

# Exploring rice farmers' perceptions and participation in the sustainability of the Integrated Pest Management programme

*Ratri Virianita\** and *Luki Sandi*

Department of Communication and Community Development Sciences, Faculty of Human Ecology, IPB University, Wing 1 Level 5 FEMA Building, IPB Campus of Dramaga, Bogor Residence, West Java Province, Indonesia, 16680.

**Abstract.** The Integrated Pest Management programme is an exertion of the Indonesian government to achieve food self-sufficiency and improve the welfare of rice farmers. Perception and participation are important factors that determine the success of the Integrated Pest Management programme. The objectives of this study are: 1) to analyse the correlation between perception and the participation of rice farmers in the Integrated Pest Management programme, and 2) to analyse the correlation between participation of rice farmers and the success of the Integrated Pest Management programme. The study employed a survey method using a questionnaire to collect data from 45 rice farmers purposively selected as beneficiaries of the programme in Karawangi Village, Depok Sub-district, Cirebon Residencial, West Java Province. The Rank Spearman correlation test shows a significant and positive correlation between perception and the participation of rice farmers in the Integrated Pest Management programme. It is also revealed that the participation of rice farmers is significantly correlated with the success of the Integrated Pest Management programme. Thus, the perception and participation of rice farmers are essential for the sustainability of the Integrated Pest Management programme, as the success of a programme contributes to its sustainability.

## 1 Introduction

Efforts to strengthen food security in Indonesia continue to prioritise approaches that raise rice productivity while ensuring ecological sustainability and rural welfare. Integrated Pest Management (IPM) has played a central role in this strategy since its promotion in the late 1980s, combining ecological principles with farmer-based learning to reduce dependence on chemical pesticides and improve agroecosystem resilience. Earlier studies have demonstrated that IPM, particularly when delivered through Farmer Field Schools (FFS), promotes participatory learning, enhances farmers' decision-making capacity, and establishes local institutions that support sustainable pest management practices [1]. Subsequent research

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\* Corresponding author: [ratru\\_v@apps.ipb.ac.id](mailto:ratru_v@apps.ipb.ac.id)

highlights how IPM initiatives contribute not only to reductions in pesticide use but also to improvements in farmer empowerment and collective action within rural communities [2].

More recent work continues to demonstrate the relevance of IPM within Indonesia's evolving agricultural landscape. Studies underscore that farmers who possess stronger knowledge and more favourable attitudes toward ecological pest control are more likely to adopt IPM-consistent behaviours [3]. Parallel assessments of IPM technology and institutional sustainability reveal that while the programme remains influential, sustainability levels vary across regions, shaped by factors such as training quality, farmer motivation, and institutional support [4]. Research on vegetable-based IPM systems suggests similar dynamics, where programme sustainability is reinforced by strong local institutions and adaptive management strategies [5]. In addition, studies on food estate development areas and rice agroecosystems have highlighted the importance of ecological literacy and institutional strengthening as foundational for long-term IPM resilience [6].

Despite this growing body of literature, several gaps persist, particularly concerning the behavioural and relational dimensions of IPM implementation. Much existing research examines knowledge, attitudes, and technology adoption; yet, fewer studies explicitly analyse how farmers' perceptions, including perceived benefits, trust in extension agents, relevance of IPM techniques, and perceived risks, shape their level of participation in Integrated Pest Management activities. Furthermore, although participation is widely assumed to be a precursor to programme success, empirical studies that quantitatively test the relationship between participation level and measurable outcomes remain limited. Recent sustainability assessments emphasise institutional and technological aspects; nonetheless, they give less attention to the micro-level social mechanisms that underpin long-term programme continuity, such as the link between farmers' lived experiences, their programme engagement, and the durability of local IPM institutions.

These gaps are particularly important given Indonesia's long-standing objective of achieving food self-sufficiency and improving the welfare of smallholder farmers. Understanding how perception and participation interact within the IPM programme can illuminate why some communities sustain IPM practices across seasons. In contrast, others experience declines in adoption or in the quality of implementation. This study, therefore, focuses on the relationships between rice farmers' perceptions of the IPM programme, their participation in its activities, and the programme's success in Karawangi Village, West Java. By examining these relationships empirically, the study contributes to a more nuanced understanding of the social foundations of Integrated Pest Management effectiveness as well as provides relevant insights for strengthening the sustainability of Integrated Pest Management initiatives in Indonesia.

