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Knowledge, adoption, and constraints in improved paddy production technologies: Implications for extension strategies in Uttar Pradesh

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Abstract

The study was conducted in Junawai block of Sambhal district, Uttar Pradesh, to assess farmers' knowledge, the extent of adoption, and constraints in adopting recommended practices. A total of 90 respondents were selected through random sampling across five villages, and data were collected using a structured interview schedule. Descriptive and inferential statistics, including mean percentage scores (MPS), frequency, percentage, and ranking techniques, were employed for analysis. Results revealed that a majority of farmers possessed a medium level of knowledge (53.33%) of improved technologies, with fewer respondents in the high (22.22%) and low (24.44%) knowledge categories. Knowledge was highest for nursery bed preparation (85.50% MPS), land preparation (82.30%), and irrigation (80.20%), while lower scores were recorded for fertilizer application (67.50%), plant protection (66.10%), and the use of improved varieties (65.00%). Adoption patterns followed a similar trend, with 52.22% of farmers in the medium adoption category, 27.78% in the low category, and only 20.00% in the high category. Among specific practices, nursery bed preparation (78.60%), land preparation (75.50%), and irrigation (73.00%) were the most widely adopted, whereas the use of improved varieties (55.20%) and plant protection measures (58.70%) recorded the lowest adoption rates. Constraints analysis revealed that pest and disease problems (78.10% MPS) were the most severe barrier, followed by non-availability of quality seed (72.50%) and lack of technical guidance (68.40%). Additional challenges included the high cost of chemicals, labour shortages, inadequate market facilities, and high technology costs. The study highlights that farmers adopt basic practices more readily than technical ones, with significant gaps in fertilizer use, varietal selection, and plant protection. Strengthened extension, efficient input systems, and improved infrastructure are crucial to bridging these gaps and ensuring sustainable rice productivity.

Keywords: Paddy production technology, knowledge level, adoption, constraints, extension services

1. Introduction

Rice (*Oryza sativa* L.) is among the most important cereal crops worldwide, serving as the staple food for more than half of the global population and accounting for nearly 95% of its production, which is directly consumed by humans (Fukagawa *et al*., 2019; Sen *et al*., 2020; Shrestha *et al*., 2020) [13, 30, 31]. As a member of the Poaceae family with a chromosome number of 2n=24, rice is cultivated across a wide range of agro-ecological regions from temperate to tropical climates (Kurata *et al*., 2002) [20].

Nutritionally, rice is not only a staple source of carbohydrates but also contributes significantly to dietary protein and essential amino acids (Chaudhari *et al*., 2018) [8]. Unprocessed paddy, or rough rice, contains approximately 88% dry matter, 7.5-8.5% crude protein, 9.6-11% crude fiber, 2.2-2.5% crude fat, and 56.6-64.3% starch, with an energy value of 3730-4240 kcal/kg (Sen *et al*., 2020, Verma *et al*., 2017) [30, 38]. It is also a source of key minerals, including calcium, phosphorus, magnesium, and potassium (Bielecka *et al*., 2021) [7], and contains essential amino acids such as lysine, methionine, threonine, valine, and leucine, which contribute to its protein quality (Jayaprakash *et al*., 2022) [16].

Rice production globally is concentrated in a handful of countries. India and China are the largest producers, each contributing approximately 27% of the total output, with production levels of 147 million tonnes and 145.28 million tonnes, respectively, during 2024-25 (Kumari & Sharma, 2025; Nayak *et al*., 2024) [19, 24]. Other major producers include Bangladesh, Indonesia, Vietnam, and Thailand, while countries such as the Philippines, Myanmar, Pakistan, and Cambodia also make substantial contributions (Nayak *et al*., 2024) [24].

In India, paddy acreage during the *rabi* season reached 43.12 lakh hectares in 2025, an increase of 5.78% compared to the previous year. Telangana, Tamil Nadu, Andhra Pradesh, and Kerala accounted for the majority of this expansion (Kumari & Sharma, 2025) [19]. The Government of India's second advance estimates projected national rice production at 1364.37 lakh tonnes in 2024-25, with Uttar Pradesh, Telangana, Punjab, West Bengal, Madhya Pradesh, Chhattisgarh, and Andhra Pradesh leading in total output (Nayak *et al*., 2024; Kumari & Sharma, 2025) [24, 19].

