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Behavioural analysis of farmers towards adoption of agricultural technologies in Satna district Madhya Pradesh

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Abstract

This study was conducted in the Satna district of Madhya Pradesh to determine the adoption behavior of farmers regarding agricultural technologies. Agriculture modernization of the peasant communities witnessed a serious problem of rural-urban migration. Migration causing lack of job opportunities, lack of high educational facilities, Considering the above few facts, the present study was planned with a scope of assessing effect of agriculture modernization of peasant communities. To study about the social and occupational change occurred as a result of agriculture modernization. The study was conducted in Satna district. There are 7 blocks in Satna district, out of which Majhagawan and Sohawal block was selected for the study. A list of villages where farmers were doing modern farming was prepared with the help of Senior Agriculture Development Officer, out of which 4 villages were selected randomly. A list of farmers, who were doing modern farming, was prepared with the help of RAEO's of block out of which 30 farmers from each village were selected on the basis of random sampling method. Thus total 120 farmers were considered as sample size of the study. The data were collected using survey method through a pre-tested interview schedule and responses were recorded. After data collection, analyzed using the SPSS software. Different statistical tools were applied based on the nature of the variables. For the independent variables (like age, education, and land holding), simple descriptive statistics such as mean, percentage, scoring, and standard deviation (SD) were used. The dependent variable, which is the overall adoption of agricultural technologies, was calculated using the Adoption Quotient (AQ). The results show that most of the farmers have a medium level of adoption (51.67%). Farmers are using mobile Agro-advisories the most, which got the highest score (AQ = 66.56%). On the other hand, the adoption of agricultural drones is the lowest (AQ = 41.17%) because they are very expensive. We also did a Multiple Linear Regression analysis in SPSS. The result ($R^2 = 0.712$) proves that the knowledge level, risk-taking ability, land holding size, and annual income of the farmers have a very strong positive impact on their technology adoption.

Keywords: Precision agriculture, adoption quotient, farmers behavior, multiple linear regression, technology use, adoption level

Introduction

Agriculture is the main source of income for most of the rural families in India. However, today farmers are facing many new problems like high cost of cultivation, low crop yield, and bad weather conditions. To solve these daily farming problems, many new tools and methods have come into the market. These new methods are together called Precision Agricultural Technologies (PAT). Examples of contemporary agricultural tools include soil health cards, drip irrigation systems, farming drones, and mobile agriculture applications. These innovations enable farmers to conserve water, minimize fertilizer usage, and enhance overall profitability. The rapid adoption of modern farming techniques is crucial for maintaining profitability and competitiveness in the agricultural market. In many developing regions, however, numerous farmers continue to employ outdated and traditional methods. These outdated techniques are both the main cause and the result of their low

income. Because of this, introducing new technological changes and modernizing the farms are considered the main engines for economic growth and the overall development of the farming community.

In rural areas, agriculture remains the primary source of livelihood for about 86 percent of households. Furthermore, around 75 percent of the poor population lives in villages and depends heavily on farming and allied activities for their daily income. Given that the agricultural sector is fundamental for providing food, employment, and income, it serves as a primary driver of growth in developing nations. To sustain this growth, modernization of agriculture is imperative. This process involves transitioning from traditional cultivation practices to technologically advanced farming methods. However, the mere availability of new tools in the market is insufficient.

The real question is whether the farmers are actually using them in their villages or not. Usually, big and rich farmers

buy these machines very easily. But small and marginal farmers think many times before taking the risk to spend money on new technology.

After the year 1966, the use of modern farming inputs has grown at a steady rate of 10 percent every year. In comparison, the use of traditional farming inputs increased by only 1 percent during the same time. To promote these modern methods, the Government of India established many large mechanized state farms and field demonstration units. The main purpose of these demonstration farms is to educate and encourage farmers to use advanced agricultural tools, better quality seeds, and modern cultivation techniques. In the Satna district, the agriculture department is doing many programs to help farmers, but the practical use of precision farming is still low. Some farmers use mobile apps, but very few use drones or micro-irrigation. Therefore, this study was planned to see the ground reality. The main aim of this study is to find out the current adoption level of these technologies. It also tries to find out the socio-economic reasons and main problems that stop farmers from using these modern tools.

