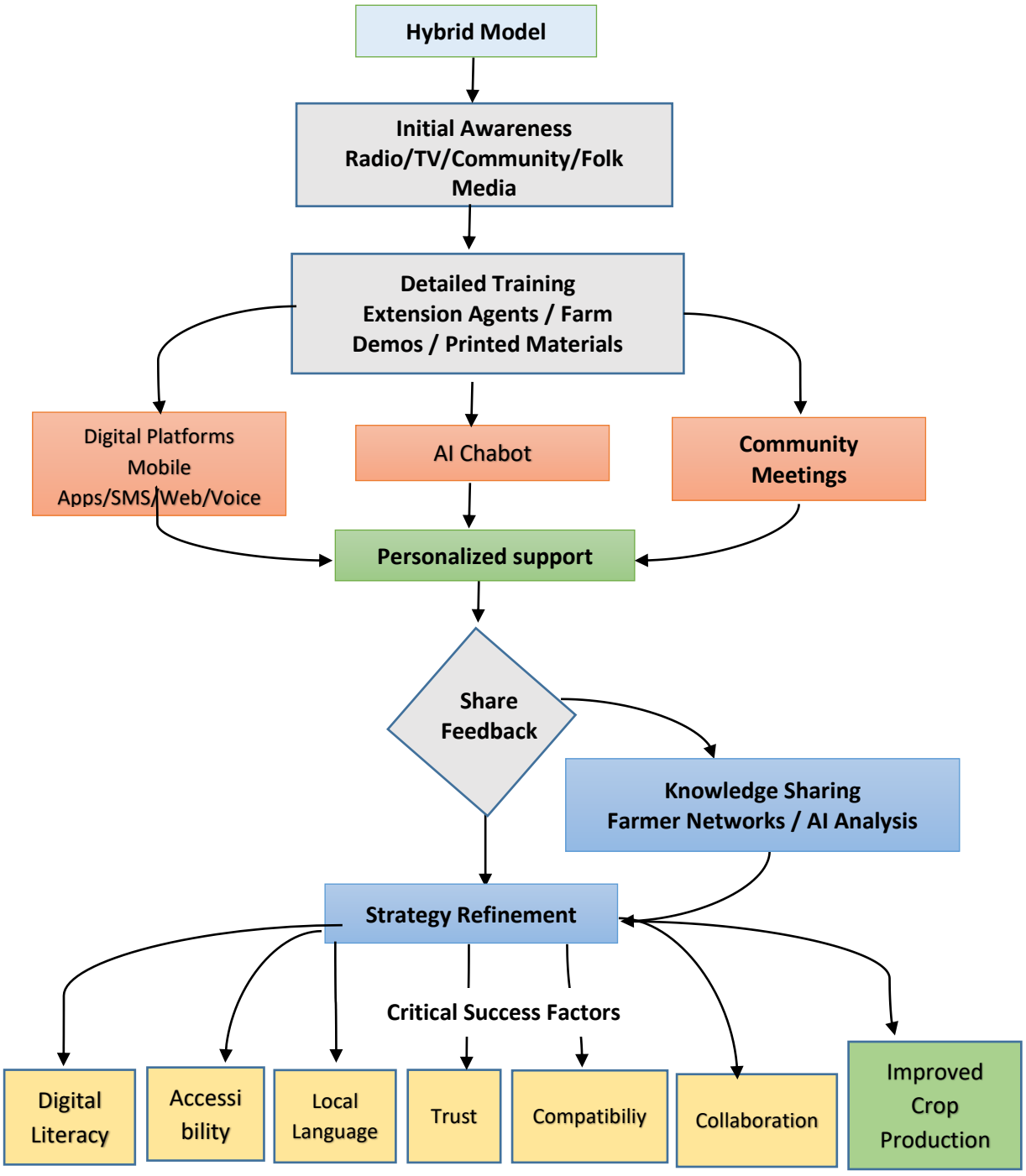
The digital gap, often known as the digital divide, is a term that describes the disparities that exist between various groups in terms of access to technology and digital literacy. Differences in access to communication possibilities exist between urban and rural people, as well as between groups that are wealthy and those that are impoverished specifically, Mefalopulos (2008) and Hilbert (2011). According to Donner (2009), the inability of extension workers, policymakers, and farmers to effectively communicate with one another causes a delay in the distribution of knowledge.

