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Article

Hurdles in the Adoption of Digital Technologies in the Agriculture Sector of Bihar

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Abstract: Purpose Since digitization has significant potential to benefit both farmers and consumers, there is currently a strong drive for its wider adoption in the agricultural sector. However, bringing technological advancements to rural areas presents a number of difficulties. Bihar's rural areas are going through a digital transformation. The primary impediments to the digitalization of the agriculture sector in Bihar are examined in this study. Research Design/ methodology There are three sources for the information used in the analysis. One from literature reviews, the second from official government websites/reports, and the third as responses of farmers towards the constraints of using Digital technologies in the agriculture sector of Bihar. It also incorporates the researcher's personal observations and measurements of events. On the basis of information collected from the 210 respondent farmers, we highlighted the main constraints of digitalization that farmers are facing in the agriculture sector in Bihar. Findings Digitalization in the agricultural sector decreases costs, boosts productivity and quality, increases prices, minimizes risks, and nurtures a more sustainable ecology. The finding of the study indicates that Hesitation in adopting digital technologies due to small and fragmented land, Lack of training and motivation to capitalize on agriculture, High cost, insufficient power supply, poor internet connection in a rural area, lack of skill and awareness, are main lack of subsidies are main hurdles in an adaptation of digitalization in the agriculture sector of Bihar. Suggestion: Effective Farmers' interest in Digitalization and financial support in terms of subsidy may aid them in startups also. A new level of development for the farm sector has been enabled by the combination of technology and financial support. The findings of the study will be helpful for policymakers to evaluate the scheme. Value/ Novelty: The study provides a fresh theoretical viewpoint on the digitalization of rural and agricultural growth, which has an impact on the entitlements of millions of farmers nationwide.

Keywords: digital technologies; smart farming; agriculture 4.0; agriculture 5.0; subsidy; sustainability

1. Introduction

India is one of the fastest-growing economies in the world and is one of the major producers of food worldwide. In India, agriculture is the key sector for guaranteeing food and nutritional security, sustainable development, and eradicating poverty. The main problems that India's agrarian economy faces today, however, are food security, population growth, monsoon whims, and the illiterate nature of its farmers [1]. The report by [2] estimate that, in order to feed India's anticipated 1.8 billion population by 2050, food production will need

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to roughly triple. Therefore, Digitization of the agriculture sector is critical to achieving this level of success. The government takes steps under the Digital Agriculture Mission for projects based on new technologies like IoT**,** artificial intelligence, Machine learning, remote sensing, drones and robots, and so on, in terms of improving farmer production, earnings, and livelihoods. On the basis of the digital revolution, India's position will be moved from the 'Green Revolution' to the 'Evergreen Revolution' [3]. Agricultural value chains are being transformed and operations are being modernized by digital technologies and services because digital technologies have been a big potential booster for the field of agriculture [4]. This digital revolution in agriculture is very promising and the agriculture industry will be able to go to the next level of farm production and profitability. [5, 6], estimated that, with advanced techniques, the IoT has the ability to boost farm productivity and profitability by 2050. Today, however, Agriculture 4.0 is based on Smart Farming principles, with farmers adopting systems that produce data on their farms, which will be analyzed in order to help farmers make the right operational and strategic decisions. Traditionally, farmers would visit the fields to assess the condition of their crops and take decisions based on their knowledge. The authors [7] claimed that the application of ICT in agriculture is referred to as "smart farming." ICT-based data collection and analysis support effective agricultural activities. ICT also makes farming practices more precise and controlled, lowering costs and having a smaller negative impact on the environment while simultaneously improving production. [8] also said that Smart farming has the potential to also improve work safety, contributing to the sustainability of agriculture. Numerous attempts have been made to improve the efficiency of agricultural production and the full value chain in the age of digitization, but compared to other sectors, adoption of technology is still quite low [9] Let's compare an average Indian farm to those in the US, Australia, and Europe in order to better comprehend the difficulties posed by digital agriculture in India. The average farm size in the US is 17, 920 Hectares, compared to 4331.21 Hectares in Australia, 16.122 Hectares in Europe, and 1.0823 Hectares in India. The implementation of Digital Agriculture in India could be severely impacted by this gap. If we want Digital Agriculture to be scalable and available to the majority of Indian farms, it must be tailored to be suitable for a typical Indian small farm [10]

