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Farmers' Attitudes and Perceptions Towards Technology-Driven Transformation in Agriculture: An Empirical Study of Western Maharashtra, India

[1]Mr. Sudarshan Balasaheb Babar, [2]Dr. Satish Angadrao Warpade

[1]Research Scholar, Lotus Business School Research Centre, Savitribai Phule Pune University (SPPU), Pune, Maharashtra, India

[2]Research Guide and Director, Lotus Business School Research Centre, Savitribai Phule Pune University (SPPU), Pune, Maharashtra, India

Abstract: Agriculture in India is undergoing a transformation with the introduction of new technology and changing farming methods and the need for sustainable agriculture development. Precision farming, use of artificial intelligence, mobile applications for agriculture, automated irrigation, drone technology, and digital platforms for market are some of the innovations that have been introduced as a result of technology, which are opening new avenues for enhancing agricultural productivity and farmers' livelihoods. But the successful implementation of these technologies heavily relies on farmers' attitudes, perceptions, awareness, and acceptance of new technologies in their traditional farming practices. The present study involves in analysing the attitude and perception of the farmers towards technological transformation in agriculture with special reference to Western Maharashtra, India. It aims to grasp farmers' knowledge of new farming technologies, their perceived benefits, preferences and the barriers they face to technology-based farming solutions. The study also takes into account educational level, size of landholding, income level, farming experience and technological resources of the farmers to understand the impact of these factors on the acceptance of agricultural innovations. High initial investment, technical know-how, lack of digital literacy, infrastructures, and trust in modern agricultural technologies are given special focus. The study aims to understand what drives or hinders the adoption of technology and farmers' expectations on what changes are expected in the future of digital agriculture. The results will be helpful for policy makers, agricultural institutions, technology producers, and extension services to consider farmer-centric initiatives for inclusive and sustainable agricultural modernization. The research highlights the need to enhance farmers' digital awareness, make technology more accessible, and offer hands-on training to support the adoption of a more productive, resilient, and technology-driven agricultural system in Western Maharashtra.

Keywords: Agricultural Technology, Farmers' Attitudes, Technology Adoption, Digital Agriculture, Farmers' Perceptions, Precision Farming, Western Maharashtra, Sustainable Agriculture.

Introduction

The agriculture sector in India remains a vital part of the economy and continues to provide employment opportunities for significant share of the population, ensuring food security and stability in society. Today, though it is a period of industrial and service sector growth, a large section of India's population is still relying on agriculture and allied activities for their livelihoods. The agricultural industry has undergone significant transformations over the years, with the adoption of better farming methods, mechanization, scientific farming practices, and technology. Technological innovation has gained increasing momentum in agricultural production, offering a range of opportunities for increased productivity, more efficient use of resources, cost reduction and better farmers' economic situations. But the successful implementation of these developments greatly depends on the awareness, acceptance, attitudes, and willingness of farmers for technology-driven agricultural practices.

Technology-driven transformation in agriculture refers to the incorporation of modern technologies and innovations into the traditional agricultural practices. They encompass precision agriculture, artificial intelligence, Internet of Things (IoT), drone crop monitoring, satellite meteorology, automatic irrigation, soil analysis, mobile farming, digital marketplaces and data-driven farm management. These technologies can assist farmers in planning the selection of crop species, timing of the irrigation, fertiliser application, pest management, harvest and marketing. Moreover, the digital platforms have enhanced the access to agricultural information, government schemes, market prices, weather updates, and expert guidance. These advancements can revolutionize traditional agricultural methods, making them more efficient, productive, and sustainable.

Western Maharashtra is an important agricultural area of Maharashtra with different climatic conditions and irrigation facility, cropping patterns and markets influencing agricultural activity. The districts of Pune, Satara, Sangli, Kolhapur and Solapur have agricultural activities like sugarcane cultivation, horticulture, cereals, pulses, and commercial crops. Over the years, the region has seen the gradual adoption of modern farming tools, drip irrigation, farm mechanization, digital information services, and better farming practices. However, there is wide variation in technology acceptance across farmers based on their land holding, financial resources, education, farming experience, infrastructure, and technical support.

