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Farmer Perceptions and Adoption of Integrated Pest Management in Cotton Production at District Umerkot

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Abstract

Cotton is a major contributor to Pakistan's agricultural economy, yet production remains heavily constrained by insect pests and excessive pesticide use, which increases costs, destroys beneficial insects, accelerates pest resistance and threatens farmers' health. Although Integrated Pest Management (IPM) is promoted as a sustainable alternative, evidence on the effectiveness of Farmer Field School (FFS) training in developing practical

IPM skills remains limited. A cross-sectional survey of 74 cotton growers in Taluka Kunri, Umerkot, Sindh, compared 37 FFS-trained farmers with 37 untrained farmers using structured interviews on IPM awareness, adoption and knowledge of Economic Threshold Level (ETL) and Economic Injury Level (EIL). FFS was identified as the most trusted information source (mean score: 3.76–3.89/5). However, none of the farmers could correctly identify the recommended ETL or EIL for bollworm species, while adoption of threshold-based spraying and biological control methods, such as *Trichogramma* cards, remained extremely low. Independent t-tests showed no significant differences between trained and untrained farmers for most IPM awareness and adoption indicators ($p > 0.05$), indicating limited effectiveness of current FFS training in transferring critical decision-making skills. Major constraints included inadequate practical knowledge, limited availability of biological control inputs and the labour-intensive nature of pest scouting. The findings demonstrate that existing FFS curricula inadequately address the core principles of rational pest management. Strengthening IPM outcomes in Sindh requires practical ETL/EIL-based training, improved biological control supply systems and stronger post-training extension support.

Keywords: Integrated Pest Management; Economic Threshold Level; Economic Injury Level; Technology adoption

INTRODUCTION

Agriculture supports approximately 70% of Pakistan's population, either directly or indirectly, providing food and industrial raw materials. Sindh Province contributes 3.8 million hectares (17%) of the country's cultivated area. However, rural poverty is acute: 30–35% of Sindh's rural inhabitants live below the poverty line and land ownership is highly skewed. Data from 2005 show that landlords constituting fewer than 1% of all farmers owned more land than the combined holdings of 62% of smallholders (Yousafzai *et al.*, 2019). Such inequality influences technology adoption, as tenants without secure land rights are risk-averse and less able to invest in long-term improvements.

After wheat, cotton is Pakistan's most valuable cash crop. It occupies the largest area of any commercial crop and generates about 55% of agricultural export earnings. Cottonseed oil meets roughly 80% of national edible oil requirements (Rehman *et al*., 2019). In the 2017-18 season, cotton output reached 11.9 million bales, contributing 1.0% to GDP and 5.5% to agricultural value added (GoP, 2020). These figures are achieved despite persistent pressure from a complex of insect pests, including sucking pests (jassids, whitefly, thrips, aphids, spider mites) and chewing pests (spotted, American, pink and army bollworms).

Historically, Pakistani farmers have relied on calendar-based pesticide applications, largely ignoring actual pest densities. This practice has caused rising input costs, destruction of natural predators, pest resistance, environmental contamination and serious health hazards. Pregnant and breastfeeding women working in cotton fields face particularly high exposure to organophosphates and synthetic pyrethroids (He *et al*., 2018; Warriach *et al*., 2019).

Integrated Pest Management (IPM) is a science-based, ecological approach combining cultural, biological, physical and chemical methods. Pesticides are used only as a last resort, when pest populations exceed the Economic Threshold Level (ETL) or approach the Economic Injury Level (EIL). These thresholds provide a rational basis for spraying decisions, which calendar schedules lack.

Pakistan's National IPM Programme, implemented largely through Farmer Field Schools (FFS), has operated for over two decades. The FFS model employs participatory, field-based learning to enhance farmers' diagnostic and decision-making capacity. Despite substantial public investment, systematic evidence on whether FFS training produces durable changes in the knowledge and practices of cotton farmers in Sindh is sparse. This study addresses that gap.

Given cotton's economic importance and the documented harms of pesticide misuse, evaluating the effectiveness of current IPM extension efforts is essential. A farmer-level assessment of knowledge, adoption and constraints provides the empirical basis for informed programme reform.

The study had three objectives:

1. To measure cotton farmers' awareness and adoption of IPM practices in Taluka Kunri, District Umerkot and identify barriers to adoption.
2. To determine which information sources farmers use and how effective they perceive them for IPM learning.
3. To formulate actionable recommendations for policymakers and extension managers.