In India, where food was extremely scarce, the first Green Revolution was implemented to guarantee food security. Eastern India will lead the second Green Revolution, which will use technology breakthroughs to create sustainable agriculture because that region's potential has not yet been actualized. Eastern India is the area of focus because it is where the Second Green Revolution must originate. Bihar is a prominent agrarian state in eastern India [11]. In Bihar, agriculture provides a living for more than two-thirds of the population. In an agricultural state like Bihar, it is especially important to focus efforts on the regions where the majority of the people earn their living. There must be action made to improve the income and standard of living of Bihar's farmers because they make an exceedingly inadequate average income. The agricultural revolution in Bihar has been hampered by farmers' lack of access to agricultural finance and digital transformation. Especially the rural parts of Bihar are undergoing a digital transformation. The first obstacle towards the full implementation of smart farming in rural areas is the lack of connectivity, i. e., digital divide. This study examines the serious constraints of the digitalization of the agriculture sector of Bihar. It also considers the factors that influence how people use digital technologies and services.

2. Problem Statement

There is widespread agreement that Indian agriculture has to be digitalized, and efforts are being made to digitize the existing value chain. Agriculture in the modern world is already heavily reliant on digital technology. Through the power of contemporary technology, ICTs assist in empowering the rural population by granting better access to technology, natural resources, enhanced agricultural methods, efficient production tactics, market access, and much more. [12] Digital Green and JEEViKA or government-led Bihar Rural Livelihoods Project have been partners for the last three years, using an ICT-enabled collective learning approach to promote best practices among rural community groups. The level of penetration of digital technologies in agriculture in Bihar as compared to the other states is relatively small and the introduction of advanced digital services is slow. If hurdles in adaptation of digitalization in agriculture sector would be studied,

it will provide various bottlenecks that hindered the growth of economy and agriculture sector. Moreover, if the problems or reasons of hesitation will be found out, then appropriate suggestions for the problems would be provided, which would be helpful for the policy-makers, government, and scholars.

3. Review of Literature

Some research has been done in the field of digitalization and modernization of the agriculture sector. Some of the important works are mentioned here. The authors [13] explained that a variety of factors affect the adoption of technology, and that both the impact and the degree of that adoption fluctuate widely on the farmer and the area.They also said that any agricultural technology or strategy related to it must take into account small and marginal farmers as its most important component. Similar to this, the authors [14] highlighted the political, social, and economic concerns influencing the adoption of digital technology in the agriculture sector. They argued that implementing digital technology presents major difficulties and constraints for small-scale farmers. The study's conclusions demonstrate the importance of the state's institutional support and role in governance in fostering cross-sector cooperation and engagement. The authors [15] highlight the impact of digitalization on the Indian economy in several sectors. Similarly, a study where the author noted that Digitalization of agriculture is key to the rapid evolution from the inefficient and even detrimental farming practices of the current scenario [11]. He conclude that the success of digital agriculture in India depends on the availability of low-cost technology, user-friendly portable equipment, pay-per-use rental models, legislative support, and the ability to leverage farmer collectives' strengths. In the next, [16] describe the main opportunities and difficulties brought about by digitalization processes in the agri-food sector. He said that the food system and farming issues might both benefit from digitization. Similarly, [17] explored the challenges and opportunities associated to the adoption of precision farming in India with the use of in-depth interviews with ten farmers from Hyderabad. In another paper the authors [18] stated that, especially in emerging nations, the digital divide in rural areas is a significant social problem. The study shows that the mobile platform is viewed as a cutting-edge and efficient instrument to close the digital divide and aid rural areas in achieving social and economic empowerment based on a case study of one mobile platform in rural China. Again in a study, the author [19] outlined organizational constraints and structural changes that influence the digitization process's favorable and negative effects. In one of the study, the authors [20] claimed that the biggest barrier to India's agricultural potential realization is the transfer of technology. They concentrated on the degree of contemporary technology adoption, accessibility and quality, access to extension institutions, and challenges faced by extension authorities in the transfer of technology. Further the authors [21] have been examined the problems affecting the agricultural sector in Bihar state, India, along with potential strategic interventions to adopt a multi-pronged development plan and make the greatest use of the resources at hand. Additionally, it discusses difficulties unique to the location and makes suggestions for solutions. The authors [22] presents a concise framework for outlining the key advantages of emerging information and communications technologies in his paper. The report examines current research on related technological effects in developing nations' rural sectors. Similarly a study [23] used secondary data to evaluate how digitization has affected Indian farmers. They arrive to the conclusion that digitalization may greatly boost farmers' revenue and that it has helped the agriculture industry grow and advance the economy. In the next the authors [24] aims to provide some insights on the effects of digitalization on agriculture and rural areas in terms of the digital, economic, and environmental aspects. The authors of this paper aim to identify and discuss the potential consequences of digital technology on agriculture and rural areas. They also highlight some negative impacts of digitalization i.e., Farmers may also become reliant on digital service providers, resulting in a loss of autonomy.