Materials and Methodology

Since this study related to the district Satna, Madhya Pradesh as such studies were strictly undertaken in the district. The result of this study was well acquainted with the various occupation stratification of population level, village cottage industries and the socio-cultural condition of the area. Secondly the university is situated in the district. The researcher conducted his field work during study the period of post-graduation. Satna District is a district of Madhya Pradesh state in central India. The town of Satna is the district headquarters. To collect primary data, we visited the villages and talked to the farmers directly. We used a structured interview schedule for face-to-face data collection. After collecting the data from the field, it was analyzed using the SPSS software. We used statistical tools like Adoption Quotient (AQ), Multiple Linear Regression, and Garrett's ranking technique to get the final results.

Results

Overall Extent of Adoption of Agricultural Technologies

Table 1: Comparative Adoption Quotient of selected Precision Technologies

S. No.	Precision Technology	Adoption Quotient (AQ%)	Adoption Category	Rank
1.	Mobile Agro-Advisories/Apps	66.56	Medium-to-High	I
2.	Soil Health Cards (SHC)	63.72	Medium	II
3.	Micro-irrigation (Drip/Sprinkler)	53.61	Medium	III
4.	Agricultural Drones	41.17	Low-to-Medium	IV

Overall distribution of respondents based on their composite Adoption Quotient

Table 2: Overall distribution of respondents based on their composite Adoption Quotient

S. No.	Category (Overall Adoption Level)	Score Range (AQ)	Frequency (f)	Percentage (%)
1.	Low Adoption	< 33.33%	45	37.50
2.	Medium Adoption	33.33% to 66.66%	62	51.67
3.	High Adoption	> 66.66%	13	10.83
	Total		120	100.00

Discussion

Twelve variables, namely Education (0.458), Land Holding (0.612), Annual Income (0.585), Farm Power Availability (0.543), Knowledge Level (0.684), Attitude (0.592), Innovativeness (0.515), Scientific Orientation (0.495), Risk-

Taking Ability (0.635), Decision-Making (0.384), Information-seeking (0.472), and Social Influence (0.312) were found to be positively and highly significantly correlated with the adoption of PAT at the 0.01 level of probability.

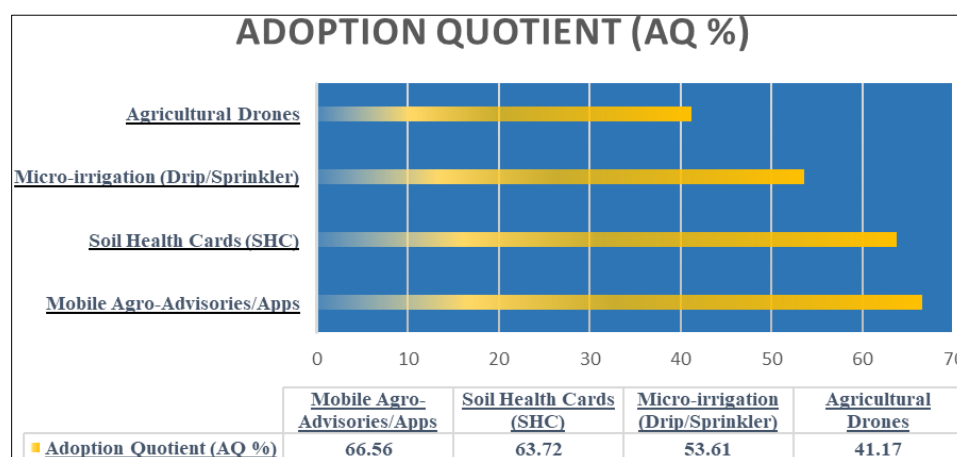


Fig 1: Bar chart showing the overall distribution of respondents based on their extent of adoption of Precision Agricultural Technologies

The strongest correlation was found with 'Knowledge Level' ($r = 0.684$) and 'Risk-Taking Ability' ($r = 0.635$). This makes sense because precision agriculture requires the use of sophisticated digital tools, such as drones and apps, along with significant financial investment. Consequently, farmers with greater technical expertise and a higher capacity for risk are much more inclined to embrace these technologies.

Large landholdings and higher annual incomes serve as economic buffers, allowing farmers to invest in expensive technologies such as micro-irrigation and drone spraying. Among the 12 variables analyzed, six emerged as the most significant positive predictors of adoption. Knowledge Level ($t=4.058$), Risk-Taking Ability ($t=3.125$), Land Holding ($t=3.000$), and Annual Income ($t=2.897$) were highly significant at the 1% probability level. Additionally, Education Level ($t=2.256$), Attitude ($t=2.028$), and Information-Seeking Behaviour ($t=2.078$) were significant at the 5% level. The other variables did not demonstrate a statistically significant contribution in this combined model.