Despite these achievements, profitability in paddy cultivation remains a major concern. In Punjab, mechanization has significantly reduced labour use but sharply increased dependence on fertilizers, agrochemicals, and machinery, leading to higher production costs and reduced net returns (Verma *et al*., 2024; Mohapatra *et al*., 2024) [39, 23]. Conversely, in Bihar and eastern Uttar Pradesh, where rice has traditionally been grown, productivity has remained low due to inadequate fertilizer use, limited mechanization, insufficient irrigation, and poor adoption of modern technologies (Singh *et al*., 2024; Verma *et al*., 2024) [35, 39]. Farmers in Punjab have realized only marginal incomes over the cost of cultivation, while in Bihar, many have experienced outright losses in recent years (Verma *et al*., 2024; Singh *et al*., 2024) [39, 35]. Although Bihar's gross income-to-total cost ratio has improved in recent years, further strengthening of technology adoption and support systems is needed to ensure sustainable profitability (Selvarani, 2024) [29].

Alongside cost dynamics, price volatility has emerged as another challenge. In 2025, rice prices declined by Rs. 100-200 per quintal in key Indian markets due to weak demand, despite the Food Corporation of India procuring 757.15 lakh metric tonnes, marking a 7.62% increase over the previous year (Kumari & Sharma, 2025) [19]. At the international level, India's rice exports reached 25.25 lakh metric tonnes in December 2024, including basmati, non-basmati, and broken rice (Selvakumar & Ramesh, 2024) [28]. However, competition from Vietnam, Pakistan, and Thailand has reduced India's price competitiveness, and global oversupply has further pressured prices (Nayak *et al*., 2024; Mohapatra *et al*., 2024) [24, 23]. Simultaneously, domestic policy interventions, such as limiting broken rice content in PDS stocks, reflect ongoing attempts to balance consumer affordability with farmer profitability (Selvakumar & Ramesh, 2024) [28].

These factors underscore the dual challenge of increasing productivity and maintaining profitability in rice cultivation. The present investigation was conducted in CD Block Junwai, District Sambhal, Uttar Pradesh to examine farmers' agronomic practices, cultivation costs, yield levels, profitability, marketing channels, and the influence of government schemes and.

2. Research Methodology

The methodology adopted in the present study describes in detail the procedures used in the selection of study area, respondents, research instruments, methods of data collection, and statistical analysis. The study was conducted in Uttar Pradesh (UP), India's largest state by population, where agriculture engages about 68% of the workforce. Nearly 70% of the state's area is cultivated, more than half is double cropped, and about 80% is irrigated. The state's climatic variability, ranging from humid Terai areas to arid southern zones, and its significant paddy area, justified its selection.

Sambhal district under Moradabad division was purposively chosen due to its agricultural base. Within it, Junawai block was selected for its dominance in paddy farming. The block has 75 villages, sandy-loam to loam soils, reliable groundwater, and medium rainfall. About 90% of its population is engaged in agriculture, with smallholders dominating. Junawai contributes significantly to district paddy output and has ongoing extension interventions by Krishi Vigyan Kendra (KVK) and Tata Chemicals Society for Rural Development (TCSRD).

Five villages: Dhanipur, Deepanagla, Bangali Colony, Semla Karanpur, and Junawai were purposively chosen for their predominance of paddy cultivation and accessibility. From each village, 10 respondents were selected through random sampling, giving a total sample of 120 farmers. A structured interview schedule was developed to collect data on socio-economic profile, knowledge, adoption, constraints, and suggested measures. The schedule was validated by experts, pre-tested on a small sample, and modified accordingly.

Knowledge was measured using a test comprising 10 major paddy practices. Each correct answer was scored 1, incorrect 0. The Knowledge Index (KI) was calculated as:

$$\text{Knowledge Index (KI)} = (K / P) \times 100$$

Where K = score obtained, P = maximum score.

Respondents were classified as low, medium, or high knowledge using mean ($\bar{x}$) and standard deviation (SD).

Adoption was assessed with a four-point continuum scale: fully (3), partially (2), occasionally (1), not at all (0). Scores were summed to compute the Adoption Index (AI), and respondents were grouped as low, medium, or high adoption ($\bar{x}$ ± SD). Mean percent scores (MPS) were calculated for each practice and ranked.

Constraints were identified through expert consultation and measured on a five-point scale: very much (4) to not at all (0). Scores were summed, converted to MPS, and ranked to indicate severity. Respondent's suggestions for overcoming constraints were recorded and summarized through frequency and percentage distribution.