The researches done earlier were unable to depict some of the new and hidden hurdles in adaptation of digitals tools in agriculture sector of Bihar. Hence, this aspect has been covered in this study. Apart from that most of the previous studies are related to other states rather than Bihar.

4. Research Design/Methodology

Materials used in the analysis come from three sources- one from literature reviews, second from official

government websites/reports and third as responses of farmers towards Digital technologies in agriculture sector of Bihar. A questionnaire that has been written in both Hindi and English was used to collect the primary data. The questionnaire includes the land holding, age, farming experience, and opinion of the farmers regarding the various problems of digitalization of the agriculture sector of Bihar on a Likert scale of 1 to7. On the basis of responses collected from the 210 respondent farmers of Khagaria district of Bihar, we highlight the main constraints of digitalization which farmers are facing in the agriculture sector in Bihar. It also incorporates the researcher's personal observations and measurements of events. For the purpose of finding the mean rank of various constraints of digitalization in agriculture sector, Kendall's Coefficient of Concordance which is the non-parametric version of ANOVA has been applied. The scope of the research is limited to the agricultural sector of Bihar only. The study's limitations are addressed, and potential areas for future research are recommended.

4.1. Analysis, Findings and Discussion of Primary Data

4.2. How Digitalization Took footprints of It in Agriculture Sector?

By 2050, the globe will need to generate at least 70% more food. As a result of the widespread use and depletion of our natural resources and the dwindling size of our agricultural lands, the need to increase farm productivity raises severe ethical questions. Despite the difficulties associated with the environment, agriculture must develop to keep up with the need for food since the world's population is expanding at a very rapid rate. Future generations will utilize smart agriculture and other technology in the years to come. Common terms for the applications of IoT solutions in agriculture include smart agriculture and smart farming. Through the Internet of Things (IoT), smart farming and precision farming are enabling the agriculture sector to minimize costs, eliminate waste, improve operational efficiency, and increase crop quality. In modern technology era, drones for agriculture are one of the popular applications. Crop health assessments, crop spraying, planting, and many more operations involve the usage of aerial and ground drones. Drone technology has renewed and changed the whole agriculture sector with the appropriate planning and strategy based on real-time data. The importance of digitalization in Indian agriculture is widely recognized, and efforts are underway to digitalize the current value chain. To encourage farmers to utilize technology, the Ministry of Agriculture and Farmers Welfare has developed many important digital applications. Digital agriculture refers to the use of data and technology to inform agricultural decisions and processes, and it has the potential to make the entire agricultural sector more effective, transparent, profitable, and ethical. Using modern technologies, rural India can undergo transformation. Farmers can gain new perspectives and receive improved guidance from sensors in the field, automated farm machinery, and data from satellites and drones. A survey has been conducted within Khagaria District in Bihar with the help of questionnaire method. The Khagaria district is known as "languishing land of seven rivers" and it faces floods almost every year. With the use of tables and figures, the findings and analyses are described below (as shown in Table 1).

Table 1. Number of respondent farmers on the basis of operational land holdings.

Types of Farmers on the Basis of Operational Holdings	Numbers of Respondents Farmers
Marginal farmers (Below 1 ha)	97
Small Farmers (1 ha to 2 ha)	63
Semi-medium (2 ha to 4 ha)	31
Medium (4 ha to 10 ha)	14
Large (more than 10 ha)	5
Grand Total	210

Source: Authors' Computation using excel.

The above table mentioned total numbers and types of respondent farmers on the basis of operational land holding.

