



Evaluating the Adoption Levels of IPM among Vegetable Cultivators in Eastern Uttar Pradesh

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HIGHLIGHTS

- 49.16 per cent of vegetable growers exhibited medium adoption, with cultural practices like deep ploughing better adopted than biological or mechanical methods due to labor and knowledge constraints.
- Education, landholding size, and extension contact positively impacted IPM adoption, while social participation and scientific orientation had minimal or negative correlations.
- Low adoption of biological and mechanical methods stems from labor intensity, technical challenges, and farmers' preference for chemical controls, highlighting the need for targeted training and resource support.

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ABSTRACT

This study examines the adoption of Integrated Pest Management (IPM) practices among vegetable growers in Mau District, Uttar Pradesh, during 2022-2023. Two significant blocks, Ratanpura and Kopaganj, were purposively selected, with data collected from 120 respondents across 12 randomly chosen villages. Respondents were categorized into marginal, small, medium, and large growers. Using a semi-structured interview schedule, adoption levels were measured, revealing that 49.16 per cent of respondents had a medium level of IPM adoption. Correlation analysis demonstrated that socio-economic factors, including age, education, landholding, income, risk orientation, and extension contact, had a significant positive relationship with IPM adoption. Conversely, social participation and scientific orientation exhibited significant negative correlations with adoption levels, while marital status and family type had a non-significant positive association. These findings underscore the necessity for policy interventions aimed at overcoming barriers to IPM adoption. Enhancing the accessibility and quality of extension services, implementing targeted training programs to improve awareness, and providing financial incentives and infrastructural support. Promoting sustainable pest management practices not only improves agricultural productivity but also strengthens ecological balance, contributing to long-term agricultural sustainability. These results suggest that increased socio-economic factors are associated with greater IPM adoption among vegetable growers.

INTRODUCTION

Horticultural crops include a wide variety of fruits, vegetables, flowers, and plantation crops, with vegetable farming being particularly attractive due to its higher profitability compared to

field crops. Vegetables play a crucial role in crop diversification, employment generation, and enhancing nutritional security, improving farmers' economic conditions. They are rich in vitamins A and C, proteins, and fibers, contributing to human health. India

is the second-largest producer of vegetables globally, contributing about 14 per cent of the world's vegetable production (Kumar et al., 2022).

India's total horticultural output is forecasted to reach 355.48 million tonnes in 2022-2023, an increase of 8.3 million tonnes (2.39%) from the previous year. The area under horticultural cultivation expanded by 1.41 per cent, with vegetable production rising from 209.14 million tonnes in 2021-22 to 212.55 million tonnes in 2022-23. India leads the world in the production of onions, ginger, and okra, and ranks second in potatoes, cauliflowers, brinjal, and cabbages (FAO, 2022). Despite India's global market share being near 1%, the acceptance of Indian horticultural produce is increasing, thanks to advancements in cold chain infrastructure and quality assurance. In 2023-24, India exported fruits and vegetables worth Rs. 15,039.27 crores (US \$1,814.58 million), with vegetables contributing Rs. 6,861.05 crores (US \$828.26 million) (apeda.gov.in).

Vegetables have contributed 59-61 per cent to India's horticultural crop production over the past five years. There is a growing focus not just on high yields but on producing better-quality vegetables, as these fetch higher prices. Vegetables are grown in diverse agro-climatic conditions across India, with major crops including onions, potatoes, tomatoes, cabbages, radishes, and cucumbers. India is the world's largest producer of cauliflower, second-largest producer of onions, and among the top producers of cabbage, peas, potatoes, and tomatoes (Ahmad et al., 2017). The development of high-yielding, disease-resistant varieties and hybrids has boosted vegetable production. However, these varieties often require excessive fertilizer, leading to pest problems. Farmers then turn to chemical pesticides, resulting in pest resurgence, harm to natural enemies, and destruction of beneficial insects (Bhardwaj et al., 2021). Integrated Pest Management (IPM) is a comprehensive approach to pest control that combines biological, cultural, physical, and chemical methods to manage pest populations while minimizing environmental harm. IPM is crucial for sustainable agriculture, reducing dependence on chemical pesticides and their negative effects on human health and the environment (Ram et al., 2012). However, the adoption of IPM practices among vegetable growers in India is inconsistent, influenced by socio-economic, technical, and informational barriers. Factors such as awareness, knowledge, access to resources, and extension services play a significant role in the adoption of IPM (Singh et al., 2022).

