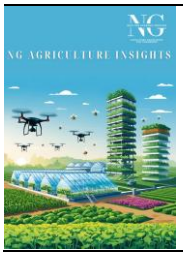

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Sowing the Seed of Digital Literacy for Agricultural Sustainability

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A B S T R A C T

Digital literacy of farmers has the potential of balancing farm productivity with environmental sustainability. The growing adoption of digital technologies in mobile advisory applications, precision agriculture technology, tools of remote sensing, and data-driven decision-support systems has enabled farmers to practice in a more environmentally sustainable manner. With digital capabilities, farmers will be in a better position to receive real-time data referring to the state of the weather conditions, the health of the soils, pests and diseases, and the wise application of inputs, resulting in a decrease in the unreasonable use of fertilizers, pesticides, and irrigation water. This type of evidence-based decision making improves efficiency in resource-use, reduces the emission of greenhouse gases, and alleviates the ecological degradation. Moreover, online platforms foster a more robust climate-wise and organic farming and sustainable land management practices uptake. Digital literacy advances the economic viability by availing timely access to information in the market and extension support services, which contributes to the long-term sustainability of environmental responsibility. Digital competencies interacting with indigenous and experience-based agricultural knowledge further enhances the adaptive ability of farmers and allows them to respond more effectively to climatic fluctuations and environmental risks. Together, the transformative role of digital literacy in agricultural sustainability is being made in the light of the on-farm behavioural change towards digital literacy adoption and reclaimation which highlights the importance of digital literacy in the deployment of environmentally sustainable agricultural systems in digital era. This analysis of the transformative nature of digital literacy on agricultural sustainability has been prepared along Indian context and has identified some recent reports and case studies. The debate of this paper will be highly useful to farmers to modernize themselves and explore the new hot spots in the plantation world.

Keywords: Precision agriculture, Environmental sustainability, Climate-smart farming, Resource-use efficiency, Sustainable agricultural practices

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1. INTRODUCTION

Digital literacy may be utilized to encourage sustainable behavior (Sharma et al.,2016). This facilitates the ability to locate data on reducing wastes and consumption of less energy, as well as shaping bizarrely advantageous behaviors. People are able to find out about conservation efforts, environmentally friendly products, and technologies through digital channels. Imagine apps that track the carbon footprints or online courses that educate on sustainability. The resources allow individuals to make environmentally friendly decisions (Dash et al.,2024) such as, internet networks provide tools and support of sustainable living, and energy-saving apps help track and reduce the amount of electricity used. Digital literacy promotes

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the participation of the community in sustainability projects (Saini and Kharb 2025). Internet campaigns, discussion rooms and social networking sites encourage collective action in meeting environmental goals. By encouraging other people and exchanging their knowledge digitally literate people can bring a positive change in their communities (Nedungadi et al.,2018). Digital literacy is today a necessity, but not just an advantage, in the modern technological society. This is the same with the agricultural industry. Digital literacy can be very helpful to the farmers because industries are being digitized and it could be through e-commerce to sell their commodities, precision farming, or through the cell phones to get real-time market prices (Periginji et al., 2025; Pradhan et al., 2024). So what then is the digital literacy of farmers and why is it so important? The blog also explores these questions and discusses the importance of digital literacy in modern day farming and the challenges faced by farmers in acquiring these skills (Kumar et al.,2022). Digital literacy is the ability to utilize digital devices and digital content and communicate with people through the Internet. It consists of a range of skills, among which are the skills on using software, browsing the internet, and evaluating the information that is accessible on the internet critically. In this era, possession of these skills is necessary in career as well as personal development. Digitally literate individuals feel comfortable using technology and this can assist them in various activities such as internet banking, accessing government services and communicating with family (Sarwatay et al.,2021). Also, it promotes lifelong education as it enables individuals to access internet services to acquire new skills and knowledge. Digital literacy will help teach people about the issues and solutions of the environmental problem in the context of sustainable development (Mohanty et al.,2024; Saha et al., 2024). Individuals can also make educated lifestyle decisions and play their part in ensuring sustainability by accessing online content and participating in online discussions.