MATERIALS AND METHODS

Study design and setting

A cross-sectional survey was conducted in Taluka Kunri, District Umerkot, Sindh a predominantly agricultural area where cotton is the main cash crop. The design allowed comparison of two farmer groups (trained vs. untrained) at a single time point to assess associations between prior training and current knowledge/practice.

Questionnaire development

A structured questionnaire was developed after reviewing published literature on IPM adoption in South Asian cotton systems and consulting agricultural extension specialists and university faculty. The draft was translated into Sindhi and Urdu. A pilot test with ten cotton farmers (excluded from the final sample) identified unclear items and improved wording.

The final instrument comprised two sections:

- **Section A** collected socio-economic and farm data: age, education, land tenure, total farm size, cotton area, yield and irrigation sources.
- **Section B** assessed IPM variables using Likert-type scales: frequency of information source use (1 = Never to 4 = Almost always), perceived effectiveness of sources (1 = Very poor to 5 = Excellent), awareness and adoption of 15 IPM practices (1 = Very low/Never to 4 = Very

high/Always), knowledge of ETL/EIL for four bollworm species (binary: 0 = No, 1 = Yes) and barriers to adoption (1 = No problem to 3 = Major problem).

Sampling and data collection

The study population comprised all cotton growers registered in Taluka Kunri. A sampling frame was constructed from records of the local Revenue Department and the FFS programme office. Using simple random sampling, 74 farmers were selected: 37 who had completed at least one full FFS cycle under the National IPM Programme (trained group) and 37 who had received no formal IPM instruction (untrained group).

Face-to-face interviews were conducted by the lead researcher at respondents' homes or farms, each lasting 35-40 minutes. Informed verbal consent was obtained and confidentiality and voluntary participation were assured.

Data Analysis

Data were coded and entered into IBM SPSS Statistics Version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies, percentages, means, standard deviations) were computed. Independent samples t-tests were used to compare mean awareness and adoption scores between trained and untrained groups. Statistical significance was set at $p < 0.05$.

RESULTS

Socio-economic characteristics

Table 1 summarises the background traits of the two groups. Most trained farmers (51.4%, n=19) were aged 31-40 years, whereas the largest share of untrained farmers (35.1%, n=13) were aged 20-30 years. Primary education was the modal level in both groups (35.1%, n=13 each). The untrained group had a wider educational spread: more had intermediate education (24.3%, n=9), but also a higher illiteracy rate (16.2%, n=6) compared to the trained group (13.5%, n=5). Trained farmers tended to operate larger landholdings (32.4%, n=12 farmed 21-30 acres), while untrained farmers were more evenly distributed across farm sizes.

Table 1. Socio-economic profile of cotton growers (n=74)

Variable	Category	Trained (n=37) n (%)	Untrained (n=37) n (%)
Age	20-30 years	11 (29.7)	13 (35.1)
	31-40 years	19 (51.4)	12 (32.4)
	41-50 years	6 (16.2)	7 (18.9)
	51+ years	1 (2.7)	5 (13.6)
Education	Illiterate	5 (13.5)	6 (16.2)
	Primary	13 (35.1)	13 (35.1)
	Middle	8 (21.6)	6 (16.2)
	Matriculation	3 (8.1)	2 (5.4)
	Intermediate	5 (13.5)	9 (24.3)
	Graduate	3 (8.2)	1 (2.7)
Land tenure	Owner	13 (35.1)	18 (48.6)
	Owner-cum-tenant	7 (18.9)	5 (13.5)

Variable	Category	Trained (n=37) n (%)	Untrained (n=37) n (%)
	Tenant	17 (46.0)	14 (37.8)

Information sources

Table 2 shows farmer ratings of IPM information sources. The Farmer Field School (FFS) was the top source in both groups, with mean effectiveness scores of 3.76 (SD=0.72) for trained and 3.89 (SD=0.74) for untrained farmers (scale 1-5). Notably, even farmers who had never attended FFS rated it highly, likely due to community word-of-mouth. Extension workers were rated as effective by trained farmers (mean=3.54, SD=0.90) but less so by untrained farmers (mean=3.11, SD=0.97). Radio and television received low scores from both groups, indicating limited utility for IPM communication.

