Next-Generation Digital Networking Through Meta-Verse: A Cynosure for Indian Agriculture

Weijimlu Tayang[1][a], M. Nirmala Devi[1,*][b], C. Katthikeyan[1][c] and Paul Mansingh[2][d]
[1]*Department of Agricultural Extension and Rural Sociology, TNAU, Coimbatore, Tamil Nadu, India*
[2]*VIT School for Agricultural Innovations and Advanced Learning, Vellore, Tamil Nadu, India*

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Abstract: With the popularization of internet usage in agricultural and allied sectors various breakthrough innovations landed in production technology, marketing and beyond aiming to benefit all the stakeholders in agriculture and allied sector. Digital revolution in agriculture sector brought disruptive technologies to enhance production operation and agricultural development. However, studies have shown that digital divide is a key matter existing among agricultural stakeholders in Indian context. Hence, the research study intends to present resilience of meta-verse to come through digital divide in the Agri. 5.0 era. Therefore, the study examined various factors from available secondary literature from Scopus international database that has impede the use of technologies to its full potential. In terms of application of technologies from Agri. 5.0, gap in social dimension, emotional dimension and economical dimension was studied thoroughly to enable meta-verse rigorously in agriculture and allied sectors. In this regard the study revealed that meta-verse characterized with high interactive service element and decentralization element which have the potential to bridge the digital gap among the agricultural stakeholders through next generation social networking. Finally, the study opened future research directions for advance functioning and development of meta-verse based agricultural and allied sectors.

1 INTRODUCTION

Indian agriculture has changed gradually and methodically throughout time with the introduction of digital application. When it comes to the quantity of digital users, the Indian telecom market ranks second globally. India's phone subscriber count rose from 1,197.87 million at the end of December 2018 to 1,203.77 million at the end of January 2019. The country also has 560 million internet users in 2018, making it the second largest country behind China (Yankam et al. 2019). The government of India also initiated "Digital India" campaign, which was unveiled on July 1st, 2015, with the aim to provide online access to a range of services, including those linked to livelihood. Digital infrastructure, digital services, and digital literacy were the three main parts of the initiative aiming to benefit rural and farm population (Goswami,2016).

Despite the benefit aimed by the government programs and increase usage of internet among the citizens, various scientific studies conducted by agricultural researchers reveals that there exists uneven utilization of digitalization in agriculture and allied sector creating digital divide. As per the previous studies digital divide includes critical factor such as unequal access to internet, lack of digital literacy among the farmers, lack of digital skills and this may further be due to geographical barrier and economic barrier faced among the farmers and other stakeholders in agriculture and allied sector (Khanal et al. 2021).

[a] https://orcid.org/0009-0001-2603-014X
[b] https://orcid.org/0000-0002-6542-3579
[c] https://orcid.org/0000-0002-0631-3820
[d] https://orcid.org/0000-0003-3423-8618
[*] Corresponding author

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In contrast to the real-world digital divide issues, where possibilities and resources may be restricted based on a person's physical ability, socioeconomic standing, or place of residence, anyone with an internet connection can access the metaverse. All people can have equal access to information, services, and experiences through the 'Metaverse'. This implies that every stakeholder would have equal access to knowledge, resources, and experiences in the metaverse regardless of one's location, income level, or physical limitations (Agarwal and Alathur, 2023).

Therefore, this paper aims to investigate critical factors concerning digital divide in digitalization of agricultural and allied sector in India and investigate significant potential impact of metaverse in overcoming the same. As limited numbers of research works were found emphasizing metaverse in agricultural and allied sector, indicating metaverse research is still in nascent stage, this paper also tried to analyze to what extent metaverse can enrich the digital revolution and how could researchers and policy makers support equitable development of digitalization in Indian agricultural and allied sector.

2 BACKGROUND

2.1 Digital Revolution and Digital Divide in Agricultural and Allied Sector

Since the beginning of time, agriculture in India has advanced from 1.0 to 5.0 to provide food for human existence. The conventional agricultural age, which is mostly dependent on human and animal forces, is ushered in by Agriculture 1.0. Farmers tried to employ self-contained machinery after then, during the Agri. 2.0 era. Agri. 2.0 increased productivity and efficiency, which led to a minor increase in the use of chemicals. Then the twentieth century saw the advent of Agriculture 3.0 as a result of the enormous technological improvements brought about by the development of computers. The computer assisted in performing precise and accurate tasks (Gagliardi et al. 2022). The cultivation of farmers' land has benefited from with the use of robotics, internet of things, and artificial intelligence in Agri.4.0 by making farming simpler and more advantageous (Naikwade et al. 2022). Modern technologies like the Internet of Things, Drone application (Daponte et al. 2019), Artificial Intelligence (Chukkapalli et al. 2020), Cloud Computing, and Remote Sensing have made significant advancements possible in the subject of Smart Sustainable Agriculture during this era (Wang et al. 2021).