## **2 Conceptual framework**

Research on Integrated Pest Management (IPM) consistently highlights that the effectiveness of the programme depends not only on technical training but also on farmers' cognitive, social, and behavioural engagement with its principles. Across several decades of scholarship, three interrelated domains repeatedly emerged as central to IPM outcomes: farmers' perceptions, their level of participation, and the observable success of IPM practices in the field. Drawing on this body of work, the present framework posits a sequential relationship in which perceptions shape participation, and participation, in turn, influences programme results.

The framework is theoretically anchored in Diffusion of Innovation Theory [7], which posits that adoption decisions are strongly influenced by how individuals perceive five attributes of an innovation, such as relative advantage, compatibility, complexity, trialability,

and observability. These attributions shape the persuasion stage of the adoption process and influence whether individuals progress to implementation and sustained use.

## **2.1 Farmers' perception of IPM**

Perception encompasses farmers' knowledge, attitudes, risk assessments, and beliefs regarding the relevance and reliability of IPM. In the Diffusion of Innovation Theory, perceived innovation attributes determine whether an innovation is worthy of adoption [7]. Within IPM contexts, farmers assess whether ecological pest management provides a clear relative advantage over pesticide-intensive strategies, whether it is compatible with existing farming routines and socio-economic conditions, whether it appears excessively complex, whether it can be tested on a limited scale (trialability), and whether its results are sufficiently observable in the field.

When farmers judge IPM as practical, beneficial, and compatible with their livelihood strategies, they are more inclined to participate in training, collaborate with peers, and apply IPM principles consistently [4]. Positive perceptions, such as viewing IPM as safer, more sustainable, or more empowering, tend to strengthen farmers' motivation to engage, while negative or uncertain perceptions can suppress participation even when knowledge levels are high. Thus, perception constitutes a foundational cognitive filter through which farmers interpret the value and feasibility of participating in IPM activities.

## **2.2 Farmers' participation in IPM activities**

Participation is shaped by farmers' prior perceptions of IPM attributes. Diffusion theory conceptualises adoption as a staged process, from knowledge to persuasion, decision, implementation, and confirmation [7]. Participation facilitates movement from persuasion to implementation by providing opportunities to test, observe, and refine ecological practices.

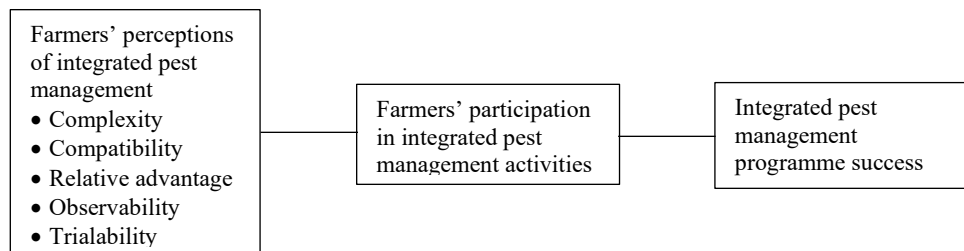
IPM participation refers to involvement in Farmer Field Schools, group monitoring, field experiments, decision-making meetings, and community-based pest management efforts. Participation is sensitive to farmers' trust in programme institutions and their perception of whether the benefits outweigh the costs [8]. These dynamics suggest that participation is not merely a function of programme availability but a behavioural outcome shaped by the perceptual variables described above. Accordingly, the framework positions participation as the behavioural mechanism through which perception exerts its influence on programme success.

## **2.3 IPM programme success**

Programme success refers to observable outcomes such as reduced dependence on chemical pesticides, improved ecological balance, strengthened farmer organisations, enhanced decision-making autonomy, and, in some contexts, improved economic performance. Early ecological and economic evaluations established that IPM can stabilise natural enemy populations, reduce pest outbreaks, and lower pesticide costs [2]. Nevertheless, outcomes vary widely, reflecting differences in participation intensity, local institutional continuity, and the consistency with which IPM principles are applied [9]. The literature thus indicates that IPM success is not determined solely by training inputs but by how actively and collectively farmers engage with the programme. Within the framework, programme success is conceptualised as the culmination of farmers' behavioural engagement, which is itself shaped by preceding perception factors.

Synthesising these strands, the conceptual framework proposes a sequential relationship, as follows: 1) Positive perceptions encompassing complexity, compatibility, relative

advantage, observability, and trialability encourage farmers to participate actively in IPM activities. Conversely, scepticism, perceived risk, and weak institutional trust can suppress participation even when farmers possess adequate knowledge; 2) Participation enhances learning, reinforces ecological decision-making, strengthens group cohesion, and enables consistent implementation of IPM techniques. As participation deepens, farmers are more likely to achieve environmental, economic, and social outcomes associated with successful IPM programmes.