2. AWARENESS OF NECESSITY TO CHANGE TRADITIONAL KNOWLEDGE TO DIGITAL LITERACY

To begin with, we must believe that sustainability is not a single phenomenon but it contains a lot of multidimensional ideas. This does not preclude that to obtain the highest level of sustainability we must just discard the generational practice with regard to any agricultural enhancement as it is the cornerstone of the current advanced form of agriculture. We must only update the mentality of the farmer towards future technology that in such a manner is the factor of harmonization in achieving the sustainability. One can find a lot of reasons why farmer, on the one hand, have to go through with digital literacy. To start with the essential determinants of crop growth the environmental factors can be closely monitored with the help of this digital literacy. In case farmer can well make use of the weather forecasting instruments that they can save without any difficulty, their crops may be spared the harmful consequences of rainfalls aberrations and draught results. Still, the farmers can use the digital literacy knowledge to easily predict the market price of any crops or commodities of a particular type, this theory is what gives birth to the concept precision agriculture. Therefore, we can see that government schemes are easily accessible in online portals. Thus with the correct level of digital literacy the farmers will be able to access such schemes as Pradhan Mantri Fasal Bima Yojana(PMFBY), PM-KISAN etc. easily. When these schemes are used well the farmers will be able to create a healthy and sustainable system of farming.And naturally the young generation today are leaving the farming profession on the wayside since somehow it is engrained in their mind as a profession of backward classes.

3. YOUNG GENERATION: THE DRIVING FORCE TO IMPLICATE DIGITAL LITERACY FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT

The entire debate on maintenance of the digital literacy will bear no fruits unless we are able to induce the new generation farmers into the same. The existing generation of farmers can be used as potential human resource due to their hard working nature and their agricultural intuition; however, the new generation is highly dependent on their smartness and their access to digital technology since they would want to work within the direct vicinity of the four walls. So we should inject the broad expanse of digital literacy with information which is up to date so the new generation does not lose its spirit of smartness. Should they pull their engagement into it and ad libitum their wholesome coherence to extreme modernism the project to create sustainability will become as easy as falling of a log. We have to begin to educate elementary school students in the basics of ICT and teach students useful skills like online payments, security, data management and web-based research. We need to attempt to introduce practical technologies like cloud computing, spreadsheets, and presentation tools and encourage online project-based assignments (Ghosh et al., 2025). Organizing symposiums and workshops according to the introduction to various AI models, digital marketing tools, cyberspace and privacy awareness information etc. Other certification programmes of various organizations such as National Skill Development Corporation, Pradhan Mantri Gramin Digital Saksharta Abhiyan will also be a good step ahead of the achievement of needs of digital literacy.

4. DIGITIZATION OF FARMERS AND ITS UPTAKE

Digital literacy leads to better awareness of the ecological aspect that consequently has sustainable practices. With the access to digital information, farmers become increasingly aware of the risks to the environment and solutions that result in the practical behaviour changes, including recycling agricultural waste, application of organic fertilisers, and the use of friendlier technologies. This consciousness also dishearts bad habits such as excessive pesticides application and dumping of wastes. This framework can be very useful in rural development planning, policy reviews and sustainability-oriented behaviour research through association of knowledge with behaviour change. One formidable yet frequently ignored route of connection between digital literacy and sustainability is the development of digital social capital. When farmers are becoming more digitally literate, they modify digital communities where the idea of sustainability is disseminated more rapidly and naturally. Green farming practices are exchanged in these digital networks in the form of peer discussions, videos and solving problems in real time. This gives a ripple effect: peer learning will increase the adoption of environmentally friendly practices faster, and the latent social pressure in the community will influence farmers to be in line with sustainable norms. Analytically this becomes very clear how such variables as digital social capital, network density and the rate of diffusion of information influence collective environmental behaviour such that sustainability is not a personal decision, but a social act of amplification of a digital connection. Digitally literate farmers would be better suited to pursue activities such as land restoration, climate-smart farming, and sustainable irrigation since they will be able to obtain timely information, weather forecasts, and market changes. Nevertheless, the effect of the digital literacy is not in a vacuum, but it is influenced by institutional trust. The digital knowledge can be more translated into the real-life engagement when farmers have confidence in the government agencies and agricultural institutions. The convergence of digital potential and institutional authority provides a useful framework through which to examine how policy is being implemented, and how successful the government-led program to achieve sustainability in agriculture is.With the growing technologization of agriculture, digital literacy is becoming one of the most critical facilitators of sustainable innovation. Those farmers that are highly digital are likely to embrace digital technologies like precision farming, smart irrigation, and weather monitoring systems that use the Internet of Things. This forms a fairly straightforward route: the greater the digital literacy, the greater the adoption of technology, which indirectly increases efficient use of resources. According to the environmental benefits, the overall reduction in fertilizer overuse, smarter water management and less agricultural emissions are vital. In addition to efficiency, digital competence enhances the capacity of farmers to respond to the variability in climate and thus it is one of the essential pillars of sustainability and resilience in contemporary agriculture.