5. HYBRID COMMUNICATION MODEL

Combining traditional Data-Driven Solutions (DSC) approaches, such as extension services and farmer networks, with AI-driven and ICT-based tools creates hybrid models that harness the strengths of both systems. This hybrid agricultural extension model integrates traditional and digital approaches to enhance farmer engagement and productivity through an organized five-stage method. The initial awareness stage

employs mass media (radio, TV) and community events to disseminate basic agricultural information widely.

Fig 1: Hybrid Communication Model for Integration of Traditional Strategies with AI-driven and ICT-based Tools



For initial awareness, traditional communication means like TV, radio, community meetings and folk media has to be used. In the second stage detailed training has to be provided through extension agents, farm demos and printed material about Digital platforms like Mobile Apps, sms, voice messages and web services, AI chatbots, and community meetings. All these communication sources will increase personalized support to agriculturalists and extension workers. Feedback at this stage is crucial as it can enhance strategy refinement and training AI for unbiased and clear information. The critical success factors include digital literacy, accessibility, local language, trust, compatibility and collaboration for improvement in crop production.

5.1 Applications of hybrid communication models in Agriculture across Different Regions

Several studies endorse the efficiency of Hybrid communication model. Kenya's "e-Voucher" system is an example of an integrated digital platform with extension services that provided farmers with personalized advice through mobile phones. The "Digital Green" project in India and "Agri-Tech East" project of Uganda combined AI apps with the local extension workers to help farmers to make well-informed decisions. These hybrid models increased yield and improved efficiency of farmers significantly.

Table 5: *AI Applications in Agriculture across Different Regions*

No.	Country/Region	AI Technology Used	Key Benefits
1	Kenya	AI-powered data integration platforms	Kenya's "e-Voucher" system integrated a digital platform with extension services that provided farmers with personalized advice through mobile phones
2	India	AI-driven crop prediction models	The "Digital Green" project in India used video-based content and mobile technology that improved farming practices.
3	Sub-Saharan Africa	Chatbot-based advisory services	Uganda's "Agri-Tech East" project integrated AI apps with the support of local extension workers, helped farmers to make well-informed decisions

6. CONCLUSIONS

The studies reviewed for analyzing current land scape of Agriculture Development Support Communication (DSC). Merging traditional agricultural communication approaches with AI-driven technologies has potential to transform Agricultural Development Support Communication (DSC). The efficiency of ethnic communication techniques like folk songs, rituals, proverbs, and riddles for knowledge sharing play an important role in passing down agricultural wisdom (Gogoi et al., 2024). These conventional approaches foster trust within communities.

The development of decision support systems for farmers, as mentioned, along with the promise of AI in delivering Agricultural Advisory Services (AASs), illustrates technology's capability to enhance extension services and improve information access.

Integrating old and new strategies provides a distinct opportunity to create a blend of more inclusive and efficient DSC strategies. The combination of AI-enabled platforms with traditional communication channels can increase the reach and personalization capabilities of technology. This can build trust and cultural significance of established community networks.

AI is still in the initial phases, and most of the agriculturalists from developing economies have low literacy levels; thus, interpreting AI-driven information will remain a challenge. To overcome this hurdle, using culturally relevant formats, as in traditional practices, can prove beneficial. The literature review highlights many challenges regarding integration of AI-based technologies in sustainable farming.

These limitations include the digital divide and inaccessibility to means of communication. Rural regions mostly face these challenges, which may restrict access to AI-driven technologies. Data privacy, ethical issues, and context-specific solutions are important concerns as well to bridge the digital gap, initiatives should be taken for contextually relevant, user-friendly, ethically sound, and well-integrated strategies.

The success of the DSC is linked to an integrated approach that has the potential to improve effectiveness and reach. The future Agriculture Development Support Communication depends on merging AI with human-led extension services for sustainable farming.

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REFERENCES

Balaji, V., & Craufurd, P. (2011). *Using information and communication technologies to disseminate and exchange agriculture-related climate information in the Indo Gangetic Plains CCAFS Project Report CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)*.