**Fig. 1.** Conceptual framework

The model envisions farmers' perceptions as the cognitive and affective antecedent that shapes their willingness to engage. Participation functions as the behavioural mediator, converting perceptions into concrete actions. Programme success is reflected in environmental sustainability, reduced pesticide dependence, more resilient farmer organisations, and improved decision-making capacities. This structure reflects an integrated understanding of IPM as not merely a technical practice but a socio-ecological system shaped by knowledge, social processes, and institutional dynamics.

Based on the conceptual framework above, it is hypothesised that:

- H1: Farmers' perceptions of integrated pest management have a positive and significant correlation with farmers' participation in integrated pest management activities
- H2: Farmers' participation in integrated pest management activities has a positive and significant correlation with integrated pest management programme success

### 3 Method

This study employed a quantitative, correlational research design to observe the relationships between farmers' perceptions of Integrated Pest Management (IPM), their participation in IPM activities, and the success of the IPM programme in a rice-farming context. A correlational approach is appropriate because the study seeks to identify the strength and direction of associations among variables without manipulating the research environment. The study was situated in Karawangi Village, Depok Sub-district, Cirebon Regency, West Java Province, an area where IPM Farmer Field School (FFS) programmes have been implemented and where farmers have varying degrees of exposure and engagement. This setting provides an appropriate context to test the sequential pathway proposed in the conceptual framework.

The population consisted of rice farmers in Karawangi Village who had been direct beneficiaries or participants in the IPM programme. A purposive sampling technique was used to ensure that respondents possessed the knowledge and experience required to provide meaningful assessments of the programme. Purposive sampling is commonly applied in IPM studies because programme beneficiaries represent information-rich cases relevant to understanding adoption dynamics. A total of 45 farmers were selected as respondents. This

sample size is appropriate for non-parametric correlation analysis and reflects the actual number of active or recent programme participants in the village at the time of data collection.

Data were collected using a structured questionnaire consisting of: 1) a perception of IPM scale ( $\alpha = 0.949$ ), contains 25-items that measures five innovation attributes, such as relative advantage, compatibility, complexity, trialability, and observability; 2) a participation in the IPM activities scale ( $\alpha = 0.975$ ), contains 20-items that assesses both frequency and intensity of involvement in Farmer Field School sessions, agroecosystem observation, group monitoring, and decision-making discussion; and 3) an IPM programme success scale ( $\alpha = 0.805$ ), contains 10-items that measures reduction in pesticide use, improve ecological awareness, strengthen farmer group cooperation, enhance decision-making autonomy, and perceived economic benefits. Responses were rated using a 4-point Likert scale (1 = strongly disagree; 4 = strongly agree), and were tested using Pearson's Product-Moment correlation for validity and Cronbach's Alpha for reliability, which have proven to be valid and reliable. Cronbach's Alpha values of  $\geq 0.70$  were considered acceptable, following standard psychometric criteria and consistent with reliability standards used in previous IPM behavioural research.

Given the sample size and the non-normal distribution typical of perception and behavioural data, Spearman's Rank Order Correlation ( $\rho$ ) was used to analyse the relationships among the variables. This method is suitable for ordinal data and non-parametric distributions and is widely applied in IPM studies that explore linkages between knowledge, perception, participation, and adoption [3]. Correlation coefficients were interpreted as follows: 0.00 to 0.19 as very weak, 0.20 to 0.39 as weak, 0.40 to 0.59 as moderate, 0.60 to 0.79 as strong, and 0.80 to 1.00 as very strong. Statistical significance was evaluated at the  $\alpha = 0.01$  level.

## **4 Results and discussion**

### **4.1 Demographic characteristics**

The demographic characteristics of the respondents provide essential insights for understanding participation patterns and behavioural responses within the Integrated Pest Management (IPM) programme. Table 1 reflects a predominantly male farming population (95.6%). This distribution has important implications for IPM implementation. While many historical FFS initiatives in Indonesia included substantial participation from women, particularly in mixed-cropping or home-garden systems [3], rice cultivation in several regions remains male-dominated. Male farmers often play the primary role in field-level pest management decisions, which may accelerate the adoption of IPM practices when perception and participation levels are favourable. The small number of women (4.4%) suggests that gender-specific constraints, such as workload distribution or land access, may have limited their involvement. However, their perspectives remain valuable, as women often contribute knowledge related to ecological indicators and the impacts of household-level pesticides.

