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Role of (Kvks) and the Atma in the Transfer of Entomology Based Technologies for Sustainable Agriculture

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ABSTRACT

Krishi Vigyan Kendras (KVKs) and the Agricultural Technology Management Agency (ATMA) constitute the two principal district-level pillars of India's public agricultural extension system and jointly mediate the flow of entomology-based crop-protection technologies — integrated pest management (IPM), biological control, pheromone-based monitoring, botanical and microbial biopesticides, and need-based, threshold-driven spray advisories — from research institutions to farmers' fields. This review synthesises the institutional mandates of KVKs and ATMA, the mechanisms through which they transfer entomological innovations (on-farm testing, frontline demonstrations, farmer field schools, farmer interest groups, exposure visits and ICT/SMS-based advisories), and the empirical evidence of impact on yield, pesticide load and farm income drawn from published frontline-demonstration and area-wide IPM studies. Reported yield gains from entomology-linked demonstrations ranged from about 25 to 40 percent over farmers' practice, while area-wide IPM implementation reduced the environmental impact quotient of pesticide use by roughly 30–45 percent relative to conventional practice. The review situates these outcomes within Rogers' diffusion-of-innovation framework, discusses persistent constraints — low farmer awareness, staff and resource shortages, and weak feedback loops — and outlines directions for strengthening entomology-focused extension for sustainable agriculture.

INTRODUCTION

Insect pests remain among the most persistent constraints on crop productivity in Indian agriculture, and the transition from a purely chemical, calendar-based approach to ecologically grounded pest management is now widely regarded as central to sustainable intensification. Research systems anchored in the Indian Council of Agricultural Research (ICAR) and the State Agricultural Universities (SAUs) continue to generate entomology-based innovations — host-plant resistance, pheromone and light-trap monitoring, biocontrol agents, microbial and botanical biopesticides, and economic-threshold-level (ETL) based decision rules. The translation of this research into field-level practice, however, depends on functioning extension institutions. In India, this task is discharged principally by two complementary structures: the Krishi Vigyan Kendra (KVK), a district-level "science of practice" institution created by ICAR, and the Agricultural Technology Management Agency (ATMA), a decentralised, farmer-driven extension mechanism operating under the Centrally Sponsored Scheme 'Support to State Extension Programmes for Extension Reforms.'

This review synthesises published literature on the roles of KVKs and ATMA in transferring entomology-based technologies for sustainable agriculture. It examines (i) the institutional mandate and structure of both organisations, (ii) the categories of entomological technology they disseminate, (iii) the specific mechanisms of transfer, (iv) the theoretical basis for understanding adoption, (v) empirical evidence of impact drawn from frontline demonstration (FLD) and area-wide IPM studies, and (vi) the constraints and future directions for strengthening this extension pipeline.

INSTITUTIONAL FRAMEWORK

Krishi Vigyan Kendra (KVK)

The first KVK was established in 1974 at Puducherry under the administrative control of the Tamil Nadu Agricultural University as a pilot institution; the network subsequently expanded through ICAR's Five-Year Plan support to more than 730 KVKs covering nearly every district in the country. Each KVK is mandated to undertake Technology Assessment and Refinement (on-farm testing, OFT), Technology Demonstration (frontline demonstration, FLD), and Capacity Development (training of farmers, farm women, rural youth and extension functionaries), supported by a multi-disciplinary team of Subject Matter Specialists (SMS) that typically includes an entomologist or plant-protection specialist. KVKs function as the district-level knowledge hub linking the National Agricultural Research System (NARS) with the farming community, and their SMS cadre is central to on-the-ground entomological advisory work — pest scouting, ETL-based spray recommendations, and dissemination of biological and microbial control options.

Agricultural Technology Management Agency (ATMA)

ATMA emerged from the Innovations in Technology Dissemination component of the World Bank-supported National Agricultural Technology Project (1998–2005) and was formally institutionalised as a registered, autonomous, district-level society from 2005 onward, with coverage extended to all districts by 2010. Unlike the KVK's research–extension bridging role, ATMA is designed as a decentralised, bottom-up planning and coordination mechanism: it integrates the district's line departments (Agriculture, Horticulture, Animal Husbandry, Fisheries), KVKs, NGOs and farmer institutions under a Governing Board and Farm Information and Advisory Committee. ATMA organises Farmer Interest Groups (FIGs), exposure visits, farm schools, kisan melas and training programmes, and channels state-level technical backstopping through the State Agricultural Management and Extension Training Institute (SAMETI).