4.3. Hurdles of digitalization in Agriculture Sector of Bihar

Transformation of Agriculture sector and rural area can be done with the help of digital technologies. There are various constraints of digitalization of agriculture sector in Bihar. Some major constraints are covered in this study. The views of the farmers were taken through the rating scale on various problems in order to determine the major Constraints of digitalization in agriculture sector. Table 2 shows the degree of agreeability of different category of farmers regarding the hurdles of digitalization in agriculture sector of Bihar.

Table 2. Degree of agreeability of farmers in bihar on various hurdles of digitalization in the agriculture sectors.

Hurdles of Digitalization in Agriculture Sector of Bihar	Degree of Agreeability							
	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	GT
Hesitation in adopting digital technologies due to small and fragmented land	5	42	20	32	14	44	53	210
Lack of training and motivation to capitalization in agriculture	24	24	35	38	22	30	37	210
There are in-sufficient power supply	12	33	23	30	19	50	43	210
State inefficiencies in distributing agriculture subsidies	16	31	22	40	20	40	41	210
Internet connection is poor or slow in your area.	18	25	21	38	24	40	44	210
Lack of skill in handling ICT tools	16	25	22	48	22	39	38	210
Lack of awareness of benefit of ICT and digitals tools	17	25	17	35	30	46	40	210
Language problems	24	24	35	38	22	30	37	210
Poor understanding of technologies (lack of knowledge)	9	32	23	31	23	56	35	210
High cost of digital tools (set up and running cost)	14	43	21	35	22	45	30	210
Lack of awareness towards banking facilities	6	33	17	48	16	44	46	210

Authors own computation using SPSS 25

The above table reveals the opinion of different types of farmers regarding the agreeability of various

hurdles of using Digital technologies in farm activities on a scale of 1 to 7. In case of hesitation in adopting digital technologies due to small and fragmented land, 143 (68%) of farmers have rated 4 or more on the scale of 7 which reflects their acceptance towards that. As per results of Agriculture census 2015–16, Bihar has one of the lowest average size of land holding in hectare (0.39) among all the state. In case of Lack of training and motivation to capitalization in agriculture 127 (60%) of farmers have rated 5 or more on the scale which indicate that there are lack of motivation factors for capitalization in agriculture. Similarly, in case of remaining hurdles of digitalization, most of the farmers have rated 5 or more on the rating scale of 1 to 7Basic literacy and numeracy skills, as well as specialized technical knowledge and abilities, are necessary for using digital technology. The major obstacle for farmers in rural areas is a lack of understanding of technology. People lacking these skills may be excluded in societies that are becoming more digitally oriented. In emerging nations, rural areas may have less access to information and education than urban ones [25] Furthermore, limited access to mechanization equipment and usual natural disasters like as floods droughts, excessive and untimely monsoon rains have restricted the implementation of digital agriculture solutions [26].

5. Hypothesis Testing

H0: All the constraints covered under this study are equally act as a hurdles in digitalization of agriculture sector in Khagaria District.

The data related to the constraints / hurdles of digitalization in agriculture sector of in Khagaria District are gathered in Likert Scale at 7 points rating scale. One way ANOVA with Repeated Measures can be used to determine whether all the factors discussed in this study are equally accountable as hurdles for the digitalization in agriculture sector of Bihar. The 07 Point Likert Scale was used to quantify the data, despite the fact that they are qualitative in nature. Therefore, a parametric test can only be used if the data is normally distributed. Before employing ANOVA with Repeated Measures, it is necessary to ensure that the data collected about the evaluation of hurdles to the digitalization of the farm industry are regularly distributed (as shown in Table 3).

Table 3. Tests of Normality.

Constraints of Digitalization of Agriculture	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Hesitation in adopting digital technologies due to small and fragmented land	0.195	210	0.000	0.897	210	0.000
Lack of training and motivation to capitalization in agriculture	0.208	210	0.000	0.894	210	0.000
There are in-sufficient power supply.	0.170	210	0.000	0.919	210	0.000
State inefficiencies in distributing agriculture subsidies	0.161	210	0.000	0.919	210	0.000
Internet connection is poor or slow in your area.	0.178	210	0.000	0.905	210	0.000
lack of skill in handling ICT tools	0.217	210	0.000	0.893	210	0.000
Lack of awareness of benefit of ICT and digitals tools	0.141	210	0.000	0.919	210	0.000
Language problems	0.171	210	0.000	0.910	210	0.000
Poor understanding of technologies (lack of knowledge)	0.173	210	0.000	0.906	210	0.000

Cont.