Table 2. Perceived effectiveness of IPM information sources (n=74)

Information source	Trained mean (SD)	Untrained mean (SD)
Farmer Field School (FFS)	3.76 (0.72)	3.89 (0.74)
Extension worker	3.54 (0.90)	3.11 (0.97)
Neighbouring farmers	3.46 (1.39)	2.86 (1.21)
Radio	2.32 (0.85)	2.78 (0.48)
Television	2.24 (0.83)	2.68 (0.58)

Note: Scale 1 = Very poor to 5 = Excellent.

Awareness and adoption of IPM practices

Table 3 presents awareness and adoption scores for five key practices. Pest scouting and neem leaf extract were well known and relatively widely used in both groups. Conservation of beneficial insects (especially ants) was also commonly reported.

In contrast, decision-making based on ETL/EIL scored lowest among all practices. Trained farmers had mean awareness of 1.89 (SD=1.29) and adoption of 1.54 (SD=0.84) on a 4-point scale. When asked directly whether they could state the recommended ETL/EIL for any bollworm species, all 74 respondents answered **no.** Not one trained farmer could specify the pest number that justifies spraying.

Awareness of *Trichogramma* cards was moderate, but adoption was very low, suggesting that availability, not just knowledge, constrains use.

Table 3. Awareness and adoption of selected IPM practices (n=74)

IPM practice	Trained awareness	Trained adoption	Untrained awareness	Untrained adoption
Pest scouting	3.16 (0.87)	3.38 (0.95)	3.30 (0.57)	3.41 (0.96)
ETL/EIL application	1.89 (1.29)	1.54 (0.84)	1.65 (0.72)	2.30 (0.81)
Neem leaf extract	3.14 (0.95)	3.19 (1.08)	3.38 (0.68)	3.32 (0.97)
Trichogramma car	3.05	1.65	3.11	2.16 (0.73)

IPM practice	Trained awareness	Trained adoption	Untrained awareness	Untrained adoption
ds	(0.99)	(0.63)	(0.70)	
Conserving ants	3.24 (0.90)	3.32 (0.88)	3.59 (0.83)	3.62 (0.95)

Note: Scale 1 = Very low/Never to 4 = Very high/Always. Values are mean (SD).

Barriers to IPM adoption

Table 4 lists farmer-reported obstacles. Trained farmers identified lack of IPM knowledge as the most severe barrier (mean=2.70, SD=0.52) – paradoxical given their training. Lack of facilities (labs, biological control supplies) was equally severe (mean=2.70, SD=0.46). Labour intensity was also a major barrier (mean=2.65, SD=0.48). For untrained farmers, poor road access was the most serious constraint (mean=2.68, SD=0.48), isolating them from extension services. Financial constraints ranked lower than knowledge and infrastructure barriers in both groups.

Table 4. Perceived barriers to IPM adoption (n=74)

Barrier	Trained mean (SD)	Untrained mean (SD)
Lack of IPM knowledge	2.70 (0.52)	2.57 (0.50)
Lack of facilities/inputs	2.70 (0.46)	2.59 (0.55)
Labour-intensive process	2.65 (0.48)	2.22 (0.53)

Barrier	Trained mean (SD)	Untrained mean (SD)
Poor road access	2.38 (0.49)	2.68 (0.48)
Financial constraints	2.41 (0.55)	2.49 (0.51)

Note: Scale 1 = No problem to 3 = Major problem.

Fig 1. *The IPM Knowledge–Adoption Disconnect; A Socio-Institutional and Decision-Making Pipeline Model*

Comparison of trained and untrained farmers

Independent t-tests revealed no statistically significant differences between the two groups for most awareness and adoption variables. For example, pest scouting awareness ($p=0.104$), beneficial insect conservation ($p=0.863$) and neem leaf extract adoption ($p=0.354$) all showed $p > 0.05$. The only exception was neem oil adoption ($p=0.017$). Thus, current FFS training does not lead to meaningful improvements in the IPM knowledge and practices that matter most 4.

DISCUSSION

Role of information sources and social networks

High ratings for FFS corroborate previous findings that participatory, field-based extension is among the most trusted and effective mechanisms for agricultural knowledge transfer in South Asia (Dara, 2019; Rijal *et al.*, 2018). Positive ratings from untrained farmers suggest reputational spill-over through community networks. However, those same networks may reinforce pesticide-dependent practices. Zahid *et al.* (2018) reported in Hasilpur, Pakistan, that farmer-to-farmer exchange often promotes calendar-based spraying because pesticide use is socially visible and associated with diligent farming. This social pressure likely undermines IPM messages, especially when follow-up is infrequent.