Bhandari, S., Karki, T., & Pandey, P. (2022). Role of Development Communication in Women Empowerment. *Malaysian Business Management Journal*, *1*(1), 23–25. https://doi.org/10.26480/mbmj.01.2022.23.25

Bourgeois, D., Cui, S., Obiomon, P. H., & Wang, Y. (n.d). *Development of a Decision Support System for Precision Agriculture*. www.ijert.org

Churi, A. J., Mlozi, M. R. S., Mahoo, F., Churi, A. J., Mlozi, M. R. S., Mahoo, H., Tumbo, S. D., & Casmir, R. (n.d.). *A Decision Support System for Enhancing Crop Productivity of Smallholder Farmers in Semi-Arid Agriculture Siza Tumbo CAMARTEC A Decision Support System for Enhancing Crop Productivity of Smallholder Farmers in Semi-Arid Agriculture*, *3*(8). http://www.esjournals.org

Cob-Parro, A. C., Lalangui, Y., & Lazcano, R. (2024). Fostering Agricultural Transformation through AI: An Open-Source AI Architecture Exploiting the MLOps Paradigm. *Agronomy*, *14*(2). https://doi.org/10.3390/agronomy14020259

Durmishi, L., Bazsik, I., & Farkas, T. (2023). Community Support and Collaboration in Women's Social Cooperative Krusha e Madhe. *European Countryside*, *15*(1), 49–65. https://doi.org/10.2478/euco-2023-0004

Fertő, I., & Bojnec, Š. (2024). Empowering women in sustainable agriculture. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-57933-y

Gaol, T. V. L., & Gustira, M. R. (2020). Utilization of Information and Communication Technology in Agriculture. *IOP Conference Series: Materials Science and Engineering*, *879*(1). https://doi.org/10.1088/1757-899X/879/1/012143

Gogoi, B. P., Ansari, M. N., Kumar, B., Sirilakshmi, Y., T, A., & Saikia, D. (2024). An investigation of Agriculture Knowledge Sharing through Indigenous Communication Systems: Insights from Ethnic Communities. *Asian Journal of Agricultural Extension, Economics & Sociology*, *42*(12), 172–180. https://doi.org/10.9734/ajaees/2024/v42i122644

Gow, G. A., Waidayanatha, N., Jayathilake, C., Hambly, H., Barlott, T., & Anwar, M. (2015). *Fostering Inclusive Innovation for Agriculture Knowledge Mobilization in Sri Lanka: A Community-University Partnership Development Project* (Vol. 12, Issue 1).

Gul, D., & Banday, R. U. Z. (2024). Transforming Crop Management Through Advanced AI and Machine Learning: Insights into Innovative Strategies for Sustainable Agriculture. *AI, Computer Science and Robotics Technology*, *3*. https://doi.org/10.5772/acrt.20240030

Heckert, J., Martinez, E. M., Seymour, G., Pereira, A., Roy, S., Kim, S. S., & Malapit, H. (2023). Development and validation of a health and nutrition module for the project-level Women's Empowerment in Agriculture Index (pro-WEAI+HN). *Maternal and Child Nutrition*, *19*(2). https://doi.org/10.1111/mcn.13464

Hoque, A., & Padhiary, M. (2024). Automation and AI in Precision Agriculture: Innovations for Enhanced Crop Management and Sustainability. *Asian Journal of Research in Computer Science*, *17*(10), 95–109. https://doi.org/10.9734/ajrcos/2024/v17i10512

Hossain, M. A., Ferdousmou, J., Khatoon, R., Saha, S., Hassan, M., Akter, J., & Debnath, A. (2025). Smart Farming Revolution: AI-Powered Solutions for Sustainable Growth and Profit. *Journal of Management World*, *2025*(2), 10–17. https://doi.org/10.53935/jomw.v2024i4.862

Izuchukwu, A., Erezi, E., & David Emeka, E. (2023). Assessing the Impact of Farmer-to-Farmer Communication Networks on Knowledge Sharing and Adoption of Sustainable Agricultural Practices in Africa. *International Journal of Agriculture and Earth Science*, *9*(4), 58–76. https://doi.org/10.56201/ijaes.v9.no4.2023.pg58.76

Ma, W., McKay, A., Rahut, D. B., & Sonobe, T. (2023). An introduction to rural and agricultural development in the digital age. *Review of Development Economics*, *27*(3), 1273–1286. https://doi.org/10.1111/rode.13025

Mowla, M. N., Mowla, N., Shah, A. F. M. S., Rabie, K. M., & Shongwe, T. (2023). Internet of Things and Wireless Sensor Networks for Smart Agriculture Applications: A Survey. *IEEE Access*, *11*, 145813–145852. https://doi.org/10.1109/ACCESS.2023.3346299