5. HOW DIGITAL LITERACY IS SHAPING AGRICULTURAL SUSTAINABILITY

Sustainability is practiced on the ground and is being revamped very fast with digital innovation. The transition is being spearheaded by precision agriculture, which entails sensor-based irrigation, satellite soil monitoring and the use of data to determine the amount of fertilizer used by farmers to reduce wastage and maximize inputs. Meanwhile, climate-intelligent information systems such as weather apps and AI forecasting as well as early warning alerts are enhancing resilience by enabling farmers to predict and respond to climate risks. The integration in the digital markets is also contributing to the same as the e-commerce platforms and traceability tools are fitting producers with the high-end green markets that pay off sustainable practices. In addition to the production, digital awareness is enhancing waste management by ensuring that there is increased recycling of pesticides packaging and composting of organic waste. Lastly, WhatsApp communities, YouTube lessons and agri-tech helplines are also increasing the pace of disseminating sustainability knowledge, making digital connectivity a potent force of community environmental mobilization.

6. IOT: A SMOOTH CONTEMPORARY SOLUTION TOWARDS CROP SOLUTIONS AND SUSTAINABILITY (ROLE OF IOT IN SUSTAINABILITY)

With the use of wireless sensor networks (WSNs) and Internet of Things (IoT) applications, the concept of collecting and monitoring data in farms has changed greatly than in conventional methods (Sanjeevi et al.,2020). Due to those innovations, farmers have the opportunity to monitor various regions of their fields using tracking devices now remotely. Unlike the previous methods of collecting and observing data, it allows real-time monitoring and management of different farm areas. The IoT-based system allows farmers to have insightful information by analyzing and processing remotely acquired data using the cloud to aid in decision-making (Dhanaraju et al.,2022). IoT also ensures remote monitoring of the environment through simple electronic devices and communication technology in such a way that any person can study the environment when in their presence. Through IoT it is

possible to make and continuously revise detailed maps of the radiation levels, noise, air quality, water pollution, and the weather (Selvam et al.,2023). Moreover, the user can get the message in the form of texts or notifications sent by the nominated officials when the situation makes the data transmission to be out of the office. The activities in the form of farmlands are now less labour-intensive and more efficient, and due to the Internet of Things, which has enhanced organisation and lowered the overall expenses (Gupta et al.,2023).

7. INDIA-SPECIFIC CASE STUDIES ON DIGITAL LITERACY TOWARDS THE SUSTAINABILITY

In India, there are on-the-ground case studies of digital literacy by itself delivering tangible benefits of sustainability. Farmers in Vidarbha region (Maharashtra) have been prescribed to take pictures of the crops through the Plantix app to receive immediate diagnostic assistance in local languages and this will help in reducing the overuse of pesticides due to timely identification and giving accurate treatments to the crops. On a national level, agritechs such as DeHaat, IFFCO Bazar, and Samunnati are establishing digital ecosystems to bridge the gap between advisory services and marketplaces, triggering the efficient use of fertilizers and reduced food waste (Pradhan et al., 2025). In Andhra Pradesh, AI-based crop surveillance supported by the Government of Andhra Pradesh has both made it possible to give real-time advice and reduced the use of pesticides, and Gujarat the dairy industry in Gujarat introduced innovation with Amul launching the voice-based AI assistant "Sarlaben" to make livestock management easier and decrease emissions. The grassroots efforts also serve to accentuate the role of access and inclusion in outcomes. The Smart Gaon Project within the villages of Uttar Pradesh and Maharashtra indicates that digital infrastructure can alter the irrigation process, as well as sharing of knowledge. Meanwhile, the plans such as Sanchar Kranti Yojana in Chhattisgarh have opened access to smartphones particularly among women-increasing climate awareness and advisory reach. Innovation through Farmer also contributes to this as in the case of Ram Saran Verma whose high-tech agricultural trainings have scaled the sustainable practices, using peer learning. New AI chatbots and chat tools are now expanding this border, providing voice-based advice in local languages and to support farmers make wiser and more sustainable decisions. Kisan e-Mitra is a voice-based chatbot that is an AI-enabled chatbot designed to assist farmers with their queries regarding the PM Kisan Credit Card, PM Fasal Bhima Yojna, and PM Kisan Samman Nidhi program. This solution supports eleven regional languages and is also undergoing development to support additional government agendas. To fight the loss of output caused by climate change, the artificial intelligence (AI) and machine learning applied by the National Pest Surveillance System can detect the existence of pests in a cropping problem and take immediate measures to produce healthier crops. This tool is currently used by over 10,000 extension agents who help farmers to capture images of pests in order to reduce losses of crops and infestation by insects. It already has over 432 pests and 66 crops.