Complementary Linkage

KVK and ATMA are functionally complementary rather than duplicative: KVKs generate location-specific validation of technology (including entomological packages) through OFT/FLD, while ATMA provides the district-wide institutional scaffolding — farmer organisation, convergence with line departments, and demand-driven planning — that scales a validated technology beyond demonstration plots. Figure 1 depicts this research–extension–farmer linkage as it applies specifically to entomology-based technology flow.

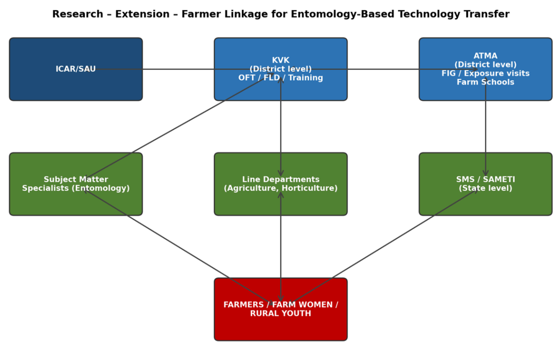

Figure 1. Institutional linkage through which entomology-based technologies move from research institutions (ICAR/SAU) to farmers via KVK and ATMA

ENTOMOLOGY-BASED TECHNOLOGIES RELEVANT TO SUSTAINABLE AGRICULTURE

The technologies most commonly transferred through KVK and ATMA channels for insect-pest management include the following:

• Integrated Pest Management (IPM) modules combining cultural, mechanical, biological and judicious chemical control, structured around the eight EU-endorsed IPM principles — prevention, monitoring, threshold-based decisions, non-chemical methods, selective pesticide use, reduced pesticide use, anti-resistance strategy and evaluation.

• Pheromone and light-trap based pest monitoring for early warning and threshold-based spray decisions (e.g., Helicoverpa armigera in pulses and cotton).

• Biological control agents — Trichogramma spp., Chrysoperla carnea, and nuclear polyhedrosis virus (HaNPV) — released through KVK-supported production and distribution units.

• Microbial and botanical biopesticides (e.g., Trichoderma viride seed treatment, neem-based formulations) that substitute for or reduce reliance on synthetic insecticides.

• Host-plant resistance and seed-treatment packages that lower initial pest pressure and reduce the number of curative sprays required.

• ICT-enabled advisory services, including short message service (SMS)-based, threshold-triggered spray guidance.

MECHANISMS OF TECHNOLOGY TRANSFER

On-Farm Testing and Frontline Demonstrations

On-farm testing allows KVK entomologists to assess location-specific efficacy of a technology before wider release, while frontline demonstrations (FLDs) — typically conducted on farmers' own fields under farmer participation but scientist supervision — serve as the principal vehicle for showcasing yield and pest-management benefits under real farm conditions. Cluster FLDs, in particular, aggregate demonstrations across contiguous villages to generate a visible, area-wide impact that encourages neighbour-to-neighbour learning.

Training, Farmer Field Schools and Farmer Interest Groups

KVKs conduct structured, need-based training for farmers, farm women, rural youth and extension personnel on pest identification, natural-enemy conservation and safe pesticide use. ATMA-supported Farmer Field Schools and Farmer Interest Groups extend this by organising season-long, participatory learning cycles in which farmers themselves conduct field-level agro-ecosystem analysis — a format shown to build durable identification and decision-making skills for IPM.

Exposure Visits and Kisan Melas

ATMA-financed exposure visits expose farmers to successful IPM adopters and research stations, functioning as an experiential channel that complements formal training and accelerates trust-building around unfamiliar biological or microbial inputs.

ICT and SMS-Based Advisories

Area-wide IPM programmes have combined weekly pheromone-trap scouting with SMS advisories that inform farmers, in real time, when pest populations cross the economic threshold and which class of pesticide to apply — reducing calendar-based, prophylactic spraying and its associated cost and environmental burden.

THEORETICAL BASIS: DIFFUSION OF INNOVATION

Rogers' diffusion-of-innovation framework remains the dominant lens for understanding how KVK/ATMA-mediated entomological innovations spread through a farming community. The framework classifies adopters into innovators, early adopters, early majority, late majority and laggards, and identifies the perceived relative advantage, compatibility, complexity, trialability and observability of an innovation as key determinants of its adoption rate. KVK demonstration plots function as an observability and trialability mechanism — letting early-majority and late-majority farmers see and evaluate an IPM package before committing their own land — while ATMA's Farmer Interest Groups leverage peer/social-network effects among early adopters to accelerate diffusion outward.