Today Agri. 5.0 builds upon previous digital revolutions and emphasizes on building human centric to drive the superior services and products by seamlessly integrating technologies such as artificial intelligence, robotics, virtual reality and augmented reality. Incorporation of advance technologies such as use of Internet, Artificial Intelligence, Sensors and Robotics in agricultural production technologies, marketing and management has been extensively promoted as means to improve farm production, productivity and farmers income (Rotz et al., 2019) while minimizing the use of resource wastage in any form. The use of digital tools became necessary for farmers, research scholars and other stakeholders of agriculture and allied sector in decision making and this have significantly improved the lives of farmers and others stakeholders of agricultural sector who can afford the use of digital technologies.

However, in contrast, various literature also publicized the struggle to harness the full potential of digital technologies which still sits uneasily among the farmers and agricultural policy makers, increasing the weights towards digital divide. The American Library Association (ALA) defined digital divide, as the difference in access to information via the Internet and other information technologies and services, including the Internet and mobile divide between rural and urban areas, as well as differences in access due to geography, economic status, gender, and physical ability. The three main areas of the digital divide idea are infrastructure, capacity building, and resource usage (Yankam et al. 2019).

2.1.1 Factors Crafting Digital Divide Among the Stakeholders of Agricultural and Allied Sector

Disparate access to digital devices is not the main cause of the digital divide; rather, it is the distinct uses of those technologies (Yankam et al. 2019). Thus, with the exploration of digital divide in agricultural and allied sector it is clear that factors crafting digital divide among farmers was observed to be the outcome of 'Social Dimension' (such as poor educational quality, low literacy rate of an individual farmers and geographical barrier), 'Emotional Dimension' (such as introvert behavior of an individual farmer and weak or lack of digital literacy), and 'Economical Dimension' (such as poor financial and technical assistance) in adapting themselves to digital revolution (Gasperini and Mclean, 2001).

2.1.2 Meta-Verse for Agricultural and Allied Sector

The word 'Meta-verse' was first introduced in the book called 'Snow Crash' in 1992 written by Neil Stephenson (N. Stephenson, 1992) and outlined Meta-verse as an imaginary space free from physical reality. In the book 'The Metaverse, And How It Will Revolutionize Everything' written by Mathew Bells further described metaverse as the space that mimics the interaction of real world by integrating technologies (Rameshwar and Graham, 2023) through virtual interaction, spatio-temporal extensibility and human-computer symbiosis (Sun et al. 2022). Today Meta-verse can be understood as a space knitted by the user and for the users to manifest their extended reality, through integration of virtual tools that connects humans forming a common framework (Rameshwar, 2022). Users' virtual experiences are shaped by human imagination combined with ever-evolving technical advancements. As with the physical self, each user in the metaverse has an avatar that they utilize to experience a different life in a virtuality that is a metaphor of their real surroundings (Lee et al. 2021). This allows users using virtual reality or augmented reality systems to interact with the metaverse and exist on a spectrum between the actual world and virtual reality (Fu et al. 2022).

3 MATERIALS AND METHODS

To understand the landscape of application of metaverse related to Indian agriculture and allied sector a systematic literature review was conducted from international database 'Google Scholar'. This approach helped in facilitating a comprehensive review on number of agricultural researchers working towards enabling metaverse in Indian agriculture scenario. Based on the primary objective set for the research and purpose if study, a set of keywords i.e. "Metaverse", "Agri-metaverse", and "Metaverse" AND "Agriculture" AND "India" were identified. The platform provided extensive multidisciplinary literature available on metaverse (Figure 1).

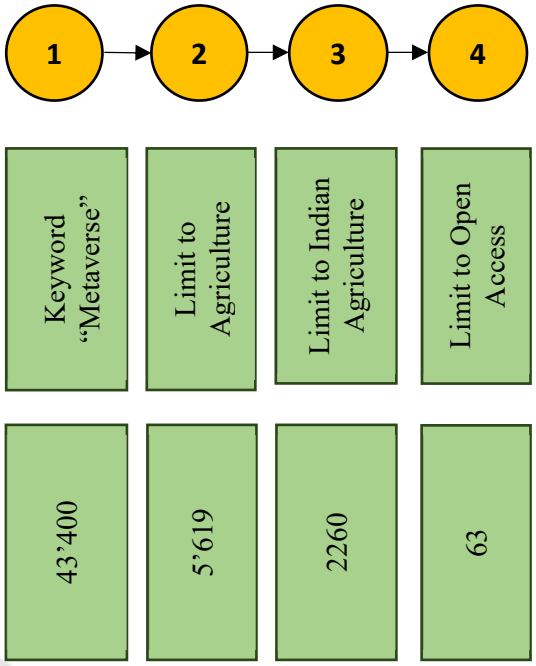

Figure 1: Bibliometric review search for the topic metaverse in Indian agricultural and allied sector

Further the inclusion of literature was restricted to English language, articles available in open access, Whereas the articles that did not provide accurate information with the objective of research were excluded based on the title, abstract and reading of full-length article as shown in the Table 1.

