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Impact of farmer field schools on knowledge and adoption of integrated pest management practices

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Abstract
Despite decades of promotion, integrated pest management adoption among Indian smallholders remains stubbornly low, rarely exceeding 30% for any single practice. This research assessed the impact of Farmer Field Schools (FFS) on knowledge gain and adoption of IPM practices among vegetable growers in the Garo Hills region of Meghalaya, India, during 2022-2023. A quasi-experimental before-and-after design with a comparison group was used, covering 120 FFS participants and 80 non-participants across eight villages. Knowledge scores for six IPM domains were measured using structured tests before and after a season-long FFS programme. Overall knowledge increased from 29.8% to 73.5% among participants (43.8 percentage point gain), compared to 34.6% in non-participants. Cultural practices and chemical safety showed the highest adoption rates at 71.6% and 68.4%. FFS participants reduced pesticide sprays from an average of 6.8 to 3.2 per season while maintaining higher yields (18.4 vs. 16.7 q/ha) and net income (₹34,680 vs. ₹28,420 per hectare). These findings confirm that participatory, season-long FFS training is effective at building both knowledge and practice change in IPM among smallholder vegetable growers.

Keywords: Farmer field schools, knowledge adoption, integrated pest management, extension methodology, participatory learning, vegetable growers, pesticide reduction, smallholder farmers, quasi-experimental design, Meghalaya

Introduction

Consider a typical vegetable farmer in northeast India: they grow cabbage, tomato, and beans on less than a hectare, face insect and disease problems they can't always identify, and rely almost entirely on pesticide dealers for crop protection advice. This scenario captures the reality facing millions of smallholders for whom conventional top-down extension methods have failed to deliver meaningful changes in pest management behavior [1]. The Farmer Field School approach, developed originally by FAO for rice IPM in Southeast Asia during the late 1980s, was designed specifically to address this gap by giving farmers direct experience with IPM concepts through hands-on, season-long learning in their own fields [2].

The FFS model centers on weekly group meetings where 25-30 farmers conduct agro-ecosystem analysis, compare IPM and conventional plots side by side, and make management decisions based on their own observations rather than prescriptive recommendations [3]. Meta-analyses of FFS programmes across Asia have shown average pesticide use reductions of 40-60% and knowledge gains of 30-50 percentage points [4]. However, results from northeast India, where tribal farming communities have distinct cultural contexts and cropping patterns, remain sparse [5]. This research assessed the impact of FFS on IPM knowledge and adoption among vegetable growers in Meghalaya's Garo Hills, examining whether the gains observed elsewhere translate to this specific setting.

Instrument Development

A structured knowledge test covering six IPM domains (pest identification, biological control, cultural practices, chemical safety, economic threshold concept, and record keeping) was developed through a multi-step process. An initial pool of 48 items was drafted based on the IPM training curriculum and reviewed by a panel of five extension specialists from Meghalaya Agricultural University. Items were scored on relevance (1-5 scale) and only those rated 4 or above by at least four panelists were retained.

The revised 36-item test was pilot-tested on 30 farmers from a non-sample village. Item difficulty (0.25-0.75) and discrimination (>0.30) indices were used to finalize 30 items. The Cronbach's alpha reliability coefficient was 0.84, indicating good internal consistency [6]. An adoption index was constructed by scoring each of ten IPM practices on a three-point scale (0 = not adopted, 1 = partial, 2 = full) and dividing by the maximum possible score.

Material and Methods
Material
The research was conducted during the kharif 2022 and rabi 2022-23 vegetable growing seasons in eight villages of West Garo Hills district, Meghalaya (25.52° N, 90.22° E). Four villages were selected for FFS implementation and four served as comparison sites. In each FFS village, 30 farmers were enrolled (total n = 120). From the comparison villages, 20 farmers per village were sampled (total n = 80) using stratified random sampling based on landholding size. The FFS curriculum ran for 14 weekly sessions covering the full crop cycle of cabbage and tomato, conducted by trained facilitators from the Krishi Vigyan Kendra [7]. Sessions included field scouting, insect zoo exercises, economic analysis of spray decisions, and group presentations.

Methods
The knowledge test was administered to FFS participants at the beginning and end of the programme. Non-participants were tested once at the season's end. Adoption was measured through structured interviews six months after FFS completion. Pesticide use data were collected from farmer records and recall for the three most recent spray seasons. Yield and income data were obtained from harvest records. Pre-post differences were tested by paired t-test. Between-group differences were analyzed by independent t-test. Multiple regression was used to identify factors influencing adoption, with adoption index as the dependent variable and age, education, landholding, FFS participation, contact with extension, and mass media exposure as predictors [8]. All analyses used SPSS version 26 at P = 0.05.