Primary data were collected through personal interviews in the local language (Hindi). Secondary data were sourced from official records and published reports. The data collected from the respondents were analyzed using both descriptive and inferential statistics. Percentages were computed to determine the proportion of respondents under different categories, while mean scores were used to assess overall responses for individual items. Mean percent score (MPS) was calculated to compare the relative importance of knowledge items, adoption practices, and constraints, and to rank them in order of priority.

The arithmetic mean was employed to obtain average values, and standard deviation was used to measure the extent of variability in the responses. To establish relationships between variables, the coefficient of correlation was computed, which quantified the degree and direction of association between knowledge, and adoption of paddy production technologies. Ranking techniques were applied wherever prioritization was required, particularly in the case of production constraints and suggested remedial measures. These statistical methods ensured the reliability of findings and provided a sound basis for drawing meaningful conclusions.

3. Results and Discussion

3.1 Knowledge about paddy production technology

The results of the present study reveal that the majority of respondents (53.33%) possessed a medium level of knowledge about improved paddy production technology (Table 1). This suggests that most farmers in CD Block Junwai, District Sambhal, Uttar Pradesh, have at least moderate awareness of recommended practices, including seed treatment, optimum sowing time, fertilizer application, irrigation schedules, pest management, and harvesting techniques. These findings are consistent with studies in other regions of India, indicating that a large proportion of smallholder rice farmers possess only partial knowledge and frequently adopt some, but not all, recommended practices (Saikia & Rajalakshmi, 2023; Alam *et al*., 2024) [25, 1].

A significant segment (24.44%) of respondents were found to have a low level of knowledge. This group is likely to adhere to traditional methods due to limited access to extension services, training opportunities, or modern agricultural inputs. Studies have highlighted that knowledge gaps persist, especially in regions with poor infrastructure or few extension interventions, resulting in suboptimal adoption rates for innovation and lower yield (Danjumah *et al*., 2024; Varma, 2016) [11, 36].

On the other hand, 22.22% of respondents were categorized under the high knowledge group, representing farmers who are well-informed regarding advanced paddy production practices. These farmers are more likely to adopt scientific recommendations and utilize new inputs efficiently, thereby achieving higher yields and economic returns. Similar patterns have been observed where increased knowledge, especially through structured extension programs or exposure to digital technologies, correlates strongly with higher adoption rates of advanced practices and improved productivity (Checco *et al*., 2023; Salam *et al*., 2024) [10, 26].

Comparative studies in Assam and Tamil Nadu have demonstrated that targeted and innovative extension programs can substantially enhance farmer awareness and adoption of modern rice technologies, leading to measurable improvements in yield and farm income (Saikia & Rajalakshmi, 2023; Ghosh *et al*., 2022) [25, 14]. Statistical analyses from high-impact studies indicate a significant positive relationship between training, extension exposure, and the knowledge level of farmers, with extension packages boosting rice productivity by providing timely, relevant, and contextualized recommendations (Ghosh *et al*., 2022; Alam *et al*., 2024) [14, 1]. The adoption of practices such as the System of Rice Intensification (SRI) and hybrid rice varieties is often limited by knowledge gaps and constraints in access, underscoring the role of extension as a catalyst for technology diffusion (Varma, 2016; Bannor *et al*., 2020) [36, 5].

Overall, this study's findings indicate that while the majority of farmers have a medium level of knowledge, a significant proportion remains in the low-knowledge category. These observations highlight the urgent need for focused extension interventions, awareness campaigns, training programs, and farmer-to-farmer knowledge sharing to bridge the knowledge gap, increase adoption of improved paddy technologies, and boost productivity. This is echoed by high-impact research that advocates for innovation-driven and targeted extension strategies to promote sustainable rice farming, improve resilience, and enhance the livelihoods of smallholder farmers (Saikia & Rajalakshmi, 2023; Danjumah *et al*., 2024; Alam *et al*., 2024) [25, 11, 1].

Table 1: Distribution of respondents according to their knowledge about paddy production technology.

S. No.	Categories	f	%
1.	Low (below to 56)	22	22.44
2.	Medium (57 to 70)	48	53.33
3.	High (71 and above)	20	22.22
	Total	90	100.00

Mean=63.5, S.D. =8.2, Min=45, Max=80, f=Frequency,%=Percentage

The data presented in Table 2 illustrates the extent of knowledge possessed by respondents regarding different aspects of paddy production technology. The table provides mean percentage scores for each practice, reflecting the level of knowledge among the respondents, and ranks them accordingly.