Constraints of Digitalization of Agriculture	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
High cost of digital tools (set up and running cost)	0.210	210	0.000	0.900	210	0.000
Lack of awareness towards banking facilities	0.174	210	0.000	0.909	210	0.000

a. Lilliefors Significance Correction

Source: Authors' Computation using SPSS 25.

Based on the aforementioned Kolmogorov-Smirnov and Shapiro-Wilk test results, it can be concluded that the study's data on the obstacles of agricultural digitalization is not normally distributed. A parametric test like an ANOVA with Repeated Measures cannot be used as a result. Here, the non-parametric test of ANOVA with Repeated Measures, known as the Kendall's Coefficient of Concordance, has been used to examine the mean rank of hurdles of digitalization in the Khagaria district of Bihar (as shown in Tables 4 and 5).

Table 4. Mean rank of hurdles of digitalization of agriculture sector.

Hurdles of Digitalization in Agriculture	Mean Rank	Rank
Hesitation in adopting digital technologies due to small and fragmented land	6.46	I
Lack of training and motivation to capitalization in agriculture	6.37	II
There are in-sufficient power supply	5.61	IX
State inefficiencies in distributing agriculture subsidies	5.90	VIII
Internet connection is poor or slow in your area.	6.23	IV
Lack of skill in handling ICT tools	6.17	V
Lack of awareness of benefit of ICT and digitals tools	5.40	XI
Language problems	5.47	X
Poor understanding of technologies (lack of knowledge)	6.07	VI
High cost of digital tools (set up and running cost)	6.36	III
Lack of awareness towards banking facilities	5.97	VII

Source: Authors' Computation using SPSS 25.

Table 5. Test Statistics Kendall's Coefficient of Concordance.

Test Statistics	
N	210
Kendall's Wa	0.015
Chi-Square	31.881
Df	10
Asymp. Sig.	0.000

a. Kendall's Coefficient of Concordance

Source: Authors' Computation using SPSS 25.

Applying Kendall's Coefficient of Concordance reveals that the Significance value is less than 0.05, indicating that not all causes are equally to blame for the difficulties in digitalization in Bihar's agricultural

sector.

6. Conclusions and Suggestions

In the upcoming years, farming and food production will change significantly as a result of the digitalization of agriculture [27–29]. The above observations and results of hypothesis testing depict that the major hurdles of digitalization in agriculture sector is small and fragmented land holding of famers followed by Lack of training and motivation to capitalization in agriculture followed by High cost of digital tools (set up and running cost). Many of the farmers hesitate to move on digital technologies because without having the power supply and proper internet facilities digital transformation of farm activities are no be possible. Apart from that some of the of the respondents farmers feel that the Lack of awareness and skill to use of ICT and digitals tools State inefficiencies in distributing agriculture subsidies Lack of awareness towards banking facilities are also the restraints in using digital technologies in agriculture sector of Bihar. Affordability of technology, ease of use and operation, ease of system maintenance, internet accessibility, and supportive regulatory frameworks are crucial elements that will decide the success of digital agriculture in India Similarly, The Dalwai committee report estimates that the average farmer's income in India is Rupees 7, 797, 625 (about $1000 USD) per year, so lowering the cost of technology will make it more accessible and affordable for smaller farmers. For the typical Indian farmer, it is essential that the technology be appealing to farmers and affordable through subsidies. Natural disasters are common, particularly floods in north Bihar and drought in south Bihar. By utilizing the right crop technologies and providing crop insurance to all farmers, the risk of natural catastrophes will be reduced. Further, the government must frequently organize awareness, training, and motivational programs and must also monitor those programs. Our extension services and agriculture related academic institutions should also change their focus to digital agriculture because they are the people who are interacting with farmers for introducing anything new.

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S.K. conceptualization, methodology, software; Md.A.: data curation, writing—original draft preparation; S.K.: visualization, investigation; Md.A.: supervision; S.K.: software, validation; Md.A. and S.K.: writing—reviewing and editing. All authors have read and agreed to the published version of the manuscript.

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The authors declare no conflict of interest.

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