INITIATIVE ON
Transforming Agrifood Systems in South Asia

Exploring underlying drivers and factors, and the impact of social networks on farmers' use of integrated pest management strategies in Bangladesh

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ABOUT THIS NOTE

This report presents findings from a research study conducted under the Bangladesh Integrated Pest Management Activity (IPMA) involving 2,250 respondents, including 2,000 farmers, 100 dealers/retailers, 100 local service providers (LSPs) or pesticide sprayers, and 50 Sub-Assistant Agriculture Officers (SAAOs) across ten districts in Bangladesh. The study examined pest management strategies among farmers, both IPM users and non-users, focusing on decision-making processes, factors influencing IPM usage in five key crops—rice, maize, tomato, mungbean, and mango—and the role of stakeholders and social networks in pesticide selection and use.

KEY STUDY FINDINGS

1. For rice farmers, sustainable pest management is driven by education, experience, IPM training, family labor, land suitability, climate, consumer preferences, extension access, credit, and institutional support.
2. Among maize farmers, IPM usage is influenced by farm size, family labor, land suitability, economic conditions, social networks, and extension access.
3. For mungbean cultivation, key drivers of IPM include topography, soil fertility, climate, economic considerations, sociocultural factors, and extension access.
4. Tomato producers practice sustainable pest management based on experience, soil fertility, global standards, consumer preferences, economic factors, and extension access.
5. Mango farmers' IPM is shaped by age, training, land suitability, climate, consumer preferences, and economic and sociocultural factors.
6. Social network analysis highlights the role of farmers, extension officers, retailers, local leaders, and officials, in influencing pesticide use.
7. Policy recommendations emphasize collaboration among stakeholders to strengthen knowledge transfer, and capacity building for encouraging sustainable pest management practices.

BACKGROUND

Pesticides are widely used in modern agriculture for their effectiveness in protecting crops, contributing to higher yields globally (Damalas, 2009; Damalas & Eleftherohorinos, 2011). However, the annual application of approximately 5 billion kg of pesticides poses significant risks to non-target organisms, biodiversity, and human health (Miller, 2004; Verger & Boobis, 2013). Since the 1950s, pesticide use has grown worldwide, but this has led to increased pest resistance and rising concerns over environmental and health impacts (Pingali, 1995; Antle & Pingali, 1994).

In Bangladesh, pesticide use expanded significantly in the 1970s with government support, though excessive application has harmed the environment, farmers' health, and net returns (Dasgupta et al., 2005). The Bangladeshi government now promotes Integrated Pest Management (IPM) to reduce production costs and improve sustainability (GoB, 2002).

Farmers' pesticide use is influenced by factors like knowledge, retailer interactions, perceptions, and cultural practices (Damalas et al., 2006). Socioeconomic factors, including age, education, and credit access, also drive technology adoption (Moga et al., 2012). Understanding these influences is vital for shaping policies that promote sustainable pest management.

The Bangladesh Integrated Pest Management Activity (IPMA), funded by USAID and USDA, aimed to empower agricultural stakeholders in Bangladesh to address agricultural threats while promoting efficient, profitable, and environmentally sustainable production. Led by CIMMYT in collaboration with partners including Virginia Tech, Bangladesh Agricultural Research Institute (BARI), and FAO, the project focused on advancing IPM adoption among smallholder farmers.

As part of the IPMA, the study presented in this report evaluated pesticide use and its impact on productivity, with an emphasis on minimizing environmental risks. It analyzed the use of chemical and biopesticides, farmers' decision-making processes, and factors influencing productivity across ten districts in Bangladesh: Jashore, Jhenaidah, Sathkhira, Barisal, Patuakhali, Cox's Bazar, Dinajpur, Rangpur, Narsinghdi, and Chuadanga.

Five key crops—rice, maize, tomato, mungbean, and mango—were selected for analysis. Data was collected from 2,250 respondents, including farmers, dealers/retailers, local service providers, and Sub-Assistant Agriculture Officers. The findings offer valuable insights for scientists, policymakers, and donors to refine IPM technologies and support sustainable agricultural practices.

Above: Insect trap set-up in rice field, Bangladesh; photo: CIMMYT

OBJECTIVES

To address the study objectives, two interconnected conceptual frameworks were developed:

Farmers' Decision-Making Framework:

This framework examined the factors and circumstances influencing farmers' decisions regarding pesticide use in specific crops. It highlighted the interplay of direct and indirect factors shaping their preferences, ranging from sustainable practices to indiscriminate pesticide application, driven by diverse motivations and external conditions.

Stakeholder Influence Framework:

This framework investigated the role of stakeholders in determining pesticide selection, quantity, and application methods. It explored the social networks connecting stakeholders, analyzing their influence from pesticide production and sales to eventual application. These networks emerged as critical in shaping decision-making within the broader context of pest management and pesticide application. The two frameworks were interlinked, offering a holistic perspective. The first framework identified the drivers of farmers' adoption of sustainable pest management practices, while the second revealed the dynamic interactions among stakeholders that influenced these decisions. Together, they provided a comprehensive understanding of the factors and networks shaping pesticide use in Bangladesh's agricultural context.