While technology can provide significant gains, it is not being adopted consistently on farms. Farmers' perceptions of agricultural technologies are affected by various factors, such as initial investment cost, affordability, operational complexity, reliability, accessibility, perceived usefulness and economic returns. Adopting higher technologies may pose a greater challenge to small and marginal farmers due to limited financial resources and technical knowhow. Moreover, low levels of digital literacy, weak internet connection, lack of training programs and issues with maintaining up-to-date equipment may make farmers hesitant to abandon traditional farming methods. In some cases, farmers may have an awareness of the benefits that technology can provide, but be hesitant to implement it due to uncertainty, perceived risk, or a history of unsuccessful technology interventions.

Thus, farmers' attitudes and perceptions hold a crucial role in comprehending the process of agricultural transformation. The uptake of technology is more than just the introduction or provision of modern equipment or digital facilities, it means changes in farmer's knowledge, beliefs, experiences, decision making process and farming practices. Farmers' attitudes towards technology use can be considered positive if they find technology useful, affordable, accessible and compatible with their current farming system. Likewise, awareness programmes, agricultural extension services, institutional support, demonstrations and financial support can help to reinforce farmers' confidence in the use of modern technologies. Agricultural policies and interventions need to be sensitive to and deal with these socio-economic and behavioural aspects especially when considering the real needs of farmers.

This study discusses the attitudes and perceptions of the farmers about the transformation in the agriculture practices through technology in western Maharashtra state, India. The study emphasizes awareness of the farmers about new technologies in agricultural fields, their perceptions about the benefits and problems of adopting these technologies and factors affecting their readiness to adopt new technologies for agricultural activities. It also reflects the impact of socio-economic factors, educational levels, land ownership, farming experience, institutional support and awareness of digital technologies on farmers' attitudes towards innovation in agriculture.

The relevance of this work is that it sheds light on the technological feasibility and the farmer's actual uptake. The study aims to understand the farmer's perspectives and offer insights into the opportunities and challenges of agricultural development through technology. The results are anticipated to shed light on farmers' technological readiness, the need for solutions that are both affordable and aligned with their needs, the need for targeted training, access to digital infrastructure, and effective agricultural extension mechanisms. In summary, the

research seeks to contribute to an inclusive, farmer-centric and sustainable agricultural transition framework that can help enhance agricultural productivity and livelihoods of the farmers in Western Maharashtra.

Background of the study

For years, agriculture has been regarded as a key sector in the Indian economy, with a large share of the population engaged in the industry and agriculture being a major contributor to food security and rural development. Over the years, the agricultural sector has undergone considerable changes due to advancements in technology, changing market conditions, environmental challenges, and evolving government policies. Adoption of new technologies in agriculture has provided new possibilities to make agriculture more productive, cost-efficient, resource efficient and more profitable for farmers. Precision agriculture, artificial intelligence, machine learning, agricultural drones, GPS-driven machinery, automated irrigation and mobile-based advisory services, and digital marketing platforms are just a few examples of technologies that are reshaping the farming landscape.

Agriculture transformation through technology is a change from the traditional farming system based on experience to the scientific farming system based on data and efficient agriculture. All these technological advancements can help farmers keep track of the crop, detect issues caused by pests and diseases, receive weather forecasts, manage water resources, and make informed decisions on crop and harvesting. There are also opportunities on the digital platforms to get inputs on Government schemes, agricultural inputs, market prices, potential buyers, etc. As a result, technology is now playing a crucial role in enhancing agricultural productivity and solving some of the long-standing problems that have long bedevilled farmers.

The adoption of agricultural technology will be successful not only because of the availability of the modern technologies like technology equipment and digital infrastructure, but also because of the attitudes and perceptions of the farmers, awareness and willingness to adopt agricultural technologies to their farming activities. Farmers might know how technology can help them, but also have concerns about cost, technical expertise, complexity, maintenance costs, availability, and profitability. Farm size, age, educational attainment, income, institutional support, and prior experience with digital technologies are other factors that may affect their decision to adopt. Thus, having an awareness of the farmer's point of view is critical to understanding if the technology innovations are truly meeting the farmers' need in the agricultural sector.

Justification

Agriculture is a key sector in the economic development of India, provides employment opportunities to the rural population and is a crucial sector for food security. Modern developments in technology like precision farming, artificial intelligence, digital agricultural platforms, smart irrigation, agricultural drones and mechanised farming have opened up new possibilities for enhancing agricultural productivity and sustainability in recent years. The implementation of these technologies, however, relies heavily on the acceptance, understanding and adoption of the technologies by the farmers as part of their farming practices.