Among the ten major practices, nursery bed preparation secured the highest rank (Rank I) with a mean percentage score of 85.50 per cent. This indicates that the majority of farmers in the study area were well aware of the correct procedures for preparing nursery beds, likely due to its frequent application and relatively simpler methods involved.

The second highest rank (Rank II) was occupied by land preparation with a mean score of 82.30 per cent, showing that farmers generally have good knowledge of land preparation techniques such as ploughing, leveling, and puddling, which are crucial for successful paddy cultivation. Irrigation ranked third (Rank III) with a mean score of 80.20 per cent. This suggests that farmers had considerable knowledge about proper irrigation scheduling and methods, which is expected given the water-intensive nature of paddy cultivation.

Practices such as weeding (77.60 per cent, Rank IV) and harvesting and storage (75.80 per cent, Rank V) also had relatively high knowledge levels among the farmers, indicating awareness about timely weed management and proper harvesting techniques. Moderate knowledge levels were observed for nursery sowing and raising (70.40 per cent, Rank VI) and transplanting (68.75 per cent, Rank VII). Similarly, fertilizer application was ranked eighth with a mean score of 67.50 per cent, indicating that although farmers applied fertilizers, their technical knowledge on proper methods and doses might be limited.

The mean percentage scores for various paddy production practices reveal distinct patterns in farmers' knowledge levels (Table 2). Respondents exhibited the highest awareness of nursery bed preparation (85.50%), followed by land preparation (82.30%), irrigation (80.20%), weeding (77.60%), and harvesting and storage (75.80%). These findings demonstrate that farmers possess greater knowledge of foundational field operations and irrigation scheduling, which are routine and essential for crop establishment.

Moderate knowledge levels were recorded for nursery sowing and raising (70.40%), transplanting (68.75%), and fertilizer application (67.50%). The lowest knowledge scores were observed for plant protection measures (66.10%) and improved varieties (65.00%). This ranking indicates that farmers are proficient in basic and culturally embedded practices but encounter challenges with technical and input-intensive practices such as fertilizer management, pest control, and varietal selection.

These findings are consistent with earlier studies. Jallaraph and Pathak (2018) [15] reported that farmers in Chhattisgarh ranked field preparation, irrigation, and plant protection highest in awareness, reflecting similar strengths in basic operations. Likewise, Kumari *et al*. (2023) [18] observed in eastern India that nursery bed and land preparation scored highest, while knowledge of fertilizer and pest management remained weak due to their technical complexity and limited direct observation. Singh *et al*. (2022) [34] noted that while

irrigation knowledge was strong in Punjab due to its critical role in rice cultivation, fertilizer management ranked lower because farmers often relied on traditional practices, leading to overuse or misuse. Similarly, Manjula *et al*. (2024) [22] found that high knowledge was often associated with traditional practices integrated into local culture, whereas modern recommendations, such as balanced fertilizer use and integrated pest management (IPM), were less familiar.
The relatively low knowledge of fertilizer application and plant protection practices highlights a knowledge gap in input use and scientific crop management, a gap that has also been emphasized in earlier reviews (Chaudhari *et al*., 2018) [9]. Addressing these gaps requires farmer-centric training, participatory demonstrations, and ICT-enabled advisory services to enhance technical competencies. Moreover, leveraging farmer-to-farmer extension and strengthening the role of Krishi Vigyan Kendras and NGOs can enhance the dissemination of complex technologies.

Table 2: Distribution of respondents according to knowledge extent about paddy production technology. (n=90)

S. No.	Practices	Respondents	
		Mean% score	Rank
1.	Improved varieties	65.00	X
2.	Nursery bed preparation	85.50	I
3.	Nursery sowing and raising	70.40	VI
4.	Land preparation	82.30	II
5.	Transplanting	68.75	VII
6.	Fertilizer application	67.50	VIII
7.	Irrigation	80.20	III
8.	Weeding	77.60	IV
9.	Plant protection measure	66.10	IX
10.	Harvesting and storage	75.80	V