Above: Pheromone sex trap in vegetables garden, Bangladesh; photo: CIMMYT

ANALYTICAL FRAMEWORK

The analytical framework developed includes: (1) the Framework of Drivers and Factors Influencing Sustainable Pest Management Decisions, and (2) Social Networks and Spheres of Influence Shaping Farmers' Pesticide Selection and Use Decisions.

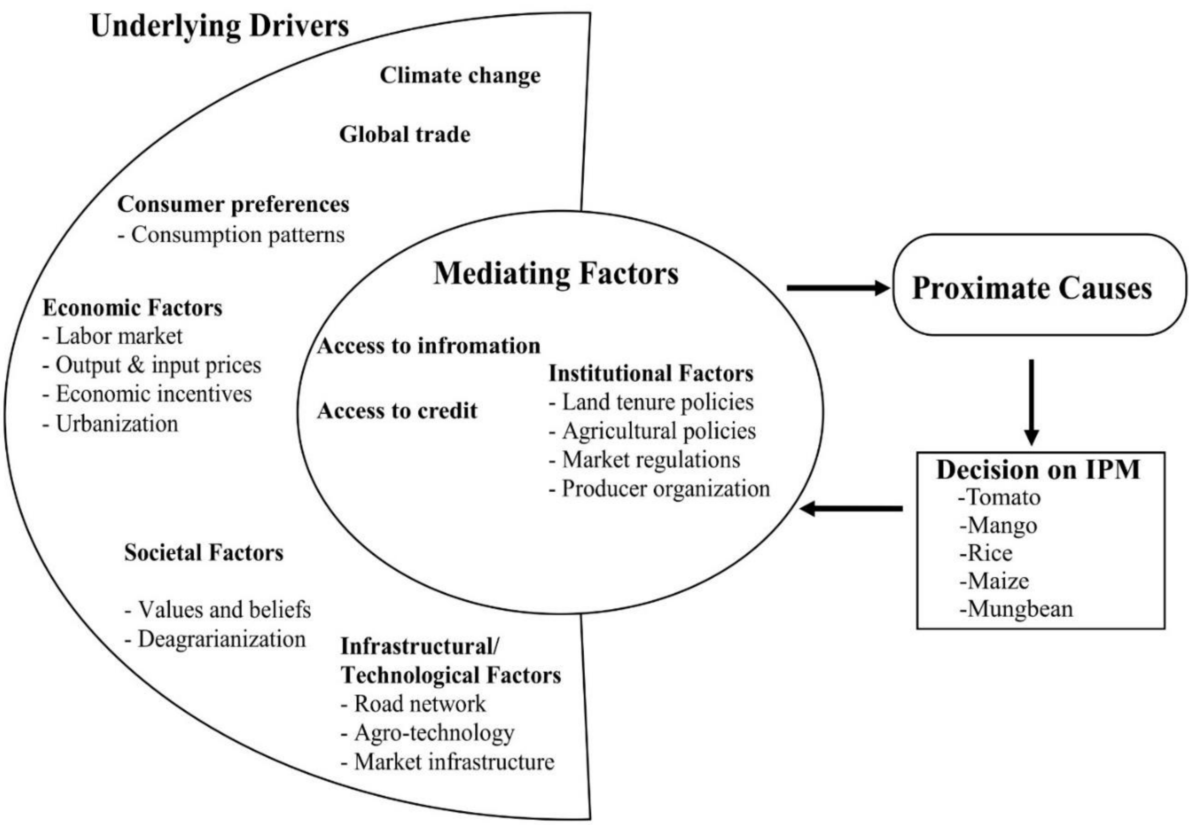

Figure 1. Conceptual Framework of Drivers and Factors Affecting Sustainable Pest Management Decisions.

Framework 1: The multi-factor framework (Fig. 1) in this research highlights the interplay among systemic, mediating, and direct factors, emphasizing the need to address all three levels to effectively promote sustainable pest management.

Underlying Drivers (Indirect Factors): Broad socio-economic and environmental factors such as climate change, global trade, and policy shape pest management decisions and encourage pesticide-free practices (Williamson et al. 2008; Espig et al. 2022).

Mediating Factors: These bridge indirect drivers and direct actions, including access to information, cultural norms, training, institutional support, and economic incentives (e.g., market premiums) (Wyckhuys and O'Neil, 2007; Mwangi and Kariuki, 2015; Sekabira et al., 2022).

Proximate Factors (Direct Factors): Immediate, modifiable conditions like pest pressure, crop susceptibility, pesticide accessibility, and farmers' knowledge directly influence decisions. Awareness of IPM benefits and non-chemical alternatives further supports adoption (Skendžić et al. 2021).

Framework 2: The social network framework (Fig. 2) highlights the role of interconnected stakeholders in shaping farmers' pesticide selection and use decisions, emphasizing the importance of social influence and knowledge exchange in promoting sustainable pest management.