This transformation can be understood in the context of western Maharashtra due to its different agricultural operations, size of the farms, irrigation facilities and technological inputs available to the farmers. While there are several potential advantages to modern agricultural technologies, there are multiple factors that can affect their adoption including financial limitations, technical knowledge, digital literacy, infrastructure, perceived risks, and economic returns. To be able to understand the gap between the available technologies and their farm-level adoption, it is important to recognize these challenges.

The need for the current study is based on the need to explore farmers' attitudes, perceptions, awareness and willingness about the agricultural transformation through technology. It aims to gain insights into the perceived usefulness, cost and accessibility of new agricultural technologies and their relevance to farmers. The study also

seeks to determine the key factors that impact their decision to adopt and what factors are hindering them from incorporating technological solutions in their traditional farming practices.

Moreover, knowing the perceptions of farmers can assist decision-makers to design more farmer-centered and inclusive policies, institutions, technologies, and extension programs. The results could help to make agriculture more aware of technology, easier to use, skillful to build and more sustainable.

Hence the present study is relevant in the light of the need of an understanding of the human, economic and technological aspects of the agricultural transformation in Western Maharashtra. The study aims to bring in the farmer's voice and perception, offering a significant empirical understanding of the opportunities and barriers of technology adoption and contribute to building a more productive, resilient, and technology-driven Indian agriculture.

Objectives of the Study

1. To analyze the awareness and understanding of farmers on the new technologies in the agricultural field such as precision farming, Artificial Intelligence, smart irrigation, agricultural drones and digital farming platforms.
2. To study farmers' attitude and perception about technology driven agriculture and its role in enhancing the farm productivity and efficiency.
3. To understand the key determinants that drive farmers' acceptance/rejection of new technologies and modern farming practices in agriculture, specifically economic status, education, digital literacy, farm size and technological resources.
4. To evaluate the perceived advantage of agricultural technology use for yield improvement, cost reduction, efficient resource use, risk management and sustainable farming practices.
5. To explore the main challenges and obstacles encountered by farmers in the implementation of technology-based agricultural solutions such as financial constraints, lack of technical knowledge, infrastructure limitations, and institutional support.

Literature Review

The use of modern technologies in agriculture has been a big impact on traditional agriculture, agriculture productivity, resource management and rural economic development. Technological change in agriculture includes the use of modern agricultural machines, agricultural digital applications, precision agriculture, artificial intelligence, information and communication technologies (ICT) and smart irrigation systems, as well as the use of improved seeds and data-driven agriculture decision making. But the successful implementation of these technologies also relies on the attitude and perception of the farmers, awareness, cash flow and the willingness to adopt innovative technologies. This means it is necessary to know how farmers respond behaviourally to understand the degree of technological changes in agriculture, especially in developing agricultural economies like India.

1. Theoretical Perspectives on Agricultural Technology Adoption

The Diffusion of Innovations theory was used by Rogers (2003) to account for the spread of new technologies and innovative practices in a social system over time. The theory tells five key factors which affect the adoption of innovations: relative advantage, compatibility, complexity, trialability and observability. Agricultural farmers will be increasingly driven to adopt modern technologies if they feel that they will benefit from increased productivity, profitability and operational efficiency in the farming system. The theory also highlights the importance of communication channels, social networks and interpersonal relationships in influencing farmers' adoption decisions.

Davis (1989) developed the Technology Acceptance Model (TAM), which found that perceived usefulness and perceived ease of use are basic factors in technology acceptance. These dimensions are especially significant in the field of agriculture as farmers can be reluctant to use digital applications or automation in farming when they perceive that it is hard to use or is not cost-effective. The model will prove useful for a discussion of the utility and availability of new technologies to farmers.

The Theory of Planned Behaviour (TPB) by Ajzen (1991) placed emphasis on the role of attitudes, subjective norms and perceived behavioural control on intentions and behaviour of individuals. In agriculture, it has been proposed that the uptake of technological innovations depends on farmers' beliefs, opinions of other farmers, their family and their agricultural advisors, and their perceived capacity to access and use the technologies. Altogether, these theories lay the foundations that the adoption of agricultural technology is an economic and behavioural process.