3.2 Adoption of paddy production technology

The distribution of respondents according to their adoption of improved paddy production technologies is presented in Table 3. The findings reveal that a majority of farmers (52.22%) were in the medium adoption category, indicating partial use of recommended practices such as improved varieties, land preparation, proper sowing, irrigation scheduling, and harvesting methods. This suggests that while most farmers were familiar with modern practices, their adoption remained incomplete, likely due to socio-economic and institutional constraints.
About 27.78% of respondents were categorized as low adopters, reflecting continued reliance on traditional methods or minimal integration of scientific practices. This group may face challenges such as limited access to extension services, resource shortages, and risk-averse attitudes. In contrast, only 20.00% of respondents were in the high adoption category, representing progressive farmers with wider acceptance of scientific recommendations, often facilitated by greater resource endowment, institutional linkages, and active engagement with extension systems.
These findings are consistent with adoption trends reported in previous studies. Bhagwat and Gohad (2018) [6] observed similar patterns in Karnataka, where the majority of farmers were medium adopters, influenced by education, landholding, and extension participation. Wani *et al*. (2022) [40] in Kashmir also reported nearly half of the respondents in the medium adoption group, highlighting the role of institutional support and extension contact. Likewise, Saikia and Rajalakshmi (2023) [25] in Assam found that adoption was higher among younger, better-educated, and resource-rich farmers, while resource-constrained groups lagged behind, reinforcing the importance of locally adapted, cost-effective technologies.
The predominance of medium adoption in the present study indicates that while awareness exists, full adoption is limited by structural barriers. The presence of a considerable low adoption group underscores the need for strengthened extension outreach, training programs, and farmer-friendly credit and input supply systems. The high adoption group, though relatively small, demonstrates the potential impact of education, extension, and resources in driving technological change. Overall, the results highlight the importance of farmer-centric extension strategies, participatory demonstrations, and supportive policies to bridge adoption gaps and enhance the widespread use of improved paddy production technologies.

Table: 3: Distribution of respondents on the basis of their level of adoption of improved paddy production technology n=90

S. No.	Categories	f	%
1.	Low (below to 56)	25	27.78
2.	Medium (57 to 70)	47	52.22
3.	High (71 and above)	18	20.00
	Total	90	100.00

Mean = 63.2, S.D = 7.9, Min= 50, Max=78, f= Frequency,%=percentage

The extent of adoption of improved paddy production practices by farmers, ranked according to Mean Percentage Score (MPS), is presented in Table 4. The results indicate that nursery bed preparation was the most widely adopted practice (MPS 78.60%), reflecting high farmer awareness and routine application due to its simplicity and visible impact on crop establishment. This was followed by land preparation (75.50%), which included practices such as ploughing, leveling, and puddling, confirming its importance in ensuring proper field conditions. Irrigation management ranked third (73.00%), underscoring farmers' recognition of water as a critical input in this water-intensive crop.
Relatively higher adoption was also observed for harvesting and storage (70.20%) and weeding (68.50%), practices that are closely tied to yield and quality outcomes. Moderate adoption levels were recorded for nursery sowing and raising (65.40%) and fertilizer application (62.80%), suggesting partial adherence to recommended practices, possibly due to limited technical knowledge or resource constraints. Lower adoption was evident in transplanting (60.10%) and plant protection measures (58.70%), highlighting gaps in adoption of labor- and knowledge-intensive practices. The use of improved varieties recorded the lowest adoption (55.20%), suggesting continued reliance on traditional cultivars and highlighting constraints such as seed availability, cost, and farmer hesitancy toward varietal change.
These findings are consistent with earlier studies. Lakitan *et al*. (2018) [21] similarly reported that nursery and land preparation practices were among the most widely adopted due to their visibility and perceived importance.

Andriatsiorimanana *et al*. (2023) [2] emphasized the crucial role of irrigation in rice cultivation, supporting its high adoption ranking in the present study. Moderate adoption of fertilizer management and nursery practices agrees with Kumari *et al*. (2023) [18], who observed persistent gaps in farmers' knowledge of precise fertilizer application in Eastern India. Low adoption of transplanting and plant protection practices mirrors trends highlighted by the Sustainable Rice Platform (2024), which attributed these challenges to inadequate technical guidance and high input costs.

The least adoption of improved varieties aligns with observations by Das and Mohanty (2019) [12] and Verma *et al*. (2021) [37], who found that slow varietal adoption was linked to limited seed availability, affordability issues, and farmers' reluctance to abandon traditional, well-adapted cultivars. Addressing these challenges through efficient seed distribution systems, cost incentives, and participatory varietal testing could accelerate varietal adoption. Furthermore, Saikia and Rajalakshmi (2023) [25] reported that adoption of innovations is strongly associated with education, socio-economic status, and extension participation, reaffirming the role of institutional support in shaping adoption behaviour.