In Mau District, Uttar Pradesh, vegetable cultivation is integral to the local economy. This study evaluates IPM adoption levels among vegetable growers in Mau District, aiming to assess the extent of IPM integration and identify the factors influencing adoption. The findings will help governmental and private agencies tailor support and training programs to improve IPM adoption, promoting sustainable farming practices.

METHODOLOGY

The study was conducted in Mau District, Uttar Pradesh, during 2022–2023 to evaluate the adoption of Integrated Pest Management (IPM) practices among vegetable growers. Among the nine blocks in the district, Ratanpura and Kopaganj were purposively selected due to their significance in vegetable cultivation

and representation of diverse agro-economic conditions. These blocks are recognized for their intensive vegetable farming practices and offer a diverse range of socio-economic and agro-ecological characteristics, making them ideal for capturing regional trends in IPM adoption. The purposive selection ensured that the study focused on areas most relevant to its objectives while providing insights applicable to similar regions. A multi-stage sampling procedure was employed to ensure systematic data collection. In the first stage, six villages were randomly selected from each block, totalling 12 villages. In the second stage, farmers in these villages were stratified into four categories based on their landholding size: marginal, small, medium, and large. Proportionate random sampling was then applied to select 120 respondents, ensuring balanced representation of all farmer categories and allowing the findings to reflect the diversity of the farming community.

The sample size was determined using a statistical formula that incorporated the total population of vegetable growers, an estimated proportion of medium IPM adopters, a 5% margin of error, and a 95 per cent confidence level. This rigorous sampling framework ensured that the study was both representative and robust. Data collection involved both primary and secondary sources. Primary data were gathered using a semi-structured interview schedule designed to capture the socio-economic and psychological attributes of respondents, as well as their adoption levels of IPM practices. Secondary data were obtained from agricultural records and reports relevant to the study area. Adoption levels were assessed through a scoring system based on the extent of IPM practices implemented by the respondents, with scores reflecting full, partial, or no adoption. The collected data were analyzed using descriptive statistics and correlation analyses to identify trends and factors influencing IPM adoption. The purposive selection of blocks, combined with a robust sampling framework and rigorous data analysis, ensured that the study findings are reliable, representative, and provide valuable insights for promoting sustainable vegetable farming practices in Mau District and similar agro-ecological regions.

RESULTS

From the Table 1, farmers show a strong preference for practical cultural methods like deep ploughing and mixed cropping, reflecting their effectiveness. Moderate adoption of residue removal and spacing highlights their routine use, while low adoption of crop rotation points to barriers like land constraints. Overall, cultural practices are well-adopted, with scope for improvement in less-preferred methods.

Table 1. Adoption of Cultural Methods in vegetable growing

Statement	Adoption rates		
	High (%)	Medium (%)	Low (%)
Deep summer ploughing	43.34	46.66	10.00
Removal of previous crop residues	25.00	63.34	11.66
Recommended seed rate	13.34	76.66	10.00
Adoption of proper spacing	14.16	74.16	11.68
Adoption of crop rotation	05.84	73.34	20.82
Adoption of mixed cropping	42.50	44.16	13.34
Average Percentage	24.04	63.04	12.92

Table 2. Adoption of Mechanical Methods in vegetable growing

Statement	Adoption rates		
	High (%)	Medium (%)	Low (%)
Roughing practices in crop	18.34	35.00	46.66
Hand picking of insect-pest and their destruction	20.00	23.34	56.66
Use of light and pheromone trap	10.84	25.84	63.32
Monitoring of insect- pest	09.16	24.16	66.68
The burning of pervious crop residues for ratoon crop	33.34	20.00	46.66
Average Percentage	18.44	25.66	55.90

From the above Table 2, mechanical methods show low adoption overall, with labor-intensive practices like hand-picking and pest monitoring facing challenges. Advanced techniques such as pheromone traps are underutilized due to technical barriers, while residue burning sees better adoption due to its practicality. Training and resources are needed to improve adoption.