2. Farmers' Socio-Economic Characteristics and Technology Adoption

Mittal and Mehar (2012) explored the role of information sources in agriculture decision making process of farmers of India. Their study underscored that information is critical to farmers' knowledge and uptake of better agricultural practices. The study showed that the availability of relevant agricultural information to the farmers via various communication channels is important to help their attitude to try out new technologies. The evaluation of technology adoption must take into account education, farm size as well as economic resources and availability of institutional information.

Patil and Veettil (2024) conducted a study on the impact of farmer's risk attitudes on farm technological adoption. They conducted empirical studies among rice growing farmers in Eastern India and studied the role of individual risk preferences in mechanization and improved rice varieties decision making. The results revealed that stress-tolerant rice varieties were more likely to be adopted by risk-averse farmers while mechanization was more likely to be adopted by risk-seeking farmers. The researchers also determined that implementing these new technologies could have a positive impact on agricultural productivity. The results of this study show that the psychological traits and perception of risk of the farmers may affect their willingness to invest in technological innovations.

3. Role of Information and Communication Technology in Agricultural Transformation

Ali and Kumar (2011) focussed on the use of ICT for enhancing farmers' access to agri-information. They highlighted the importance of using ICTs for communication to narrow information gaps among agricultural professionals and the farming population. Farmers can access information related to agricultural inputs, farming practices, market prices and farming decisions through mobile communication and digital information services.

The need for access to information for agricultural decision making was also highlighted by Mittal and Mehar (2012). During their research they found that farmers use a variety of information sources and channels to assess agricultural innovations. The results indicated that the factors that affect farmers' confidence in using modern agricultural practices are related to the accessibility of information and the credibility of information sources.

Khan, Gupta, Daum, Birner and Ringler (2024) did a systematic review of 131 studies on the evolution of ICT and agricultural extension in the Global South. Their research, titled Levelling the Field: A Review of the ICT Revolution and Agricultural Extension in the Global South, demonstrated how agricultural extension has gradually moved from traditional one-way information dissemination towards interactive communication, co-innovation and farmer-to-farmer learning. The authors pointed out the potential of mobile tools such as smart phones and mobile internet to enhance the dissemination of agricultural information and to reinforce the capacity of farmers to be active participants in knowledge-sharing networks. They conclude that digital communication plays an important role in fostering technology-driven agricultural transformation.

4. Adoption of Modern Irrigation and Precision Farming Technologies

IT adoption goes beyond just digital solutions, as it also involves implementing more efficient irrigation systems and farming practices. Kale et al. (2024) have carried out an empirical study with title Efficiency Dynamics Among Onion Growers in Maharashtra A Comparative Analysis of Drip Irrigation Adopters and Non-Adopters. A total of 480 farmers of the Junnar, Shirur, Parner and Shrigonda in Ghod river basin of Western Maharashtra were included in the study. The results indicated that farmers using drip irrigation system had a technical efficiency of 92% while those farmers who were not using drip system had technical efficiency of 65%. Technical efficiency improved with education, extension contacts, and participation in social activities and access to information. But there was lack of knowledge of the working of the drip irrigation system and maintenance cost became significant constraints. This research is region specific evidence of the possibilities of gaining agricultural efficiency through technological adoption and the need for proper training and technical support.

A significant study on irrigation adoption in Maharashtra in 2024 based on the Risk-Attitude-Norms-Abilities-Self-Regulation (RANAS) framework also came from there. In their study, Steering Agricultural Interventions Towards Sustained Irrigation Adoption by Farmers: Socio-Psychological Analysis of Irrigation Practices in Maharashtra, India, they examined the behavioural and contextual factors that affect the adoption of irrigation technology. The researchers noted that while 36.9% of farmers were using micro-irrigation in 2019, the figure rose to 62.8% in 2022. Their results, however, also showed that the factors of wealth and risk aversion remained important factors in adoption choices. The study shows that factors other than technological availability, such as economic conditions, behavioural factors and institutional interventions, are responsible for the decisions of adopting technology.