Table 1: Article Selection for the topic metaverse in Indian agricultural and allied sector

S.no	Criteria for Inclusion of article	No. of articles Selected
1	Open Access	63
2	English Language	54
	Criteria for Exclusion of article	No. of articles Rejected
1	Excluded by Title	13
2	Excluded by Abstract	28
3	Excluded by Full Length Paper	9
Total Number of Articles Selected		4

4 RESULTS AND DISCUSSION

The systematic literature review generated increased research attention on metaverse in the field of agriculture world-wide and in Indian agricultural context (Figure 2). It can be observed that the scientific research study has been increasing every year indicating the potential shift of digital revolution to metaverse in near future.

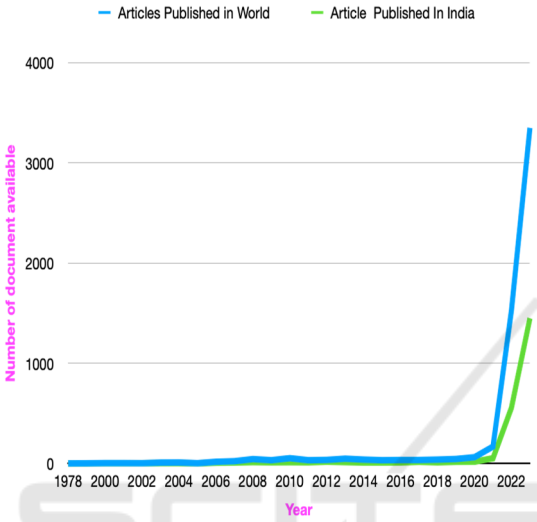

Figure 2: Growing number of scientific research on metaverse in agricultural and allied sector

Although research on metaverse in agricultural field in worldwide were conducted extensively, according to the search very few literatures was available in in Indian context that aligns with the current research study. Table 2 represents the detail analysis on selected articles that supports the objective of current research study.

Table 2: Meta-verse research works on Indian agriculture and allied sector

S.no	Authors	Findings
1	Dixit, 2022	The study demonstrated how several people can interact in the virtual world with each other through avatars, creating a very immersive experience. The effects on digital identity, privacy, and interpersonal relationships are societal.
2	Kumar et al. 2022	The study designed secure data sharing framework for IoT-based IA by exploiting deep learning and smart contract to propose a new IoT-enabled IA framework.
3	Srivastava , 2022	The metaverse makes it possible to digitally tour farms, making it a fantastic chance for both consumers and farmers to interact. The platform also provides tools for data visualization and deliver the information to decision-makers or other important stakeholders.
4	Rathore, 2018	Future marketing could be influenced by the metaverse to become more technologically sophisticated and sustainable.

4.1 Meta-Verse: A Cynosure for Indian Agriculture

When it comes to agricultural and allied sector combination of digital tools such as Sensors, GPS and Modelling software's with automatic digitalization machineries (Tractors, Weeders, Drones, Irrigation Equipment's etc.) was observed to be benefiting farmers in constructing efficient use of the resources and increase farm production and income (Srivastava, 2022). Therefore, it can be assumed positively that metaverse has extraordinarily large potential in agriculture and allied sector, as digital inclusiveness is arguably one of the metaverse's most exciting uses. Work, learning, socializing, and self-entertainment can all be revolutionized in metaverse. New avenues for agricultural social engagement, education, and commercial production (Dwivedi et al. 2022) may be opened up by it.

The metaverse also holds the potential to develop into a persistent, self-sustaining virtual environment that interacts and coexists with the real world with a great degree of independence (Grieves and Vickers, 2017). Where avatars can be controlled by a user i.e. individual farmer in the real world via Extended Reality and user interaction techniques for a variety of group activities (Kumar et al. 2022). By design, the

metaverse is a user-focused application (Dixit, 2022). Such consideration can be made in metaverse, when it comes to network design, such as by making farmer experience the center of traffic management or by making farmer-centric sensing and communication possible (Kumar et al. 2022).