Social networks play a central role in shaping agricultural practices and decision-making in Bangladesh, where farmers, pesticide companies, dealers, retailers, and extension agents form closely connected systems (Islam & Walkerden, 2015; Islam & Nursey-Bray, 2017) (Figure 2). These networks facilitate the exchange of ideas and knowledge, making them critical for the diffusion of sustainable pest management practices (Skaalsveen et al., 2020).

Social influence, driven by village leaders, neighbors, and technical experts, is key to advancing technology adoption, including sustainable pest management approaches. Experiential knowledge and social learning—developed through on-farm experimentation, observation, and adaptive problem-solving—are pivotal as farmers refine their practices over time (Šūmane et al., 2018).

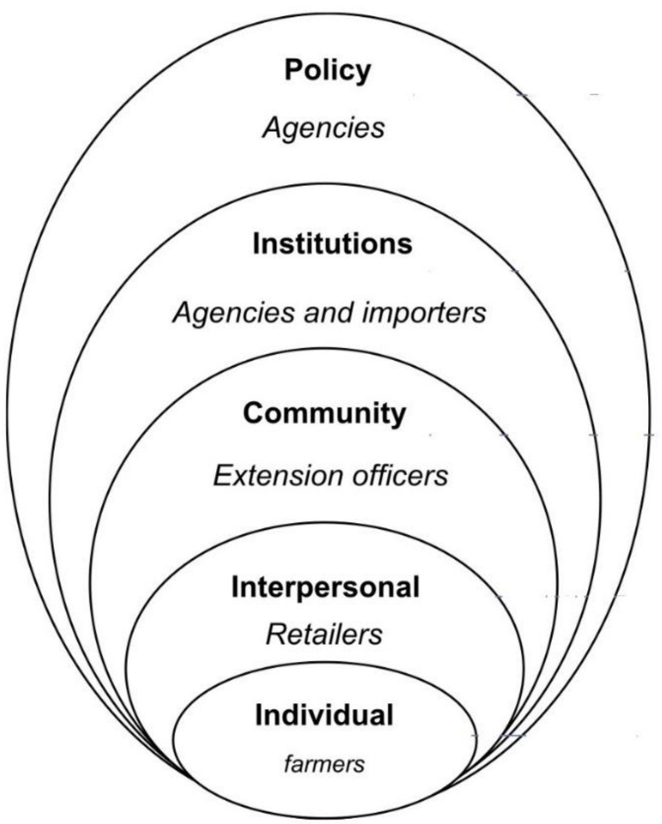

Figure 2. Social networks and sphere of influence that affect farmers' pesticide selection and use decisions (Adapted from Oludoye et al. 2021):

DATA AND METHODS

The study was conducted across ten districts of Bangladesh: Jashore (JA), Jhenaidah (JH), Sathkhira (SK), Barisal (BA), Patuakhali (PK), Cox's Bazar (CB), Dinajpur (DP), Rangpur (RP), Narsinghdi (ND), and Chuadanga (CH). These regions were selected for their significance in agricultural production and relevance to pest management practices. Five major crops—rice, maize, tomato, mungbean, and mango—were chosen based on their cultivation importance and susceptibility to pest pressure.

To identify eligible crop growers, collaboration was undertaken with the Department of Agricultural Extension, Bangladesh. A total of 2,000 farmers, comprising both Integrated Pest Management (IPM) users and non-users, were randomly selected for face-to-face interviews. Each crop sample included 400 farmers, evenly distributed between IPM users (200 farmers) and non-users (200 farmers). Additionally, the sampling framework included other stakeholders, such as pesticide dealers/retailers, local service providers (LSPs), and Sub-Assistant Agriculture Officers (SAAOs), as key actors influencing pest management practices (Figure 3).