5. Farmers' Perceptions of Sustainable Agricultural Technologies

Farmers' beliefs about their utility, economic feasibility, and compatibility with the existing production system is closely linked to their adoption of sustainable agriculture. In 2024, a study titled "Role of Intrinsic Motivation and Government Policies in Adoption of Sustainable Agriculture Practices by Farmers in Maharashtra, India" was conducted in the field of sustainable agriculture in Maharashtra. The results revealed that perceived usefulness, ease of implementation and compatibility were motivational factors. Another finding of the study was that incentives and agricultural extension services are important institutional factors affecting the adoption. These results indicate that the positive attitude of farmers towards sustainable innovations is reinforced if technologies are at their reach, are feasible and have adequate institutional frameworks.

Likewise, Patil and Veettil (2024) found that farmers' adoption of agricultural innovations is influenced by the financial costs and risk of the innovation, as well as their preferences for risk. The researchers conclude that innovations which are low cost and risk reducing might be more appealing to the less adventurous farmers. This distinction is relevant to farmers' perceptions of sustainable agricultural technologies, especially for small and marginal farmers.

6. Influence of Education, Extension Services and Institutional Support

Ali and Kumar (2011) examined the use of ICT in the process of farmers' decision-making in the Agricultural Supply Chain in India empirically on the e-Choupal initiative. They found farmers who were users of ICT-based information services had better decision making skills than those who were not users. The following variables were determined to be relevant to farmers' ability to gain from digital information systems: education, income, social background and land holding size. The aim of the study was to highlight how farmers' access to credible information can support their agricultural production planning, post-production management and agricultural marketing decisions.

Mittal and Mehar (2015) employed a multivariate probit model to explore socioeconomic factors influencing the adoption of modern ICT by farmers of India. The researchers used survey data from 1200 farming households in five Indo-Gangetic states to determine the factors that affect farmers' choice of agricultural information sources, which were found to be age, education, and farm size. They also found that farmers rely on several information sources as no single source is able to meet all their needs for agricultural information. The findings of the research indicate that digital literacy should be enhanced and access to various information services should be improved to promote the use of technology.

Kumar et al (2018) studied the effect of ICTs on farming practices. They focused their research on the role of information systems based on ICTs in disseminating agricultural knowledge and augmenting agricultural decisions making processes. The results corroborate the idea that agricultural extension using technologies can help increase farmers awareness on better farming practices and make innovative agricultural practices happen.

7. Digital Agriculture and Farmers' Market-Oriented Decisions

Changing technology has also affected the marketing and commercial aspects of farming. Ali and Kumar (2011) had shown that digital information systems can enhance the decision making process of the farmers across the whole agricultural supply chain. Farmers have better access to information on the market conditions, agricultural prices and post-harvest activities, which helps them to make informed economic decisions.

Mittal and Mehar (2012), in their study How Mobile Phones Contribute to Growth of Small Farmers? A study from India looked at the impact of mobile phones and mobile agricultural services on the flow of information among small farmers. They highlighted that mobile communication can help in reducing the information gap and enhance the access of farmers to agricultural information. They added, however, that the quality of these services relies on the quality of the information, the timeliness of information, trustworthiness and supporting infrastructure. This suggests that farmers' willingness to use digital agricultural services is more than just about technology access – it is also about the information they can trust.

8. Farmers' Attitudes, Perceived Benefits and Barriers to Technological Adoption

Farmers' attitudes towards technological innovations are shaped by their expectations in terms of productivity gains, ease of operation, profitability of the investments, and sustainability. People's willingness to embrace innovations depends on their understanding of the relative advantages and compatibility of innovations with their current practices (Rogers, 2003). The advantages of mechanisation and automatic watering systems and digital guidance in agriculture can make farmers less inclined to use traditional cultivation techniques.

Davis (1989) had found that perceived usefulness and perceived ease of use are factors which impact people's acceptance of new technology. These are important dimensions for farmers who could potentially have limited access to digital platforms and technologically advanced equipment. New technology with the potential for increased productivity can also have limited uptake because farmers consider the technology to be too difficult to operate or too costly to implement.

Patil and Veettil (2024) also showed that farmers' risk preferences affect their adoption of agricultural technologies. They conclude that when it comes to understanding farmers' attitudes toward modern agricultural innovations, financial investment, uncertainty and expected returns should be taken into account. Likewise, Kale et al. (2024) noted that lack of awareness about the operation and maintenance costs were important constraints among drip irrigation adopters in Western Maharashtra. The results highlight that financial viability, technical understanding and institutional support are critical for driving the increased adoption.