Taken together, the results confirm that foundational and traditional practices such as nursery and land preparation are widely adopted, while knowledge-intensive and resource-demanding practices like fertilizer application, plant protection, and varietal replacement lag behind. To enhance comprehensive adoption, there is a need for strengthened extension services, farmer-centric demonstrations, improved input delivery systems, and context-specific capacity-building programs. These measures will ensure that farmers move beyond partial adoption and achieve sustained productivity and profitability in paddy cultivation.

Table 4: Distribution of respondents according to Adoption extent about paddy production technology. N=90

S. No.	Practices	Respondents	
		MPS	Rank
1.	Improved varieties	55.20	X
2.	Nursery bed preparation	78.60	I
3.	Nursery sowing and raising	65.40	VI
4.	Land preparation	75.50	II
5.	Transplanting	60.10	VIII
6.	Fertilizer application	62.80	VII
7.	Irrigation	73.00	III
8.	Weeding	68.50	V
9.	Plant protection measure	58.70	IX
10.	Harvesting and storage	70.20	IV

3.3 Constraints

The constraints encountered by farmers in adopting improved paddy production technologies, ranked by Mean Percentage Scores (MPS) were presented in table 5. Pest and disease problems (MPS 78.10%) emerged as the most significant constraint, underscoring farmers' vulnerability to biotic stresses and the inadequacy of current pest management strategies. Contributing factors include insufficient knowledge of integrated pest management (IPM), restricted access to plant protection chemicals, and ineffective control methods.

Non-availability of quality seed ranked second (72.50%), demonstrating that farmers experience challenges in obtaining timely and reliable supplies of improved varieties, thereby limiting productivity improvements. Lack of technical guidance ranked third (68.40%), revealing deficiencies in extension services, training, and expert support, all of which are necessary for the successful adoption of recommended practices.

Additional major constraints were the high cost of chemicals (63.80%), shortage of skilled labor (60.20%), inadequate market facilities (58.70%), and the high cost of technology (55.30%). These factors represent broader socio-economic and infrastructural barriers that impede consistent adoption of improved technologies by farmers.

These findings are consistent with earlier studies. Konsam and Sakthivel (2020) [17] and Singh *et al*. (2018) [33] also identified pest and disease incidence particularly stem borer and plant hopper as key constraints in rice cultivation, emphasizing the need for strengthened IPM practices. Similarly, the limited availability of quality seeds has been widely reported (Kumari *et al*. 2023) [18], with seed scarcity and high costs identified as systemic challenges that restrict varietal replacement and adoption.

The persistence of inadequate technical guidance echoes observations by Sangeetha *et al*. (2018) [27], who highlighted weak extension delivery as a major barrier to technology uptake. Financial constraints, such as high input costs and labor shortages, have also been recognized as critical obstacles (Arunachalam, 2000; Singh *et al*., 2007) [4, 32]. Meanwhile, marketing constraints—including poor infrastructure, unstable prices, and limited storage—have been documented by Kumar and Alagaraja (2018).

Table 5: Distribution of respondents according to constraints.

S. No.	Constraints	MPS	Rank
1.	Lack of technical guidance	68.40	III
2.	Non availability of seed	72.50	II
3.	High cost of technology	55.30	VII
4.	Non availability of skilled labour	60.20	V
5.	Pest and disease problem	78.10	I
6.	High cost of chemicals	63.80	IV
7.	Inadequate market facilities	58.70	VI

4. Conclusion

The study revealed that a majority of farmers possessed medium levels of knowledge (53.33%) and adoption (52.22%) of improved paddy technologies, with stronger awareness and uptake of basic practices such as nursery preparation, land preparation, and irrigation. However, adoption of knowledge-intensive practices like fertilizer management, plant protection, and varietal replacement remained limited, largely due to persistent constraints. Key barriers included pest and disease problems (78.10% MPS), non-availability of quality seed, high input costs, labor shortages, and inadequate market facilities. Addressing these gaps through strengthened extension services, efficient seed and input delivery, participatory demonstrations, and improved infrastructure is crucial for enhancing adoption, productivity, and sustainability in rice farming.

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