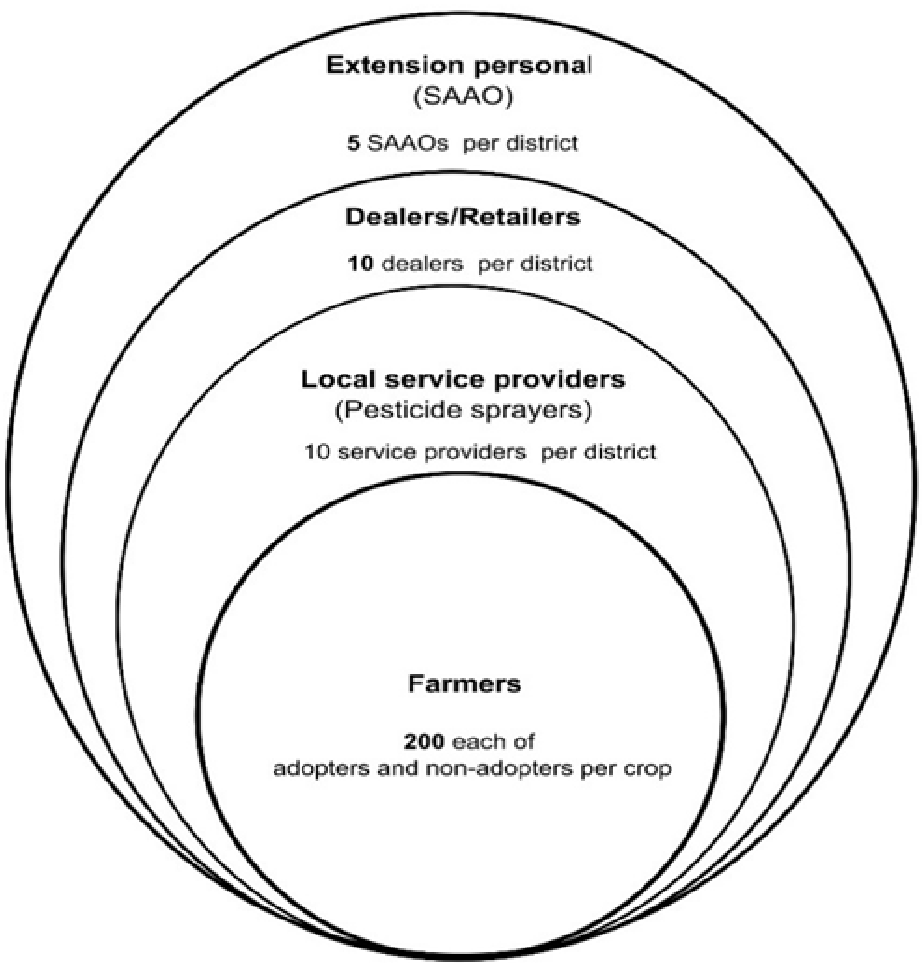

Figure 2. Social networks and sphere of influence that affect farmers' pesticide selection and use decisions (Adapted from Oludoye et al. 2021):

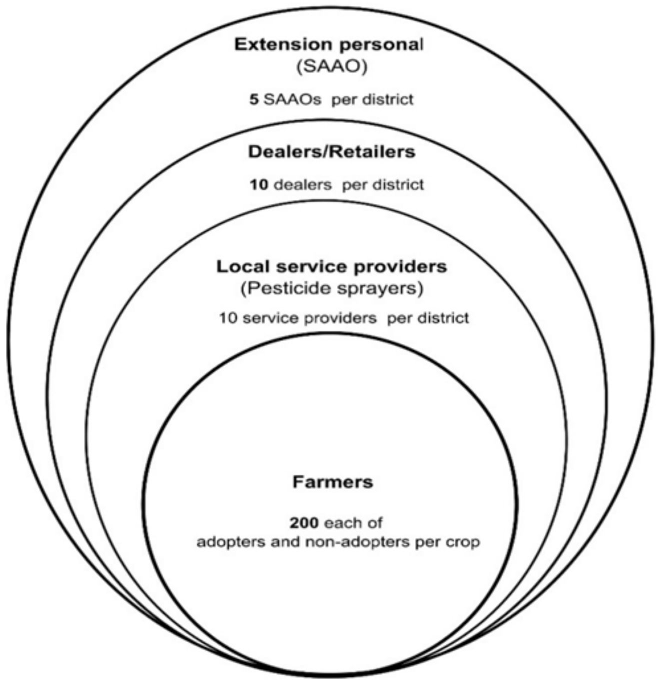

Figure 3. Sampling frame and stakeholders involved in pest management

A structured survey questionnaire and Focus Group Discussions (FGDs) were used to gather both quantitative and qualitative data. The face-to-face survey collected information on socioeconomic characteristics, IPM practices, pesticide applications, labor use, and crop productivity. Questions were tailored to capture farmers' decision-making processes, factors influencing IPM usage, and barriers to sustainable pest management practices. In addition to the survey, FGDs were conducted to engage a broad range of stakeholders, including farmers, pesticide companies, dealers, retailers, extension agents, and local service providers. These discussions provided deeper insights into farmers' knowledge-sharing networks, social influences, and experiential learning related to pest management. The survey instrument was pre-tested to ensure clarity, consistency, and reliability before full-scale data collection.

The study employed a hybrid analytical approach, combining qualitative and quantitative methods to ensure robust and comprehensive analysis. Descriptive statistics were used to summarize and compare key variables derived from survey respondents. To examine the factors shaping farmers' decision-making processes regarding pesticide use, Structural Equation Modeling (SEM) was applied following the methods by Despotović et al. (2019), based on Framework 1. The SEM model analyzed the relationships among three primary constructs: underlying drivers, mediating factors, and proximate factors.

Underlying drivers included broad forces such as climate change, global trade, consumer preferences, and policies. Underlying drivers included broad forces such as climate change, global trade, consumer preferences, and policies.

Mediating factors represented connecting elements like access to information, economic incentives, social norms, and institutional support. Proximate factors encompassed immediate conditions like pest pressure, crop type, economic considerations, and pesticide availability.

SEM analysis was conducted using R software, specifically the lavaan package (Rosseel, 2012). Pathways were developed to represent the hypothesized relationships among constructs, with path coefficients estimating the strength and direction of these relationships. Significance tests were performed to identify key factors influencing farmers' use of IPM practices.

Model fit was assessed using multiple indices, including the Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR), ensuring alignment between the theoretical model and observed data.