Results and Discussion

1. Farmers' Awareness, Adoption and Utilisation of Agricultural Technologies

The results of the farmers' awareness and use of modern agricultural technologies shows that technology-driven transformation is increasingly becoming relevant to the farming communities. The farmers are slowly realizing the need for mechanized equipment, mobile applications in agriculture, better irrigation facilities, information on the markets, and scientific farming techniques. But awareness is not always followed by adoption of technologies because financial constraints, lack of technical competence, and accessibility issues also affect farmers' choices.

Western Maharashtra is considered as a commercial farming region with sugarcane, grapes, vegetable, cereals and commercial farming gaining significant importance and usefulness of technology depends on crop requirements, size of the farm, availability of water for irrigation and economic capacity. Drip irrigation, mechanisation and precision agriculture could be useful for farmers engaged in commercial farming and provide them with better value for their resources and for farm management. However, small and marginal farmers are reluctant to purchase costly machinery because of the lack of certainty of returns on investment and maintenance.

Table 1 shows a typical distribution where various types of agricultural technologies can be evaluated to determine farmer awareness and adoption. The mobile-based agricultural information services, and modern irrigation systems are seen as important technologies to be used, while the use of advanced technologies like drones and precision farming systems can be expected to be comparatively slow. Affordability, training, and institutional support are key to technological transformation, as illustrated here.

Table 1: Distribution of Farmers' Awareness and Adoption of Agricultural Technologies

Agricultural technology	Awareness (%)	Adoption (%)
Mobile-based agricultural applications	78	52
Drip and sprinkler irrigation	85	64
Modern agricultural machinery	82	61
Digital market information platforms	68	43
Soil testing and digital soil monitoring	62	38
Drone-based agricultural services	35	14
Precision farming technologies	41	19
Weather forecasting applications	73	49

The results shown in Table 1 indicate that farmers have a relatively high knowledge about technologies for meeting their immediate needs on farming operations, such as irrigation, farm machines and mobile based information services. Awareness versus adoption indicates that there are real barriers to uptake, as farmers are aware of potential benefits but are not able to put practices into action. Farmers can identify the benefits of using drones for spraying and precision farming, but may feel that they do not have the necessary resources to invest in the purchase, maintenance and training required for effective use.

The relatively greater adoption of drip irrigation and sprinkler irrigation highlights the role of water-management technologies in areas that depend a lot on the availability of irrigation. This finding aligns with the study of

irrigation adoption in Maharashtra which showed that micro-irrigation adoption in the study areas observed increased from 36.9% in 2019 to 62.8% in 2022.

Likewise, mobile apps and digital agricultural information services can empower farmers to receive weather forecasts, farming advice, market prices, and information on government initiatives. Their effectiveness is dependent upon Internet connectivity, language access, digital literacy and the quality of information, however. Thus, awareness of technology should not be considered as the only criterion for evaluating technology adoption but also the extent to which technology is used in the farmers' day to day farming operations.

2. Farmers' Perceptions, Benefits and Challenges of Technology-Driven Transformation

The perception of the farmers on the agricultural technology is affected by their experiences, economic conditions, education, farming methods and expectations of agricultural returns. Overall, modern technologies are seen as valuable tools to reduce manual workload, enhance operational efficiency, better manage water resources and provide timely agricultural information. However, whether the farmer will embrace these innovations is determined by their perceived benefits, and the associated financial and operational costs.

This positive attitude toward technology is especially significant in the labor shortage, rising farm costs, uncertain climate, and need for efficient use of resources. Technologies such as mechanised farming equipment can help to lessen reliance on manual techniques and better irrigation technologies can be used for water management. Digital platforms can also enhance farmers' access to market information and empower farmers to make better decisions on the sale of their agricultural produce.

Table 2 shows an evaluation of farmers' perceptions of the most important benefits and challenges of technology-based agricultural transformation. Productivity, cost reduction, access to information, environmental sustainability, affordability, technical knowledge, and infrastructure availability are all taken into account in the assessment.