4.2 Meta-Verse for Social Dimension

The first step toward digital inclusion is access. Using extended reality, the meta-verse enables individual farmers to collaborate electronically and plan diverse training and fully immersive learning experiences which was not possible all cases due to a geographical barrier (Dixit, 2022). This enables a single farmer to visit the fields of other successful and progressive farmers. The metaverse facilitates experiential learning by enabling users to physically handle objects within the virtual digital twin and explore their curiosity (Voinea et al. 2022).

Further the interaction between the agricultural stakeholders could be completely transformed by the metaverse (Agarwal and Alathur, 2023). In the metaverse, these groups can connect with others, build supportive networks, and contribute to the development of new ideas and initiatives for the progress of agricultural and allied sector. The metaverse has the potential to break down the social barriers and geographical boundaries enabling the development of a more equitable and inclusive farming society (Kumar et al. 2022).

The users in the metaverse also have the access to create virtual environment in digital twins unlike users in virtual reality and augmented reality has to pay full attention to the virtual environment. This aligns with the well-established needs of virtual environments: a method to communicate (by gesture, writing, voice, etc.), a way to share information and control things, and a shared feeling of presence, place, and real-time interaction. Additionally, users can communicate consistently and in real time with one another (Grubert et al. 2016).

4.3 Meta-Verse for Emotional Dimension

Participation in agricultural development program initiatives is hampered by the fact that some stakeholders in the agricultural and related sectors lack the knowledge and abilities necessary to manage digital operations in virtual environments. Despite having professional assistance, a person's limited comprehension of digital language prevents them from paying attention and engaging fully in the application. This is where metaverse comes to focus. Accessing the metaverse doesn't require complicated commands or comprehension. In the metaverse, simple human gestures that have been used for millennia are sufficient to complete any work (Xi et al. 2022). The computer vision techniques available today are not capable of capturing and reflecting in real time the emotions, behaviors, and interactions of users which can be achieved with additional input modality in granularity of avatars in metaverse (Kumar et al. 2023). The virtual space also shows the potential to amplify the issue of shyness among introvert stakeholders, as users can hide behind the anonymous avatars and share their opinion freely without the fear of discrimination and judgment.

The metaverse holds the potential to break down a great deal of obstacles and bring everyone up to speed so they can all take use of technology made available for the farming community and it could be used as powerful tool for raising awareness and promoting agricultural and allied sector. Therefore, it is crucial to make metaverse technology accessible.

4.4 Meta-Verse for Economic Dimension

When it comes to economic accessibility, it is proven that technology on its own is not the solution for digital divide. One needs to have greater balance on economic condition to use and adapt to newly introduced digital technologies. This becomes additional major issues among the small and marginal farmers of India, which is unavoidable. Therefore, It is must to fund initiatives that aims to provide affordable access to the digital world if it is to actually close the digital divide. It is imperative to support programs that aims at giving everyone access to high-quality, reasonably priced, and dependable internet (Rathore, 2018).

Today too many of the digital products used in daily basis are too complex to use. In addition to instructional initiatives, agricultural policy makers should fund on technology that will be easy to use by the farmers and every agricultural stakeholders; with metaverse being the key example (Vidal-Tomas, 2023). Redefining technology usability itself is crucial.

5 CONCLUSION

The physical world and its digital twins will be interconnected in the metaverse's final stage, allowing all human users in the real world to interact

with avatars and virtual objects located in both the metaverse and the mixed reality in real-world settings. In other words, there will be constant influence between the real and virtual worlds. It is vital to facilitate ubiquitous user interaction with digital entities. Unlike most of the current technology only permitting users to interact with the keyboard and mouse pair, which is unable to faithfully replicate the avatar's movements as required by the users or learners. Therefore, technologies other than the Internet, social networks, use of avatars and virtual environments should be taken into consideration in order to realize the metaverse. As the foundation of the metaverse is provided by the development of augmented reality and virtual reality, edge computing and high-speed networks, artificial intelligence and hyperledgers.

No matter how groundbreaking agricultural technology is, it is only useful if farming community adopts it. Hence, the metaverse opens opportunities to use technology not just as a tool for advancement, but as a tool for empowerment creating digital equity in which all individual stakeholders of agricultural and allied sector to have the information technology capacity desired for full participation in farming society and farm economy. In other words, the metaverse ought to be discussed in public to create collaborative solutions among the agricultural and allied sector stakeholders. Finally, metaverse to make an impact, it must become widely accepted.

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CONFLICTS OF INTEREST

Regarding the subject matter of this paper, the writers have no relevant conflicts of interest to disclose

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