To explore the roles of stakeholders and social networks in influencing pesticide selection, quantity, and application methods, Social Network Analysis (SNA) was employed, based on Framework 2. SNA examined the interactions and relationships among farmers, extension agents, retailers, and other key actors in pest management. This analysis highlighted the critical role of social influence and knowledge exchange in farmers' decision-making processes.

RESULTS

Drivers and factors affecting sustainable pest management decisions

The results of the Structural Equation Modeling (SEM) analysis, conducted on a sample of 1,000 IPM users and 1,000 IPM non-users across five crops, identify the factors influencing the use of Integrated Pest Management (IPM) (Table 1). The analysis covers rice (column 1), maize (column 2), mungbean (column 3), tomato (column 4), and mango (column 5). These findings highlight key proximate causes, underlying drivers, and mediating factors that shape farmers' decisions regarding IPM use in Bangladesh.

Figure 2. Social networks and sphere of influence that affect farmers' pesticide selection and use decisions (Adapted from Oludoye et al. 2021):

Table 1. Drivers of sustainable pest management decision in cereals and horticultural crops

Columns Predictor	(1) Rice (n=400)	(2) Maize (n=400)	(3) Mungbean (n=400)	(4) Tomato (n=400)	(5) Mango (n=400)
Proximate causes					
Farmer Age	-0.000 (0.005)	-0.007 (0.008)	0.027 (0.018)	0.007 (0.007)	-0.0002
Farmer Education	0.010** (0.003)	-0.002 (0.008)	0.029 (0.017)	-0.012 (0.007)	-0.015 (0.010)
Farmer Experience	0.012*** (0.003)	-0.014 (0.009)	-0.031 (0.018)	-0.000152	0.003 (0.010)
IPM Training	0.020*** (0.003)	0.012* (0.010)	0.015 (0.021)	0.010* (0.006)	0.031*** (0.007)
Farm Size	0.004 (0.005)	0.015** (0.005)	-0.017 (0.021)	-0.001 (0.008)	0.004 (0.008)
Farm Topography	0.005 (0.006)	-0.010 (0.008)	-0.040 (0.019) *	-0.005 (0.008)	-0.015 (0.011)
Family Labor Availability	0.014*** (0.003)	0.019* (0.009)	0.020 (0.022)	-0.008 (0.007)	0.017 (0.009)
Soil Fertility	-0.001 (0.003)	-0.010 (0.005)	-0.030 (0.015) *	-0.000105	0.004 (0.007)
Land Suitability for Farming	-6E-05	0.028*** (0.006)	-0.017 (0.017)	0.055*** (0.006)	0.043*** (0.009)
Underlying drivers					
Climate Factors	0.098*** (0.011)	-0.009 (0.005)	-0.021 (0.009) *	-0.001 (0.007)	-0.0002
Global Standards	0.002 (0.003)	-0.003 (0.005)	-0.008 (0.009)	0.062*** (0.012)	-0.017 (0.013)
Consumer Preferences	0.096*** (0.009)	-0.001 (0.006)	0.009 (0.009)	0.087*** (0.019)	0.091*** (0.022)
Economic Factors	0.003 (0.003)	0.260*** (0.014)	0.022 (0.010) *	0.082*** (0.023)	0.231*** (0.027)
Societal Factors	-0.002 (0.003)	0.038*** (0.007)	0.020 (0.010) *	-0.010 (0.008)	-0.043*** (0.013)
Infrastructure and Technological Factors	-0.002 (0.003)	-0.006 (0.006)	0.009 (0.009)	0.035 (0.023)	0.003 (0.017)
Mediating factors					
Extension Access	0.046*** (0.009)	0.147*** (0.011)	0.478 (0.008) ***	0.157*** (0.015)	0.068*** (0.017)
Credit Access	0.091*** (0.010)	-0.003 (0.005)	0.002 (0.008)	-0.015 (0.008)	-0.030 (0.020)

Columns	(1)	(2)	(3)	(4)	(5)
Predictor	Rice (n=400)	Maize (n=400)	Mungbean (n=400)	Tomato (n=400)	Mango (n=400)
Goodness-of-fit-measures					
Chi-Square	1835.39	1438.679	932.132	1145.813	1031.632
Degrees of Freedom	19.00	19.00	19.00	19.00	19.00
P-Value	0.00	0.00	0.00	0.00	0.00
CFI	1.00	1.00	1.00	1.00	1.00
TLI	1.00	1.00	1.00	1.00	1.00
RMSEA	0.00	0.00	0.00	0.00	0.00
SRMR	0.00	0.00	0.00	0.00	0.00
Akaike (AIC)	-1214.800	-818.046	-311.499	-527.436	-410.999
Bayesian (BIC)	-1134.900	-738.217	-231.669	-447.607	-331.169
Sample-size adjusted Bayesian (SABIC)	-1198.4	-801.678	-295.131	-511.068	-394.631

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Predictor values are estimates from crop-specific Structural Equation Models (SEM), where IPM use is coded as 1 and non-use as 0. Values in parentheses are standard errors.