Table 3. Adoption of Biological Methods in vegetable growing

Statement	Adoption rates		
	High (%)	Medium (%)	Low (%)
Use of bio-pesticides	10.00	53.34	36.66
Use of bio-agent	09.16	14.16	76.68
Use of natural enemies	09.16	17.50	73.34
Use resistant varieties	12.50	61.66	25.84
Use neem-based product	20.00	33.34	46.66
Use bio-fertilizer	31.68	46.66	21.66
Average Percentage	15.51	37.77	46.72

From the above Table 3 the adoption of biological methods in vegetable growing is generally low, with a high proportion of farmers in the low-adoption category. Practices like bio-agents and natural enemies face significant challenges due to limited availability and perceived inefficacy. Bio-fertilizers and resistant varieties show relatively better adoption, driven by subsidies and proven benefits. Overall, biological methods require greater awareness, availability, and demonstration to enhance their adoption.

Table 4. Adoption of Chemical Methods in vegetable growing

Statement	Adoption rates		
	High (%)	Medium (%)	Low (%)
Apply seed treatment practices	10.84	28.34	60.82
Use balance dose of fertilizers	28.34	46.66	25.00
Apply recommended dose of pesticides	18.34	30.84	50.84
Soil treatment	26.66	37.50	35.84
Average Percentage	21.04	35.84	43.12

From the above Table 4, the adoption of chemical methods in vegetable growing is moderate, with a considerable proportion of farmers in the low-adoption category. Practices like soil treatment and balanced fertilizer use show relatively higher adoption,

reflecting their effectiveness and familiarity. However, seed treatment and recommended pesticide doses exhibit low adoption, indicating limited awareness and reliance on post-emergence solutions. Enhanced training and guidance are needed to optimize chemical use sustainably.

Table 5. Correlation coefficient (r) between different Independent variables and Adoption

Variables	Correlation Coefficientr value
Age	0.05751*
Education	0.05154*
Caste	0.05666*
Family type	0.06075*
Family size	0.04134 ^{NS}
Occupation	0.07525*
Land Holding	0.06181*
Marital Status	0.10270 ^{NS}
Annual Income	0.04213*
Social Participation	-0.00417*
Risk Orientation	0.21012*
Scientific Orientation	-0.01107*
Extension Contact	0.16976*

*Significant at 0.05%, NS= non-significant

Table 5 the correlation analysis shows positive influences of factors like risk orientation (0.21012) and extension contact (0.16976) on IPM adoption, highlighting the importance of risk-taking ability and regular advisory support. Education, landholding size, and annual income also positively impact adoption, reflecting the role of knowledge and resources. Negative correlations with social participation (-0.00417) and scientific orientation (-0.01107) indicate gaps in community focus and practical application. Family size and marital status showed minimal impact. These results emphasize the need for focused extension services and community-driven strategies to promote IPM adoption.

DISCUSSION

The study found moderate-to-high adoption of cultural methods among vegetable farmers in Mau District. Deep summer ploughing had a high adoption rate (43.34%) and medium (46.66%) due to its effectiveness in pest control and improving soil. Removal of crop residues was moderately adopted by 63.34 per cent, highlighting its role in pest prevention. However, crop rotation had a low adoption rate (5.84% high), likely due to small landholdings and monocropping practices (Tripathi et al., 2012), which mirror findings from similar studies in Haryana, where tomato growers faced constraints in adopting crop diversification strategies due to limited land availability and market-driven monoculture preferences (Anamika et al., 2023) (Anamika et al., 2023).