Table 1. Recent data on adoption digital literacy in India

Timeline	Incident
2022	A world bank survey cited by 2024 industry analysis notes revealed that around 23.4% adult farmers lack basic digital literacy skills which includes small and marginal farmers
2024	An agri-tech survey report reveals that only 25% farmers are comfortable using smartphone and the internet led to a digital adoption gap.
2025	Although ID generation does not always equate to high levels of digital literacy, the government has already produced over 4.85 crore farmer IDs, demonstrating the quick scaling of digital farmer registration.

Crop-weather matching tracks sown crops is AI-based and uses field photos to map crops by satellite. Also, academics have designed a WSN-based system which measures farming conditions such as soil temperature, humidity, and water levels through GPS and ZigBee specifications (Jawad et al.,2017). Due to the capacity of the system to capture data effectively and fully, this connection enables farmers to make informed decisions using current and extensive data. To apply to the exact requirements of cultivation, a Real-Time Crop-Tracking System has been created. The benefit of this is that it will increase the yield of rice and also boost crop management by constantly monitoring the important indexes and offering farmers timely feedback (Alam et al.,2013). A number of IoT-based solutions have been devised to solve these problems since agricultural land is among the most unpredictable landforms, which are affected by the environment. These solutions are useful in providing effective monitoring and management of the environmental factors. There has been a development of a global system of mobile communication (GSM)-based irrigation tracking device. This gadget contains the Android application that monitors temperature, humidity, and water levels (Suryawanshi et al.,2025) This cheap irrigation controllable wireless solution requires one to have

knowledge of the commands that activate the motors and change the settings of the crops. Combined, these case studies indicate that at the intersection of digital literacy and localized innovation sustainability turns from theory to daily agricultural practice.

8. CONCLUSION

Farmers have become digital savvy and this has become a critical measure in balancing agricultural output with the sustainability of the environment. Digital literacy enables more responsible and accurate management of natural resources and agrochemicals, water, soil nutrients, and other natural resources by providing more access to real-time, site specific, and scientifically reliable information. This is an efficient utilization of resources, which will reduce greenhouse gases, environmental degradation, and improve in general, the state of the ecosystem. Digital literacy also enables farmers to better embrace climate-sensitive agriculture, sustainable land-use plans, and other environmentally friendly innovations that create resilience to changes in climate, and enhance economic feasibility by bridging important information gaps among farmers, extension agencies, and markets. Improved financial stability will promote long-term environmental sustainability since farmers will have more investments in sustainable methods. The adaptive capacity is further enhanced by the integration of digital technologies and local and experiential knowledge of farming, and will allow responding more appropriately to the environment on a local level. The overall impacts of digital literacy as a transformative enabler are that it synchronises farm-level activities with broader sustainability goals and therefore its pivotal position in supporting environmentally sustainable and resilient agricultural systems in the digital era.

REFERENCES

Alam, M. M., Karim, M. R., & Ladha, J. K. (2013). Integrating best management practices for rice with farmers' crop management techniques: A potential option for minimizing rice yield gap. *Field Crops Research, 144*, 62–68. https://doi.org/10.1016/j.fcr.2013.01.010

Dash, A., Mathur, B., & Patil, P. (2024, October). EcoTrack: A mobile application for real-time carbon footprint tracking and sustainable living. In *2024 IEEE International Multi-Conference on Smart Systems and Green Process (IMC-SSGP)* (pp. 1–6). IEEE. https://doi.org/10.1109/IMC-SSGP63352.2024.10919812

Dhanaraju, M., Chenniappan, P., Ramalingam, K., Pazhanivelan, S., & Kaliaperumal, R. (2022). Smart farming: Internet of Things (IoT)-based sustainable agriculture. *Agriculture, 12*(10), Article 1745. https://doi.org/10.3390/agriculture12101745

Ghosh, S., Sarkar, A., Chakraborty, S., Mondal, K., & Malitha, A. B. (2025). Agricultural extension approaches and rural youth engagement in West Bengal: A comprehensive review. *NG Agricultural Sciences, 1*(4), 33–49. https://doi.org/10.66132/ngas010404