Above: Integrated pest management training at Feni, Bangladesh; photo: CIMMYT

DRIVERS OF IPM USE IN CEREALS AND HORTICULTURAL CROPS

For rice (Table 1, column 1), significant proximate causes include farmer education (Estimate = 0.010, p = 0.001), farmer experience (Estimate = 0.012, $p < 0.001$), and family labor availability (Estimate = 0.014, $p < 0.001$). IPM-specific training emerges as the strongest predictor of IPM use (Estimate = 0.020, $p < 0.001$), emphasizing the role of targeted capacity-building initiatives. In contrast, farm size, soil fertility, and land suitability do not exhibit significant effects. Among the underlying drivers, climate factors (Estimate = 0.098, $p < 0.001$) and consumer preferences (Estimate = 0.096, $p < 0.001$) are significant positive drivers, reflecting responses to environmental pressures and market demands. Mediating factors such as extension access (Estimate = 0.046, $p < 0.001$), credit access (Estimate = 0.091, $p < 0.001$), and institutional support (Estimate = 0.071, $p < 0.001$) play critical roles.

For maize (Table 1, column 2), family labor availability (Estimate = 0.019, p = 0.034), farm size (Estimate = 0.015, p = 0.001), and land suitability (Estimate = 0.028, $p < 0.001$) significantly influence IPM use. These results highlight the importance of land and labor resources in maize production. Economic factors (Estimate = 0.260, $p < 0.001$) and societal factors (Estimate = 0.038, $p < 0.001$) emerge as significant underlying drivers, while climate and infrastructure-related factors are not significant. Among mediating factors, extension access has a strong positive effect (Estimate = 0.147, $p < 0.001$), whereas institutional factors exhibit a small negative effect (Estimate = -0.011, p = 0.017).

For mungbean (Table 1, column 3), farm topography (Estimate = -0.040, p = 0.039) and soil fertility (Estimate = -0.030, p = 0.039) have significant negative effects on IPM use, indicating physical and soil-related constraints. Climate factors also negatively influence IPM use (Estimate = -0.021, p = 0.021), while economic factors (Estimate = 0.022, p = 0.021) and societal factors (Estimate = 0.020, p = 0.046) exhibit significant positive effects. Extension access stands out as the strongest enabling factor (Estimate = 0.478, $p < 0.001$), highlighting the critical role of advisory services. Other mediating factors, such as credit access and institutional support, are not significant.

For tomato (Table 1, column 4), farmer experience (Estimate = -0.019, p = 0.012) and soil fertility (Estimate = -0.015, p = 0.023) negatively affect IPM use, suggesting that experienced farmers and those with fertile soils may rely less on IPM. Land suitability for farming is the strongest positive driver (Estimate = 0.055, $p < 0.001$). Among underlying drivers, global standards (Estimate = 0.062, $p < 0.001$), consumer preferences (Estimate = 0.087, $p < 0.001$), and economic factors (Estimate = 0.082, $p < 0.001$) significantly promote IPM use, reflecting the influence of market-oriented incentives. Extension access (Estimate = 0.157, $p < 0.001$) remains a critical mediating factor, while credit access and institutional support are not significant.

For mango (Table 1, column 5), farmer age negatively influences IPM use (Estimate = -0.020, p = 0.050), while agricultural training (Estimate = 0.031, $p < 0.001$) and land suitability (Estimate = 0.043, $p < 0.001$) have significant positive effects. Family labor availability approaches significance (Estimate = 0.017, p = 0.062). Among the underlying drivers, consumer preferences (Estimate = 0.091, $p < 0.001$) and economic factors (Estimate = 0.231, $p < 0.001$) positively drive IPM use, while societal factors (Estimate = -0.043, p = 0.001) and climate factors (Estimate = -0.020, p = 0.044) exhibit significant negative effects. Extension access (Estimate = 0.068, $p < 0.001$) emerges as a key mediating factor, while credit access and institutional support do not significantly affect IPM use.

Across all five crops, extension access consistently emerges as a significant enabling factor, highlighting the importance of advisory services in facilitating IPM use. Economic factors and consumer preferences are key underlying drivers, particularly in maize, tomato, and mango, where market demand and profitability are strong motivators. Proximate causes such as land suitability, family labor availability, and IPM-specific training play critical roles in several crops, while constraints such as soil fertility, farm topography, and adverse climate conditions are evident in mungbean and tomato.

SOCIAL NETWORK ANALYSIS OF IPM USE IN BANGLADESH

The Social Network Analysis (SNA) reveals notable differences and similarities between IPM users and non-users in Bangladesh. The analysis examines key social network attributes, including Strength of Social Ties (SST), Frequency of Information Seeking (FIS), Trust (TR), Reliability (REL), and Degree of Influence (DI), across major actors such as fellow farmers, extension officers, agrochemical retailers, local leaders, government officials, and others. The results are summarized in Table 2 and visualized in Figure 4.