Table 1 also shows that the majority of respondents fall within the middle-aged range (77.8%), a demographic group that typically combines extensive farming experience with cautious but stable decision-making tendencies. Previous IPM studies indicate that middle-aged farmers often possess the experiential foundation needed to appreciate ecological principles, yet may also perceive new practices as risky if the benefits are not immediately visible [9]. Because many IPM benefits, such as improved natural enemy populations or reduced pest resurgence, unfold gradually, training approaches must emphasise practical demonstrations and clear evidence of short-term gains [10].

Educational attainment in the sample, with a majority of farmers having low to moderate levels of formal schooling (93.3%), reinforces the importance of hands-on, field-based learning characteristic of Farmer Field Schools. The FFS approach was explicitly designed to overcome literacy barriers by focusing on observation, experimentation, and group problem-solving. Studies in Indonesia and elsewhere consistently show that farmers with limited formal education still achieve high ecological competence when training is participatory and contextually grounded [4]. Therefore, the demographic composition of this group aligns well with the pedagogical strengths of IPM-FFS.

**Table 1.** Demographic characteristics

Variable	Category	N	%
Gender	Woman	2	4.4
	Man	43	95.6
Age	Early adulthood (18 – 40 years old)	2	4.4
	Middle-aged (41 – 60 years old)	20	77.8
	Late adulthood (> 60 years old)	8	17.8
Education level	Low	24	53.3
	Moderate	18	40.0
	High	3	6.6
Land ownership status	Own land	0	0
	Land lease	45	100

Of particular significance is the finding that all 45 respondents farm under land lease arrangements and do not own the land they cultivate. Land tenure insecurity is a structural constraint repeatedly identified in IPM adoption research because tenants may be hesitant to invest in ecological practices that yield benefits over multiple seasons [9]. Tenants are often oriented toward short-term productivity and may prefer pesticide-intensive strategies that produce immediate visible effects, even if ecologically harmful in the long term [8]. This structural condition may dampen participation in activities such as pest monitoring, habitat management, or field experimentation, whereas components are central to IPM success. Strengthening farmer groups, engaging landowners, and emphasising low-cost, low-risk practices become essential under such conditions [3].

Taken collectively, the demographic profile represents male-dominated, middle-aged, modestly educated, and entirely composed of tenant farmers, providing a nuanced backdrop against which farmers’ perceptions and participation in IPM can be interpreted. The literature shows that these factors shape not only learning preferences but also risk attitudes, decision-making autonomy, and willingness to adopt ecological pest management strategies [3]. Understanding this demographic configuration is therefore crucial for contextualising subsequent correlation analyses, interpreting programme outcomes, and designing more robust and locally appropriate IPM interventions.

#### **4.2 Correlation of farmers’ perceptions and participation in integrated pest management activities**

The cross-tabulation in Table 2 shows a clear and systematic relationship between farmers’ perceptions of the IPM programme and their level of participation in IPM activities. Farmers who hold negative perceptions overwhelmingly exhibit low participation: all respondents with negative perceptions (100%) fall entirely within the low participation category, and none participate at moderate or high levels. This pattern demonstrates a complete alignment between negative attitudes and disengagement, consistent with longstanding evidence that unfavourable perceptions reduce willingness to observe fields, attend group meetings, or experiment with ecological practices [3, 8].

In contrast, farmers with neutral perceptions display a very different participation profile. Among the 24 farmers in this category, 95.83% participate at a moderate level, and only 4.17% show low participation. None reach high participation, but the concentration in the moderate category indicates that even when perceptions are not strongly positive, a certain openness or absence of resistance can still support functional engagement. This finding aligns with diffusion theory, which suggests that farmers positioned as “early majority” or “late majority” often participate when social or institutional structures prompt involvement, even without strong intrinsic motivation [7]. In IPM contexts, neutral perceptions frequently emerge when farmers recognise the potential value of ecological approaches but remain uncertain about reliability, labour demands, or outcomes, which are conditions that typically limit participation to moderate rather than high levels [11].