The critical ETL/EIL knowledge deficit

The finding that all 74 farmers, including every trained participant, could not state a single bollworm threshold is the most consequential result of this study. ETL/EIL are the operational foundation of IPM; without them, farmers cannot make rational spraying decisions and revert to prophylactic or anxiety-driven applications.

This deficit has persisted despite two decades of national IPM programming. Parsa *et al.* (2014) reviewed IPM efforts globally and identified ETL/EIL as among the most poorly understood concepts. Waman *et al.* (2006) documented similar threshold ignorance among cotton growers in India.

Khan and Damalas (2015) showed that education and training are the strongest predictors of environmentally sound pest control in Pakistan, making the complete failure of training to impart ETL/EIL competency particularly troubling.

Possible explanations include: (i) FFS curricula allocate excessive time to pest identification and botanicals, leaving little for threshold practice; (ii) some facilitators lack confidence in teaching thresholds; (iii) for farmers with limited literacy, abstract numbers have no mnemonic anchor without repeated field practice. Abstract classroom instruction is insufficient.

Patterns of selective adoption

Adoption followed a clear gradient: simple, cheap, familiar practices (neem leaf, ant conservation) were adopted at moderate to high levels, while practices requiring analytical judgement or unavailable inputs (threshold spraying, *Trichogramma* cards) were barely used. This mirrors findings from Ali and Sharif (2012) in Punjab and Dupare and Mazhar (2023) in Maharashtra, where even self-identified "IPM adopters" used only the easiest components.

The near-zero adoption of *Trichogramma* cards despite moderate awareness indicates a supply-chain failure, not a knowledge deficit. Biological control products are not reliably available locally. Training alone cannot remedy this.

Knowledge and Infrastructure outrank finance

A consistent and policy-relevant finding is that knowledge deficits and lack of facilities were stronger barriers than financial constraints. This challenges the common assumption that poverty is the primary driver of pesticide misuse. Even trained farmers with adequate self-reported income could not make threshold-based decisions because they lacked the knowledge and could not access biological controls because supply is absent. Financial subsidies for IPM inputs will have limited impact unless knowledge and infrastructure constraints are addressed simultaneously.

Limitations

Several limitations should be acknowledged. First, the sample (n=74, one taluka) limits generalisability to all of Sindh. Second, the cross-sectional design cannot establish causality; before-after studies would be stronger. Third, self-reported data may be subject to social desirability bias, especially for sensitive behaviours like pesticide overuse. Fourth, no field observation was conducted to verify reported practices. Future research should incorporate direct observation and longitudinal designs.

Future research directions

Promising avenues include: (i) mixed-methods research combining surveys with field observation to understand the ETL/EIL knowledge gap; (ii) longitudinal studies tracking knowledge retention after FFS; (iii) development and testing of simplified threshold decision aids (mobile apps, voice messages, and laminated picture cards in Sindhi) for low-literacy farmers.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Complete absence of ETL/EIL knowledge renders IPM operationally ineffective at the farm level. Farmers have no rational basis for spraying decisions and continue calendar-based or fear-driven applications.

Current FFS training does not improve the most critical IPM skill. The lack of significant differences between trained and untrained groups on most indicators is direct evidence of training failure.

Extension has successfully promoted simple, non-chemical practices but has missed the analytical core of IPM. This represents a misplaced programmatic emphasis.

Knowledge deficits and infrastructure gaps are more binding constraints than financial limitations. Policies focused solely on cost subsidies will not solve the real problems.

Recommendations

For policymakers and national IPM programme managers

Redesign the FFS curriculum to centre ETL/EIL decision-making. Every field session should include pest counting, threshold determination and group decisions on whether to spray.

Produce laminated visual reference cards in Sindhi showing thresholds for each major pest and leave them permanently at farm sites.

Retrain FFS facilitators through a dedicated "Training of Facilitators" programme to build confidence in teaching quantitative thresholds.

For extension services

Institute annual pre-season refresher sessions for all previously trained farmers, replacing one-time training with no follow-up.

Use low-cost mobile phone alert systems sending threshold reminders in Sindhi audio messages as a complement to face-to-face visits.