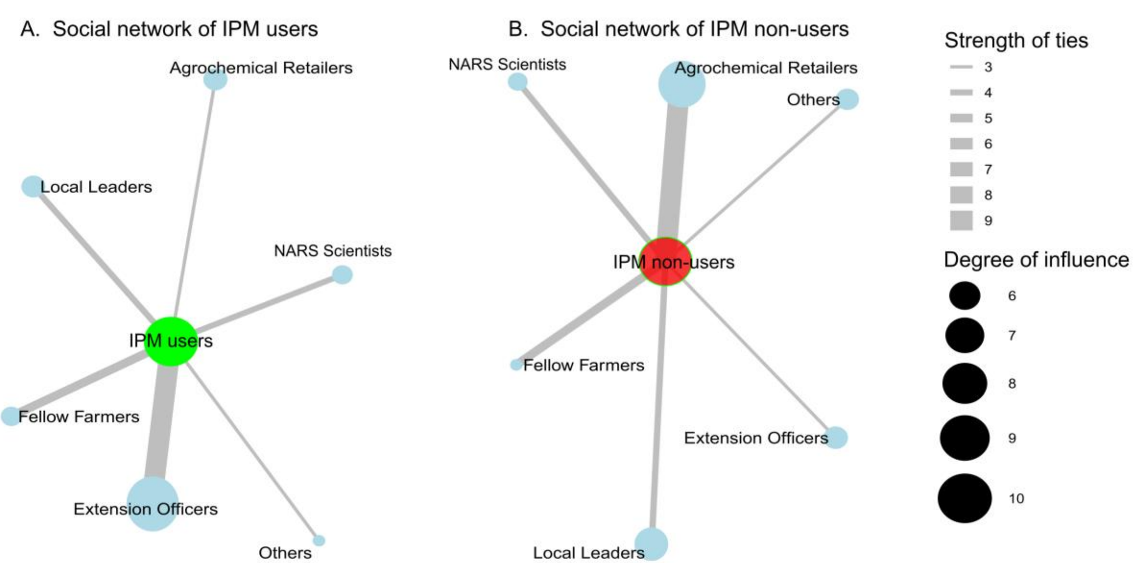

Figure 4. Social network of IPM users and non-users illustrates the strength of ties, with thicker lines representing stronger connections. The degree of influence is indicated by the size of the circles, with larger circles denoting higher influence.

STRENGTH OF SOCIAL TIES (SST)

IPM non-users generally exhibit stronger social ties compared to users, particularly with Fellow Farmers (6.13 for non-users vs. 5.72 for users) and Agrochemical Retailers (6.06 vs. 5.77). This suggests that non-users rely more heavily on peer networks and commercial sources for support and advice. In contrast, users maintain balanced social ties across all actors, with notable connections to Others (5.82), indicating broader engagement within their networks. Both groups show comparable SST values with Extension Officers (5.70 for users vs. 5.96 for non-users), suggesting a shared interaction with formal advisory services.

Table 2. Social network analysis and the relationship between pest management actors and farmers

Actor	SST	FIS	TR	REL	DI
IPM Users					
Agrochemical Retailers	5.77	6.25	5.66	5.60	5.23
Extension Officers	5.70	6.59	5.57	5.52	5.16
Fellow Farmers	5.72	6.14	5.53	5.49	5.40
Government Officials	5.72	6.30	5.75	5.60	5.39
Local Leaders	5.54	6.34	5.64	5.49	5.22
Others	5.82	6.33	5.50	5.50	5.02
IPM Non-users					
Agrochemical Retailers	6.06	6.03	6.04	5.26	5.14
Extension Officers	5.96	6.15	6.20	5.18	5.54
Fellow Farmers	6.13	5.97	5.92	5.25	5.45
Government Officials	5.81	5.91	5.89	5.27	5.54
Local Leaders	5.98	6.15	5.94	5.22	5.29
Others	6.00	6.18	5.97	5.26	5.46

Note: SST=Strength of Social Ties, FSI=Frequency of Information Seeking, TR=Trust, REL=Reliability, and DI=Degree of Influence.

Above: Integrated Pest management training at Feni, Bangladesh; photo: CIMMYT

Frequency of information seeking (FIS)

IPM users seek information more frequently from formal sources, such as Extension Officers (6.59) and Local Leaders (6.34), reflecting their engagement with structured agricultural knowledge systems. Conversely, non-users rely more on informal or market-based sources, as evidenced by higher FIS values for Fellow Farmers (6.03 for non-users vs. 6.14 for users) and Agrochemical Retailers (6.03 vs. 6.25). This distinction highlights that users prioritize institutional actors for IPM-related information, while non-users prefer peer and commercial sources.

Trust (TR)

Trust levels reveal differences in the perceived quality of relationships. Among users, Government Officials (5.75) and Agrochemical Retailers (5.66) are the most trusted actors, indicating confidence in government-led initiatives and market-based interventions. In contrast, non-users place higher trust in Extension Officers (6.20) and Agrochemical Retailers (6.04), suggesting they view these actors as key advisors in their decision-making processes. Trust in Fellow Farmers remains consistently important for both groups (5.53 for users and 5.92 for non-users), though non-users show slightly higher trust in their peer networks.