**Table 2.** Correlation between farmers’ perceptions and participation in the IPM programme

Variable	Category	Participation in the IPM programme							
		Low		Moderate		High		Total	
		n	%	n	%	n	%	N	%
Perception of the IPM programme	Negative	21	100	0	0	0	0	21	100
	Neutral	1	4.17	23	95.83	0	0	24	100
	Positive	0	0	0	0	0	0	0	0

$R_s = 0.888; p < 0.01$

Importantly, the table shows that no farmers in the dataset hold positive perceptions, and consequently, no respondents reach the high participation category. The complete absence of high participation aligns with data indicating low trialability, low observability, limited perceived compatibility, and ambiguous economic advantage, which are factors that hinder the formation of strong positive perceptions toward IPM. These perceptual barriers also explain why the programme has not cultivated highly engaged farmers, who are typically responsible for championing IPM practices, facilitating peer learning, and modelling ecological decision-making [12-14].

Statistically, the strength of the relationship between perception and participation is confirmed by a Spearman rank correlation coefficient of  $R_s = 0.888$ , with  $p < 0.01$ , indicating a strong, positive, and highly significant correlation. This means that variations in participation levels are closely aligned with how farmers evaluate IPM attributes. These findings are consistent with Diffusion of Innovations theory, which posits that perceived complexity and low observability reduce the likelihood of active adoption [7]. As farmers’ perceptions become more favourable, even shifting from negative to neutral, participation increases markedly. This finding reinforces a central insight in IPM research: perception operates as a key behavioural determinant, shaping how farmers interpret risks, benefits, and learning opportunities. When perception improves, participation in field observations, group discussions, and ecological practices becomes more consistent and engaged [10].

Weak perceptions hinder participation, and limited participation, in turn, restricts the programme’s potential to deliver ecological or economic benefits. The findings, therefore, underscore the need for future IPM interventions in Karawangi Village to prioritise perception-building strategies, such as more effective facilitation, visible demonstration plots, and opportunities for hands-on experimentation, to raise farmers’ confidence and support deeper engagement.

### 4.3 Correlation of farmers’ participation in integrated pest management activities and integrated pest management programme success

The cross-tabulation in Table 3 demonstrates a strong and systematic relationship between farmers’ participation in IPM activities and the success of the IPM programme. Among farmers with low participation, the majority (68.18%) perceive IPM programme success as low, while the remaining 31.18% rate it as moderate. Notably, none of these farmers reports high programme success. This pattern suggests that minimal engagement in IPM activities is directly associated with limited programme outcomes, a finding that aligns closely with prior research showing that ecological literacy and behavioural change in IPM are contingent on continuous, hands-on participation [12].

**Table 3.** Correlation between farmers’ participation and the IPM programme success

Variable	Category	IPM programme success							
		Low		Moderate		High		Total	
		n	%	n	%	n	%	N	%
Participation in the IPM programme	Low	15	68.18	7	31.18	0	0	22	100
	Moderate	0	0	21	91.30	2	8.69	23	100
	High	0	0	0	0	0	0	0	0

$R_s = 0.869$ ;  $p < 0.01$

Farmers with moderate participation present a markedly different profile. In this group, 91.30% perceive programme success as moderate, and 8.69% even report high programme success. None in this category describes the programme as unsuccessful. These results indicate that even moderate engagement, such as attending Farmer Field School (FFS) sessions, participating in field observations, or participating in group discussions, significantly contributes to improved programme outcomes. This is consistent with empirical evidence from multiple Indonesian IPM studies, which show that higher participation enhances farmers’ ecological decision-making, reduces pesticide dependency, and strengthens the sustainability of farmer groups [11, 15].

A critical observation is that no farmers in the dataset exhibit high participation, and consequently, no farmers achieve the highest possible success category through high participation. This absence reinforces the earlier conclusion that the programme lacks deeply engaged farmer leaders, which is an essential component for sustaining IPM initiatives long-term. Previous literature emphasises that high participation fosters collective problem-solving, enhances social capital, and strengthens institutional continuity, leading to more resilient and ecologically stable farming systems [8, 9]. Without such highly committed participants, the programme is structurally limited in its ability to reach maximum effectiveness.

The strength of the relationship is statistically confirmed by a Spearman rank correlation coefficient ( $R_s$ ) of 0.869, with  $p < 0.01$ , indicating a strong, positive, and highly significant correlation between participation and IPM programme success. This finding reinforces the conceptual positioning of participation as the behavioural mediator between perception and sustainability. Participation is not merely symbolic involvement; rather, it represents the mechanism through which ecological principles are internalised and translated into practice. The statistical evidence supports the behavioural model widely documented in IPM literature: participation acts as the mechanism through which ecological knowledge is internalised and translated into practice [11]. The data clearly demonstrate that the more farmers engage with IPM training, field observation, and group-based learning, the more likely they are to perceive and achieve successful programme outcomes.