Ozor, N., Nwakaire, J., Nyambane, A., Muhatiah, W., & Nwobodo, C. (2024). Enhancing Africa's agriculture and food systems through responsible and gender inclusive AI innovation: insights from AI4AFS network. *Frontiers in Artificial Intelligence*, *7*. https://doi.org/10.3389/frai.2024.1472236

Rajyalakshmi, P., & Nayak, Dr. V. M. (2024). E-Agriculture And Rural Development In India. *Educational Administration: Theory and Practice*. https://doi.org/10.53555/kuey.v30i5.3364

Ritambara, Kaushal, S., & Shubham. (2024). Frontiers of Artificial Intelligence in Agricultural Sector: Trends and Transformations. *Journal of Scientific Research and Reports*, *30*(10), 970–980. https://doi.org/10.9734/jsrr/2024/v30i102518

Samantaray, S., Vihariya, P., Mishra, P., Khuntia, A., Satapathy, S., & Mohanty, S. (2024). Are mobile advisory and face-to-face communication effective for enhancing the capabilities of farmers-evidence from farm science centre. *International Journal of Agriculture Extension and Social Development*, *7*(10S), 24–30. https://doi.org/10.33545/26180723.2024.v7.i10Sa.1221

Sithole, M. Z., Agholor, I. A., Msweli, N. S., Morepje, M. T., Twinomurinzi, H., Msweli, N. T., Gumbo, S., Mawela, T., Mtsweni, E., Mkhize, P., & Mnkandla, E. (n.d.). Towards Sustainable Agriculture: The Opportunities and Challenges of Artificial Intelligence in Agricultural Advisory Services EPiC Series in Education Science. In *EPiC Series in Education Science* (Vol. 6).

Sivakumar, R., Prabadevi, B., Velvizhi, G., Muthuraja, S., Kathiravan, S., Biswajita, M., & Madhumathi, A. (2022). Internet of Things and Machine Learning Applications for Smart Precision Agriculture. In *IoT Applications Computing*. IntechOpen. https://doi.org/10.5772/intechopen.97679

Sridevy, S., Devi, M. N., & Sankar, M. (2023). Decision support systems in agricultural industry perspective. *International Journal of Statistics and Applied Mathematics*, *8*(2S), 29–31. https://doi.org/10.22271/maths.2023.v8.i2sa.984

Syafuddin, K., & Meidina, A. P. (n.d.). Collaboration to Build Resilient Farmers' Human Resources: Digital Literacy Program in Agriculture as a Joint Education Effort. *WIMAYA: Interdisciplinary Journal of International Affairs*, *04*(02).

Toguzova, M., Shaimardanova, B., Shaimardanov, Z., Assylkhanova, Z. A., & Rakhymberdina, M. (2023). Analysis of the Introduction of Precision Farming Elements in East Kazakhstan: Problems and Prospects of Development. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives*, *48*(5/W2-2023), 125–130. https://doi.org/10.5194/isprs-archives-XLVIII-5-W2-2023-125-2023

Tsebee, K. A. (2021). EVALUATION OF COMMUNICATION SUPPORT MATERIALS USED FOR AGRICULTURAL DEVELOPMENT PROJECTS IN SELECTED STATES IN NORTH CENTRAL NIGERIA. *International Journal of Agricultural Extension and Rural Development Studies*, *8*(4), 1–28. https://doi.org/10.37745/ijaerds.15

Tupalo, Y. (2024). Development of intelligent systems for monitoring and management of agricultural enterprises. *International Science Journal of Engineering & Agriculture*, *3*(6), 1–9. https://doi.org/10.46299/j.isjea.20240306.01

Waltz, L., Katari, S., Hong, C., Anup, A., Colbert, J., Potlapally, A., Dill, T., Porter, C., Engle, J., Stewart, C., Subramoni, H., Shearer, S., Machiraju, R., Ortez, O., Lindsey, L., Nandi, A., & Khanal, S. (2024). Cyberinfrastructure for machine learning applications in agriculture: experiences, analysis, and vision. *Frontiers in Artificial Intelligence*, *7*. https://doi.org/10.3389/frai.2024.1496066

Wu, W., Feng, X., & Lu, C. (2024). The rise of smart agriculture in China: Current situation and suggestions for further development. *Experimental Agriculture*, *60*. https://doi.org/10.1017/S001447972400022X