Table 1: clearly delineates the adoption hierarchy among the respondents, with Mobile Agro-Advisories ranking first (AQ = 66.56%), closely followed by Soil Health Cards (63.72%). Both technologies require minimal to no capital investment from the farmers.

Conversely, capital-intensive technologies like Micro-irrigation (53.61%) and Agricultural Drones (41.17%) occupied the third and fourth ranks, respectively.

The composite data in Table 2 highlights the overall technological positioning of the farmers in the Satna district. It is evident that the majority of the respondents (51.67%) possessed a 'Medium' overall extent of adoption, followed by 37.50 per cent with a 'Low' level. Only a marginal fraction (10.83%) achieved a 'High' overall adoption level.

The diffusion of precision agriculture within the study area is presently in a transitional phase. Farmers demonstrate a high

receptivity to accessible digital information and basic interventions; however, they encounter substantial operational and financial obstacles in adopting advanced hardware-based precision tools. The use of Garrett's Ranking Technique offers a highly accurate and prioritized roadmap of the challenges faced by farmers, which directly aligns with our previous findings. The predominance of economic constraints (Rank I) is consistent with the socio-economic profile, where the majority of respondents are identified as small or marginal farmers with limited annual incomes..

Once the economic barrier is acknowledged, the secondary issue is capacity building (Rank II). Even if the government provides subsidies to buy a drone, the farmers do not know how to operate or calibrate it due to a severe lack of localized, practical training camps by agricultural agencies. The fear of machinery breaking down and the high cost of repairing these complex digital tools further deters adoption (Rank III). While network connectivity is an issue (Rank IV) for mobile apps, it is a secondary problem; if a farmer cannot afford the technology (Rank I) or does not know how to use it (Rank II), the network strength becomes irrelevant.

Perceived Constraints in the Adoption of PAT (Using Garrett's Ranking Technique)

To identify and prioritize the major bottlenecks restricting the actual adoption of precision agricultural technologies, the respondents were asked to rank the four major operational and economic constraints from Rank I to Rank IV.

The collected data was analyzed using Garrett's Ranking Technique. The percent position of each rank was calculated and converted into Garrett scores using Garrett's conversion table. The total score and mean score for each constraint were calculated to assign the final ranks. The results are presented in Table 3.

Table 3: Prioritization of constraints in PAT adoption using Garrett's Ranking ($N = 120$)

S. No.	Constraints in PAT Adoption	Rank I	Rank II	Rank III	Rank IV	Total Garrett Score	Mean Score	Final Rank
	Garrett Value for each rank ->	(73)	(58)	(42)	(27)			
1.	High initial investment cost of precision equipment.	75	25	15	5	7690	64.08	I
2.	Severe lack of operational knowledge and technical training.	30	60	20	10	6780	56.50	II
3.	High repair and maintenance cost of modern machinery.	10	25	65	20	5450	45.41	III
4.	Poor technical support and digital network connectivity.	5	10	20	85	4080	34.00	IV

(Note: Total Score is calculated by multiplying the frequency of respondents under each rank with their respective Garrett value. Mean Score = Total Score $\div$ 120)

Results

The analysis based on Garrett's ranking technique in Table 3: reveals the exact hierarchy of constraints faced by the farmers in the Satna district.

The "High initial investment cost of precision equipment"

emerged as the most severe constraint, securing the highest mean score of 64.08 and being placed at Rank I. This was followed by the "Severe lack of operational knowledge and technical training" which obtained a mean score of 56.50 and was placed at Rank II.