Mechanical methods, such as roughing (18.34% high) and hand-picking insects (20% high), had lower adoption rates compared to cultural methods. Most farmers (55.90%) reported low adoption, likely due to the labour-intensive nature of these practices, especially given smallholder farmers' labour shortages and time constraints. Additionally, methods like light and pheromone traps (63.32% low) and pest monitoring (66.68% low) were underused due to the technical knowledge and consistent monitoring they require. Limited

extension support or training likely contributed to this. Providing hands-on training and integrating mechanical methods into routine practices could boost adoption. These challenges align with findings from Bundelkhand, Uttar Pradesh, where mechanical IPM adoption was hindered by similar labour shortages and insufficient extension support (Gupta et al., 2020).

The adoption of biological methods was low, with bio-pesticides at 10 per cent high adoption and bio-agents/natural enemies at 9.16 per cent, suggesting gaps in knowledge or availability. Farmers may perceive biological controls as less effective than chemical alternatives due to slower action and variable performance (Singh et al., 2014). Overall low adoption (46.72% low) points to the need for targeted education and incentives. Demonstration plots and success stories could build confidence and encourage wider adoption (Gautam et al., 2017). However, bio-fertilizers showed moderate adoption (46.66% medium), likely due to government incentives, as seen in Manipur, where subsidies increased adoption among cabbage and cauliflower growers (Ram et al., 2012).

Chemical methods showed moderate adoption, with soil treatments having the highest high-adoption rate (26.66%), indicating farmers' reliance on immediate, visible pest management effects. However, seed treatment had a high low-adoption rate (60.82%), possibly due to lack of awareness or preference for post-emergence treatments. Over-reliance on chemicals may stem from their perceived cost-effectiveness and accessibility (Kamal et al., 2018). This trend challenges IPM implementation, as excessive chemical use can cause environmental harm and pest resistance. The over-reliance on chemicals, a concern in many regions including Madhya Pradesh, highlights the need for integrated methods to mitigate environmental harm and pest resistance (Agarwal et al., 2014). The overall adoption levels indicated that most farmers fell into the medium adoption category (49.16%), with only 20.84 per cent achieving high adoption. This distribution suggested that while the basic principles of IPM were understood, full implementation remained constrained by socio-economic factors and limited access to resources (Chouhan et al., 2013). The predominance of medium adoption might have resulted from fragmented extension services and inconsistent policy support. Addressing these challenges through comprehensive training, improved access to inputs, and financial support could elevate more farmers to the high-adoption category (Singh et al., 2018).

The correlation analysis highlights key factors influencing IPM adoption among vegetable growers. Risk orientation (0.21012) and extension contact (0.16976) showed the strongest positive relationships, indicating that risk-tolerant farmers with regular advisory support are more likely to adopt IPM. Other factors, like education, landholding size, and annual income, also positively influence adoption by enhancing farmers' understanding and capacity to implement sustainable practices. Conversely, negative correlations were observed for social participation (-0.00417) and scientific orientation (-0.01107). The negative value for social participation suggests that increased involvement in social organizations does not necessarily enhance IPM adoption and may even act as a barrier. This could be due to the focus of these groups

on non-agricultural issues or resistance to innovative methods within community dynamics. Similarly, the negative correlation with scientific orientation highlights a disconnect between theoretical knowledge and practical application, with some scientifically inclined farmers perceiving IPM as less effective compared to chemical alternatives. Family size and marital status showed minimal impact on IPM adoption. These findings highlight the need for targeted interventions focusing on factors like risk orientation and extension contact. Strengthening training programs, community demonstrations, and extension services can improve IPM adoption, aligning farmers with sustainable practices.

CONCLUSION

The study highlights moderate adoption levels of IPM practices among vegetable growers in Mau District, Uttar Pradesh, with cultural methods being the most adopted and biological methods the least. Key barriers include limited knowledge, labour intensity, and resource constraints. Correlation analysis revealed that education, landholding size, extension contact, and risk orientation positively influenced adoption, while social participation and scientific orientation negatively correlated, indicating gaps in community-driven learning and knowledge dissemination. To improve IPM adoption, targeted extension services, hands-on training, and financial incentives are essential. Demonstration plots and success stories can build farmer confidence in biological methods. Integrated support from governmental and private agencies, along with policy frameworks, can enhance resource accessibility and promote sustainable vegetable farming practices, ultimately improving productivity, environmental health, and farmers' livelihoods.

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