DISCUSSION

This study highlights the multiple factors influencing the use of Integrated Pest Management (IPM) practices in Bangladesh, emphasizing the interplay between proximate causes, underlying drivers, mediating factors, and social networks. The findings align with and expand upon previous research on sustainable pest management and the role of social networks in technology use and adoption.

PROXIMATE CAUSES AND UNDERLYING DRIVERS

Farmer-specific attributes, such as IPM-specific training, education, and land suitability, emerged as critical factors promoting IPM use. Training programs significantly enhanced farmers' technical know-how, enabling them to shift from chemical-intensive methods to integrated approaches. These findings align with studies demonstrating that farmer education and skill-building improve the likelihood of adopting sustainable agricultural innovations (Obeten et al., 2022; Sadique Rahman, 2022). Similarly, land suitability, particularly in maize and mango production, provides a conducive environment for IPM implementation, as noted in earlier studies on agricultural land-use optimization (Skendžić et al., 2021).

Conversely, constraints such as soil fertility and adverse climatic conditions were significant barriers to IPM use in mungbean and tomato production. Farmers in fertile areas often perceive less urgency to practice alternative pest management practices, a trend reported by Sadique Rahman, 2022. Additionally, climate variability adds another layer of complexity, discouraging IPM use under uncertain weather conditions (Mungai et al., 2024).

Mediating Factors

Access to extension services consistently emerged as a strong mediating factor across all crops. Extension agents play a pivotal role in disseminating knowledge and building trust, acting as intermediaries between formal research systems and farming communities. This is consistent with findings of Mungai et al. (2024) and Islam and Nursey-Bray (2017), who highlighted the importance of extension access in bridging information gaps for sustainable agricultural practices. However, weak credit systems and limited institutional tenure in some regions reduce farmers' capacity to adopt IPM, a challenge noted in prior studies emphasizing financial access as a barrier to technology adoption (Gichungi et al., 2021).

Social Networks and IPM Use

The social network analysis revealed the critical role of peer networks, extension agents, and agrochemical retailers in shaping farmers' IPM-related decisions. IPM users were more engaged with formal actors, such as extension officers and government officials, indicating a reliance on structured, evidence-based knowledge dissemination. In contrast, non-users exhibited stronger ties with fellow farmers and agrochemical retailers, highlighting the importance of informal and market-based networks in influencing pest management practices. These patterns align with the findings of Crona and Bodin (2006), who demonstrated that well-connected nodes in agricultural networks accelerate innovation adoption through trusted relationships.

Trust and perceived reliability are crucial for effective knowledge dissemination. Users' trust in government officials and agrochemical retailers reinforces the importance of credible institutional actors. Non-users, however, rely more on peers for advice, reflecting the findings of Bandiera and Rasul (2006), who reported that peer influence often drives technology adoption in rural settings. Furthermore, the absence of weak ties to formal networks, as noted by Beaman et al. (2021), may limit the flow of reliable information to non-users, perpetuating overreliance on chemical pesticides.

To address this, social network-based targeting strategies that engage central actors—such as progressive farmers and local leaders—can facilitate broader dissemination of IPM practices. As highlighted in prior studies, opinion leaders with higher betweenness centrality can bridge gaps within social networks, ensuring efficient information flow (Beaman et al., 2021; Gichungi et al., 2021).

Above: Pesticides service provider, Bangladesh; photo: CIMMYT

CONCLUSION

This report provides the results of the study and analysis of the factors influencing IPM use across five major crops—rice, maize, mungbean, tomato, and mango—in Bangladesh. Key findings highlight the significance of IPM-specific training, education, and land suitability as proximate causes facilitating IPM usage, while environmental constraints like soil fertility and climate variability hinder uptake.

The role of extension services as mediating factors is particularly noteworthy, underscoring the importance of enhancing advisory systems to address farmers' knowledge gaps. Financial access and institutional frameworks require targeted strengthening to enable broader use and adoption of IPM practices.

Social networks tend to have a major influence on IPM use, with extension officers and government officials influencing users' decisions, while non-users relied more on peer networks and agrochemical retailers. Leveraging social networks to identify influential actors and bridging communication gaps can accelerate the diffusion of sustainable pest management practices.

To promote IPM use and adoption, interventions should focus on:

- Strengthening extension systems to enhance farmers' access to reliable knowledge.
- Building farmer capacity through IPM-specific training and localized support.
- Utilizing social network-based approaches to identify and engage extension champions and opinion leaders for knowledge dissemination.
- Improving access to financial and institutional support systems, particularly in resource-constrained areas.
- Addressing crop-specific constraints, such as climate variability and soil-related challenges.

By addressing these priorities, policymakers and stakeholders can create an enabling environment for scaling IPM use, contributing to sustainable agricultural practices, reduced pesticide reliance, and improved farmer livelihoods in Bangladesh.

Above: Insect trap; photo: CIMMYT

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Above: Integrated Pest management training at Feni, Bangladesh; photo: CIMMYT

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TAFSSA (*Transforming Agrifood Systems in South Asia)* is a CGIAR Regional Integrated Initiative to support actions that improve equitable access to sustainable healthy diets, improve farmers' livelihoods and resilience, and conserve land, air, and water resources in South Asia.

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