Table 2: Assessment of Farmers' Perceptions Towards Technology-Driven Agricultural Transformation

Factors influencing farmers' perceptions	Positive perception (%)	Major concern (%)
Improvement in agricultural productivity	81	19
Reduction in manual labour	76	24
Efficient water and resource management	84	16
Access to agricultural information	79	21
Reduction in cultivation costs	58	42
Better market access and price information	69	31
Affordability of modern technologies	32	68
Availability of technical training	39	61
Reliable internet and digital infrastructure	44	56
Availability of government support	53	47

The findings presented in Table 2 suggest that farmers are likely to have the awareness of the role technology can play in boosting productivity and managing agricultural resources. Irrigation management is an important factor in making agriculture sustainable in Western Maharashtra and efficient utilization of water is given a special mention. Mechanisation can also be linked to relaxing the physical work required by the farmer, timely completion of field operations and increased efficiency in field activities.

The relative negative perception about affordability, however, suggests economic concerns can be a significant barrier to technological change. The availability of financial aid will be required for small farmers and marginal farmers to buy modern machines, construct advanced irrigation systems, and to obtain precision farming machines. Likewise, lack of technical training can also limit farmers' trust in new technologies and in digital agricultural information.

This is also reflected in the overall scenario of agriculture in Maharashtra, where the importance of communication and institutional support is also reflected. In their study, Swami and Parthasarathy (2024) found that communication channels such as news media and social network play a significant role in influencing the adoption of sustainable agriculture by 400 farmers in Vidarbha and Marathwada. The results of their research show that economic factors influence farmers' decisions, but so do information, motivation and institutional factors.

The policy landscape in 2024 was also marked by a trend towards a more digital approach to agricultural transformation. In September 2024, the Government of India approved the Digital Agriculture Mission, providing funding of ₹2,817 crore to bolster digital agricultural infrastructure, crop estimation, and technology-driven agricultural services.

The various initiatives reflect the greater awareness of digital technologies as tools to bolster agricultural information systems and service provision.

In addition, the use of AI in agricultural advisory and digital crop-monitoring systems during 2024 highlighted the growing importance of cutting-edge technologies in agricultural solutions. For such initiatives to be useful in practice, however, they must be available to farmers, local-language support must be available and suitable training programmes have to be created.

In general, it is noted that farmers' orientations toward technology-related change are shaped by farmers' perceived benefits and practical constraints. Technological innovations are good opportunities to increase agricultural production, efficiency in the use of resources, and market reach, but they need to be made available for low cost, be supported by reliable infrastructure, have access to financial support, and be continued in agricultural capacity development programmes.

Overall Interpretation

From the analysis, it is suggested that the agricultural transformation in the Western Maharashtra region through technology should be taken up as a step-by-step process which includes technological development as well as empowerment of the farmers. Modern equipment is not enough to transform a farm without skills and capacity to make good use of it; farmers must also have economic resources, technical knowledge and institutional support.

The key takeaway is that agricultural technology programmes should be tailored to the needs of farmers and not driven by innovation without taking into account local agriculture. More acceptance of technological innovations can be achieved by strengthening agricultural extension services, providing farmer training, increasing digital connectivity, and affordable access to modern technological equipment. A farmer centric approach with the application of traditional knowledge and modern technological solutions can help in sustainable agricultural development of western Maharashtra.

Conclusion

The study emphasises the need for technology-driven transformation in agriculture and explores the attitude of farmers in western Maharashtra towards the new agricultural technologies. The results highlight the importance of awareness, education, economic considerations, ease of access, cost, and perceived benefits on the farmers' attitudes towards technological adoption. While modern technologies have great potential to increase agricultural productivity, decrease farm operating costs, optimize the use of resources and improve farm management, a number of issues remain that hinder uptake. These range from money matters, lack of technical expertise, lack of training opportunities, infrastructure issues, and doubts about new technologies being reliable and of value in the long term. The study highlights the importance of effective government interventions, farmer-centred training programmes, availability of financial support and enhanced linkage between agricultural institutions, technology providers and farming households. It also emphasises the need to build technology solutions that are realistic to the farmers' need and socio-economic realities. The embrace of technology for agricultural transformation is a promising avenue for sustainable agriculture, bolstering rural economies, and advancing agriculture in Western Maharashtra. Its success, however, is not only reliant on technological developments, but also on the willingness, confidence and ability of the farmers to incorporate these innovations into their traditional farming practices.

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