Gupta, S., Rikhtehgar Berenji, H., Shukla, M., & Murthy, N. N. (2023). Opportunities in farming research from an operations management perspective. *Production and Operations Management, 32*(6), 1577–1596. https://doi.org/10.1111/poms.13967

Jawad, H. M., Nordin, R., Gharghan, S. K., Jawad, A. M., & Ismail, M. (2017). Energy-efficient wireless sensor networks for precision agriculture: A review. *Sensors, 17*(8), Article 1781. https://doi.org/10.3390/s17081781

Kumar, R. M., Nagesha, Y. N., Ranganath, G., & Boraiah, B. (2022). Digital literacy in Indian farming: Opportunities, challenges and lessons learnt during Covid-19 pandemic. *Mysore Journal of Agricultural Sciences, 56*(3), 16–28.

Mohanty, A., Alam, A., & Mohanty, A. (2024). Education for sustainable development (ESD) and global citizenship for India. *Journal of Education for Sustainable Development Studies, 1*(2), 134–159. https://doi.org/10.70232/jesds.v1i2.17

Nedungadi, P. P., Menon, R., Gutjahr, G., Erickson, L., & Raman, R. (2018). Towards an inclusive digital literacy framework for digital India. *Education + Training, 60*(6), 516–528. https://doi.org/10.1108/ET-03-2018-0061

Periginji, S. K., Pulletikurthi, V., Kulkarni, S. R., Pradhan, S. K., & Sujohn, M. (2025). Agriculture and the utilisation of information and communication technology: A bibliometric review. *NG Agricultural Sciences, 1*(3), 33–45. https://doi.org/10.66132/ngas010305

Pradhan, S. K., Prusty, A. K., Das, S., Ghosh, M., Chandra, Y. B., & Nayak, S. (2025). Empowering small-scale agriculture: Effective strategies for technology transfer. *International Journal of Advanced Biochemistry Research, 9*(3), 118–125. https://doi.org/10.33545/26174693.2025.v9.i3b.3902

Pradhan, S. K., Prusty, A. K., Priyadarshi, D., Badavath, A., Nayak, S., Munda, S. C., & Sudham, V. (2024). Impact of disruptive technologies on transforming Indian agriculture. *International Journal of Agriculture Extension and Social Development, 7*(5), 34–41. https://doi.org/10.33545/26180723.2024.v7.i5a.597

Saha, P., Prusty, A. K., & Nanda, C. (2024). Extension strategies for bridging gender digital divide. *Journal of Applied Biology & Biotechnology, 12*(4),

76–80. https://doi.org/10.7324/JABB.2024.159452

Saini, N., & Kharb, R. (2025). Empowering sustainable development through digital transformation: Insights from Digital India. *Journal of Asia Business Studies, 19*(3), 606–634. https://doi.org/10.1108/JABS-07-2024-0408

Sanjeevi, P., Prasanna, S., Siva Kumar, B., Gunasekaran, G., Alagiri, I., & Vijay Anand, R. (2020). Precision agriculture and farming using Internet of Things based on wireless sensor network. *Transactions on Emerging Telecommunications Technologies, 31*(12), e3978. https://doi.org/10.1002/ett.3978

Sarwatay, D., Raman, U., & Ramasubramanian, S. (2021). Media literacy, social connectedness, and digital citizenship in India: Mapping stakeholders on how parents and young people navigate a social world. *Frontiers in Human Dynamics, 3*, Article 601239. https://doi.org/10.3389/fhumd.2021.601239

Selvam, A. P., & Al-Humairi, S. N. S. (2023). *The impact of IoT and sensor integration on real-time weather monitoring systems: A systematic review* [Preprint]. Research Square. https://doi.org/10.21203/rs.3.rs-3579172/v1

Sharma, R. S., Fantin, A. R., Prabhu, N., Guan, C., & Dattakumar, A. (2016). Digital literacy and knowledge societies: A grounded theory investigation of sustainable development. *Telecommunications Policy, 40*(7), 628–643. https://doi.org/10.1016/j.telpol.2016.05.003

Suryawanshi, R., Wasekar, T. R., Tambe, S. R., Wagaskar, A., Sutrave, R., & Thenge, A. (2025). Efficient water management in agriculture: A comprehensive smart monitoring approach for crop irrigation using mobile application with voice control. *Grenze International Journal of Engineering and Technology, 11*.