In summary, the data reveal a clear and robust pattern that higher participation leads to higher programme success, while low participation restricts farmers to low or moderate benefits. Theoretically, this finding aligns with participatory extension models, which argue that experiential learning through field observation, experimentation, and group discussion is essential for embedding ecological reasoning in farming decisions [11]. This reinforces the core principle of IPM-FFS approaches, that learning by doing, continuous observation, and collaborative experimentation are essential for achieving meaningful ecological and economic results. The absence of high participation in the community further suggests that strengthening facilitation quality, building stronger farmer groups, and creating more opportunities for hands-on practice are critical steps for elevating programme success in future IPM cycles.

## 5 Conclusion

This study demonstrates that the effectiveness of the Integrated Pest Management (IPM) programme in Karawangi Village remains limited by the interplay of farmers' perceptions, their participation levels, and the programme's institutional environment. The findings reveal that farmers generally hold negative or neutral perceptions of IPM, with none expressing a positive view. They tend to regard IPM as complex, insufficiently compatible with their farming practices, difficult to observe, and lacking trial opportunities. These perceptions' barriers align with well-documented constraints identified in prior IPM research, where uncertainty, perceived risk, and limited experiential exposure undermine farmers' confidence in ecological pest management strategies.

These negative or uncertain perceptions significantly shape participation outcomes. The study shows that almost half of the farmers exhibit low participation, while the remainder demonstrate only moderate engagement. No farmers reach a high level of participation, reflecting insufficient immersion in field-based learning, group experimentation, or continuous observation—core principles of Farmer Field School pedagogy. As established in earlier studies, participation functions as the behavioural mechanism through which ecological knowledge is internalised, and shallow engagement restricts the development of the competencies required for informed decision-making in pest management.

The influence of participation becomes more evident when examining programme success. Most farmers perceive IPM outcomes as only moderately successful, while a substantial proportion report low success and only a minority note high success. The absence of highly engaged participants corresponds directly to the scarcity of high programme outcomes. This relationship is further validated by a strong and significant correlation between participation and programme success, indicating that greater involvement in IPM activities consistently leads to improved ecological and practical results.

Together, the correlations paint a clear behavioural pathway. Farmers with negative perceptions consistently demonstrate low participation and report lower programme success, while those with more neutral perceptions show moderate participation and correspondingly better programme outcomes. The strong correlations observed in the study confirm the explanatory power of this sequential relationship and align with broader IPM scholarship, which emphasises that perceptions shape willingness to engage, and engagement, in turn, determines the degree to which ecological practices can be successfully adopted.

Overall, the IPM programme in Karawangi Village has achieved only moderate effectiveness, primarily because it has not fostered the level of confidence, motivation, and sustained engagement required for transformative impact. Strengthening farmers' perceptions, through improved facilitation, visible demonstrations, enhanced opportunities for experimentation, and more responsive institutional support, is essential for increasing

participation. In turn, elevating participation is crucial for improving programme outcomes and ensuring the long-term sustainability of IPM practices in the community.

## 6 Recommendation

The findings of this study reveal that strengthening the IPM programme requires simultaneous improvement in farmers' perceptions, participation, and institutional support. First, farmers' negative or uncertain perceptions can be addressed by making IPM more visible and understandable through demonstration plots, frequent field observations, and hands-on learning activities that reduce perceptions of complexity and highlight practical benefits. Strengthening facilitation quality is equally important; consistent guidance, active follow-up, and interactive learning approaches can help farmers move from low to moderate participation and deepen their engagement in ecological decision-making.

Given that all respondents are tenant farmers, programme strategies should also adapt to the constraints of insecure land tenure by prioritising low-risk, low-cost IPM practices and involving landowners where possible in awareness efforts. Enhancing farmer-to-farmer learning networks can further support behaviour change, as peer examples and shared experiences often reduce scepticism and build confidence in ecological management. Additionally, creating small, structured opportunities for farmers to trial IPM practices can increase their familiarity with the methods and gradually shift perceptions toward greater acceptance.

Finally, the programme should reinforce the continuity and effectiveness of local institutions by strengthening farmer groups, ensuring stable leadership, and maintaining regular learning activities. Emphasising immediate economic benefits, such as reduced pesticide expenses, can further motivate farmers to participate more actively. Together, these actions can help elevate both participation and overall programme success, supporting a more sustainable and impactful implementation of IPM in the village.

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