Increase extension worker visit frequency during the cotton season, focusing supervision on practising field scouting rather than lectures.

For government investment

Establish small district-level insectaries to produce and supply *Trichogramma* wasps, *Chrysoperla* larvae and pheromone lures at subsidised prices, directly addressing the biological input supply gap.

Improve rural roads in remote parts of District Umerkot to reduce physical isolation that prevents untrained farmers from accessing extension services.

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Conflict of Interest

The authors declare that there is no conflict of interest

References

Ali, A., & Sharif, M. N. (2012). Impact of Farmer Field Schools on adoption of integrated pest management practices among cotton farmers in Pakistan. *Journal of the Asia Pacific Economy, 17*(3), 498–513. https://doi.org/10.1080/13547860.2012.701037

Dara, S. K. (2019). The new integrated pest management paradigm for the modern age. *Journal of Integrated Pest Management, 10*(1), Article 12. https://doi.org/10.1093/jipm/pmz010

Dupare, R. P., & Mazhar, S. H. (2023). Adoption of integrated pest management technologies in controlling pink bollworm by cotton growers in Nagpur district of Maharashtra, India. *Asian Journal of Agricultural Extension, Economics and Sociology, 41*(10), 486–495. https://doi.org/10.9734/ajaees/2023/v41i102224

Government of Pakistan (GoP). (2020). *Economic survey of Pakistan 2019–20*. Ministry of Finance, Economic Advisor's Wing.

He, Y., Luo, R., Wang, T., Gao, J., & Liu, C. (2018). Prenatal exposure to environmental tobacco smoke and early development of children in rural Guizhou Province, China. *International Journal of Environmental Research and Public Health, 15*(12), Article 2866. https://doi.org/10.3390/ijerph15122866

Khan, M. S., & Damalas, C. A. (2015). Factors preventing the adoption of alternatives to chemical pest control among Pakistani cotton farmers. *International Journal of Pest Management, 61*(1), 16–22. https://doi.org/10.1080/09670874.2014.984479

Parsa, S., Morse, S., Bonifacio, A., Chancellor, T. C. B., Condori, B., Crespo-Perez, V., & Dangles, O. (2014). Obstacles to integrated pest management adoption in developing countries. *Proceedings of the National Academy of Sciences of the United States of America, 111*(10), 3889–3894. https://doi.org/10.1073/pnas.1312693111

Rehman, A., Jingdong, L., Chandio, A. A., & Hussain, I. (2019). Livestock production and population census in Pakistan: Determining their relationship with agricultural GDP using econometric analysis. *Information Processing in Agriculture, 6*(2), 273–280. https://doi.org/10.1016/j.inpa.2018.10.001

Rijal, J. P., Regmi, R., Ghimire, R., Puri, K. D., Gyawaly, S., & Poudel, S. (2018). Farmers' knowledge on pesticide safety and pest management practices: A case study of vegetable growers in Chitwan, Nepal. *Agriculture, 8*(1), Article 16. https://doi.org/10.3390/agriculture8010016

Waman, G. K., Patil, S. A., & Wandre, S. S. (2006). Knowledge and adoption of integrated pest management (IPM) practices by irrigated cotton growers. *Journal of Maharashtra Agricultural Universities, 31*(1), 65–67.

Warriach, H. M., Wynn, P. C., Ishaq, M., Arif, S., Bhatti, A., Latif, S., Kumbher, A., Batool, Z., Majeed, S., Bush, R. D., Pasha, T. N., & McGill, D. M. (2019). Impacts of improved extension services on awareness, knowledge, adoption rates and perceived benefits of smallholder dairy farmers in Pakistan. *Animal Production Science, 59*(12), 2175–2183. https://doi.org/10.1071/AN17657

Yousafzai, W. S., Ullah, I., Ali, A., Iqbal, M., & Khan, S. (2019). An analysis of allocative efficiency of growing onion in district Swat, Khyber Pakhtunkhwa. *Sarhad Journal of Agriculture, 35*(4), 1185–1191. https://doi.org/10.17582/journal.sja/2019/35.4.1185.1191

Zahid, M., Khan, M. A. J., Idrees, M., & Khan, A. K. (2018). Awareness and adoption of integrated pest management in cotton by growers of Hasilpur area in Pakistan. *Sarhad Journal of Agriculture, 34*(1), 79–84. https://doi.org/10.17582/journal.sja/2018/34.1.79.84