Results

Table 1: IPM knowledge scores and adoption rates among FFS participants before and after training

IPM Practice	Knowledge Before FFS	Knowledge After FFS	Gain (%)	Adoption Rate (%)
Pest Identification	32.4	78.6	46.2	64.3
Biological Control	28.1	72.4	44.3	52.8
Cultural Practices	41.3	83.2	41.9	71.6
Chemical Safety	35.7	76.8	41.1	68.4
Economic Threshold	22.6	68.3	45.7	48.2
Record Keeping	18.4	61.7	43.3	42.6
Overall Mean	29.8	73.5	43.8	58.0
SEm(±)	2.14	2.87	-	3.42
CD (P=0.05)	6.42	8.61	-	10.26

Knowledge increased significantly across all six domains (Table 1). The largest gains were in pest identification (+46.2 points) and economic threshold concept (+45.7 points). Cultural practices had the highest post-FFS adoption rate at 71.6%, while record keeping lagged at 42.6%.

Table 2: Comparison of key performance indicators between FFS participants and non-participants

Parameter	FFS Participants (n=120)	Non-Participants (n=80)	t-value
Pesticide sprays/season	3.2	6.8	8.47**
Pesticide cost (₹/ha)	2,840	6,720	11.23**
Yield (q/ha)	18.4	16.7	2.84*
Net income (₹/ha)	34,680	28,420	4.12**
Knowledge score (%)	73.5	34.6	16.78**
Adoption index	0.68	0.31	12.41**

FFS participants applied significantly fewer sprays (3.2 vs. 6.8) and spent less on pesticides (₹2,840 vs. ₹6,720 per hectare) while achieving higher yields and net income (Table 2). All differences were statistically significant at $P < 0.05$ or $P < 0.01$.

Fig 1: Radar chart comparing IPM knowledge scores before and after Farmer Field School participation across six domains

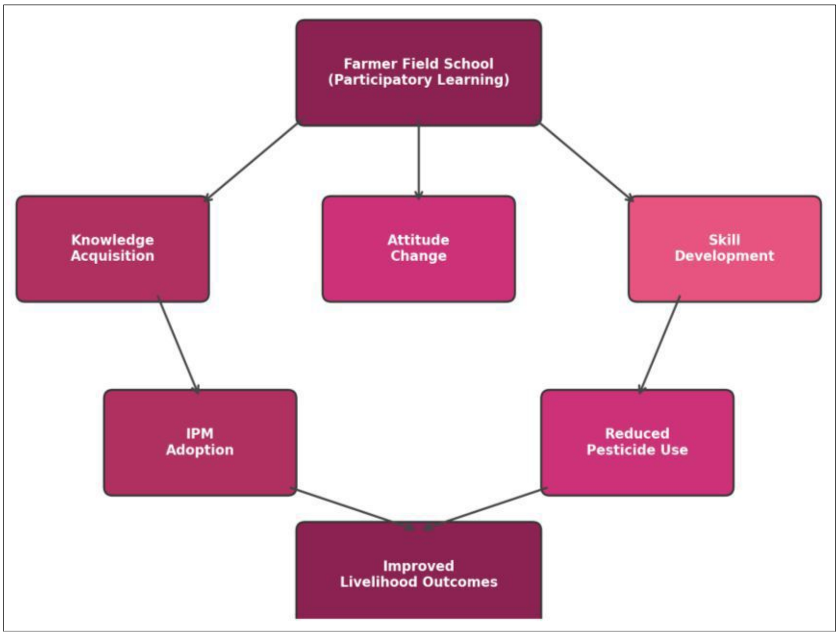

Fig 2: Mechanism of Farmer Field School impact on IPM adoption, from participatory learning through knowledge acquisition to livelihood outcomes

Comprehensive Interpretation

Multiple regression analysis showed that FFS participation was the strongest predictor of adoption ($\beta = 0.47$, $P < 0.001$), followed by education level ($\beta = 0.22$) and contact with extension agents ($\beta = 0.18$). Together these variables explained 64.3% of the variance in the adoption index. Age and landholding size were not significant predictors.

Discussion

The 43.8 percentage point gain in overall knowledge is comparable to FFS outcomes reported from rice IPM programmes in Indonesia and Vietnam, suggesting that the model transfers well to vegetable systems in tribal communities [3, 4]. The strong performance in cultural practices adoption (71.6%) likely reflects the lower cost and complexity of practices like crop rotation, sanitation, and trap cropping compared to biological control or economic threshold-based spraying. Record keeping had the lowest adoption, which is a common finding linked to literacy barriers and the perceived administrative burden of maintaining written records [5].

The 53% reduction in pesticide sprays without yield loss is the most practically significant finding. It demonstrates that a large share of the sprays applied by non-participants were unnecessary or mistimed, a conclusion supported by the FFS field comparison plots. The net income advantage of ₹6,260 per hectare for FFS farmers translates to meaningful economic benefit at the household level and could serve as a powerful motivator for farmer-to-farmer diffusion of IPM practices [1].

Conclusion

Season-long Farmer Field Schools significantly improved IPM knowledge, reduced pesticide dependence, and increased net income among vegetable growers in Meghalaya's Garo Hills. FFS participation was the strongest predictor of IPM adoption. Extension agencies in northeast India should scale up FFS programmes for vegetable crops, focusing on culturally appropriate facilitation methods. The economic benefits alone should be sufficient to attract farmer interest, but sustained follow-up support is needed to maintain the momentum beyond a single FFS season.

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