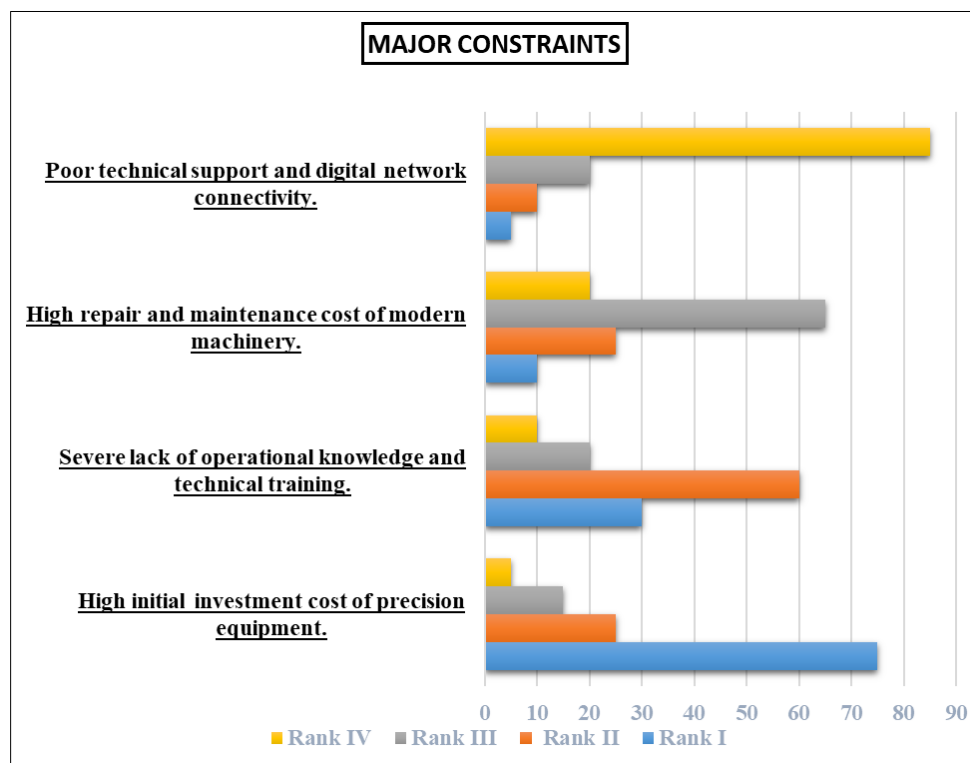


Fig 2: Bar diagram illustrating the major constraints perceived by the farmers in the adoption of Precision Agricultural Technologies

Furthermore, the "High repair and maintenance cost of modern machinery" was identified as the third most pressing issue (Mean Score 45.41, Rank III). Finally, "Poor technical support and digital network connectivity" was ranked last (Rank IV) with a mean score of 34.00, indicating it is a relatively lesser hurdle compared to economic and knowledge constraints.

Discussion

The application of Garrett's Ranking Technique provides a highly accurate, prioritized roadmap of the farmers' struggles, directly correlating with our previous findings.

The supremacy of the economic constraint (Rank I) perfectly validates the socio-economic profile (Table 1), where the majority of respondents were identified as small or marginal farmers with limited annual incomes. Precision farming tools—like drones, GPS-guided tractors, and micro-irrigation setups are extremely capital-intensive. For a small-scale farmer, arranging this massive initial capital is the biggest and most immediate roadblock, overpowering all other factors.

Once the economic barrier is acknowledged, the secondary issue is capacity building (Rank II). Even if the government provides subsidies to buy a drone, the farmers do not know how to operate or calibrate it due to a severe lack of localized, practical training camps by agricultural agencies. The fear of machinery breaking down and the high cost of repairing these complex digital tools further deters adoption (Rank III). While network connectivity is an issue (Rank IV) for mobile apps, it is a secondary problem; if a farmer cannot afford the technology (Rank I) or does not know how to use it (Rank II), the network strength becomes irrelevant.

Conclusion

The study concludes that measuring technology adoption

through the Adoption Quotient (AQ) gives a clear picture of farmers' behavior. It is not just a simple "yes" or "no" decision. The results show that farmers have a very high level of motivation to adopt new technologies. However, the actual area covered and the duration of use for expensive tools like Drones and Micro-irrigation are very low. This proves that bad financial conditions stop these small farmers from using modern tools on a large scale, even when they want to.

Since the majority of the respondents are small and marginal farmers with low annual income, they cannot take big financial risks. Because of this, they easily adopt 'zero-investment' precision tools like Mobile Agro-Advisories and Soil Health Cards. But they try to avoid buying costly machines. Furthermore, the study found that there is a practical knowledge gap. Farmers know what the technology is, but they do not have the technical training to operate it in the field.

Overall, the behavioral analysis clearly proves that the farmers of the Satna district are progressive and have a scientific mindset towards Precision Agricultural Technologies (PAT). They are not against modern farming. The slow speed of technology adoption in this area is not because the farmers are traditional or backward. Instead, it is purely because of their poor economic condition and the lack of proper operational training at the village level. Therefore, providing financial support and local capacity-building training is the only way to successfully shift them from traditional to precision farming.

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