EVIDENCE OF IMPACT

Table 1 summarises yield outcomes reported from published KVK frontline demonstrations of entomology-linked crop-protection packages across different crops and states.

Across the five cited demonstrations, yield gains over farmers' conventional practice ranged from roughly 25 to 40 percent, with the largest gain recorded for the mustard cluster-FLD in Jammu region and the smallest for the Tamil Nadu green-gram demonstration (Figure 3).

Beyond yield, the area-wide IPM programme implemented across Marathwada districts of Maharashtra (Sharma et al., 2015) offers the most detailed entomological outcome data available in the literature reviewed here, combining pheromone-trap-guided scouting, biological/botanical inputs and threshold-based selective spraying against Helicoverpa armigera in pigeonpea and chickpea. Table 2 reproduces key comparative indicators — mean pest incidence and the field-use Environmental Impact Quotient (EIQ) — for IPM versus non-IPM (farmer-practice) fields, averaged across seasons 2010–2014.

Pest incidence (larvae per plant at peak flowering) in IPM fields was consistently 25–50 percent lower than in adjoining non-IPM fields, while the field-use EIQ — a composite indicator of the environmental and health burden of pesticide applications — was reduced by roughly 30–45 percent. The IPM programme was also associated with an approximately 15 percent net economic benefit to participating farmers, driven jointly by input-cost savings and yield protection. Taken together, these findings indicate that KVK/ATMA-style area-wide dissemination of entomology-based IPM technology can simultaneously raise productivity, lower pesticide load and improve farm profitability — the three pillars commonly used to define agricultural sustainability.

ENVIRONMENTAL AND ECONOMIC SUSTAINABILITY OUTCOMES

The EIQ-based evidence in Section 6 illustrates a broader pattern reported in the wider IPM literature: substituting threshold-triggered, selective interventions (biological control, botanicals, microbials, and narrow-spectrum new-generation insecticides) for calendar-based broad-spectrum spraying reduces both the frequency of applications and the toxicological load per hectare, without compromising — and generally improving — yield. Reduced pesticide use has also been linked, in farmer field school evaluations from South India, to a lower incidence of acute pesticide poisoning among participating farmers, underscoring a human-health co-benefit of KVK/ATMA-mediated entomological technology transfer alongside the productivity and environmental gains.

Table 1. Yield outcomes of selected KVK frontline demonstrations involving entomology-based technologies.

Crop / Region	Entomology-linked technology demonstrated	Implementing agency	Yield increase over farmers' practice (%)	Source (DOI)
Green gram, Nagapattinam (Tamil Nadu)	IPM package incl. bio-control agents for seed treatment, need-based plant protection	KVK Nagapattinam	26.52	Phytojournal (no DOI located)
Green gram, Buldana (Maharashtra)	Seed treatment, Rhizobium/PSB bio-fertilizer, IPM-based crop protection	KVK Jalgaon Jamod	~32.0	RePEc: ags/ajaees/366972
Wheat, Pali (Rajasthan)	Recommended plant protection & production package under FLD, 2009–16	KVK Pali	25.1–38.4	10.25174/2249-4065/2018/76657
Mustard, Samba (Jammu & Kashmir)	Improved cultivation incl. pest-management inputs under cluster FLD	KVK Samba	~39.8	AgEconSearch record 368183
Pigeonpea, Marathwada (Maharashtra)	Area-wide IPM: pheromone traps, HaNPV, neem-based botanicals, new-generation, low-EIQ insecticides guided by SMS advisories	SAU / NCIPM (model transferable via KVK/ATMA)	~26.6 (computed)	10.1093/jipm/pmv011

Table 2. Pest incidence and pesticide environmental-impact outcomes, IPM vs. non-IPM fields, Marathwada region (2010–2014); values computed from Sharma et al. (2015).

District (Maharashtra)	Mean Helicoverpa larvae/plant – IPM	Mean larvae/plant – Non-IPM	Mean field-use EIQ – IPM	Mean field-use EIQ – Non-IPM
Badnapur (pigeonpea)	0.77	1.01	25.2	39.2
Parbhani (pigeonpea)	0.38	0.77	28.8	47.9
Naigoan (pigeonpea)	0.57	0.91	28.5	40.0
Naigoan (chickpea)	0.63	1.03	15.8	38.9

CHALLENGES AND CONSTRAINTS

• Limited farmer awareness and uneven physical/programmatic reach: district-level surveys report that a majority of farmers in some KVK command areas have never directly engaged with a KVK programme, indicating an awareness and outreach gap even where facilities exist.

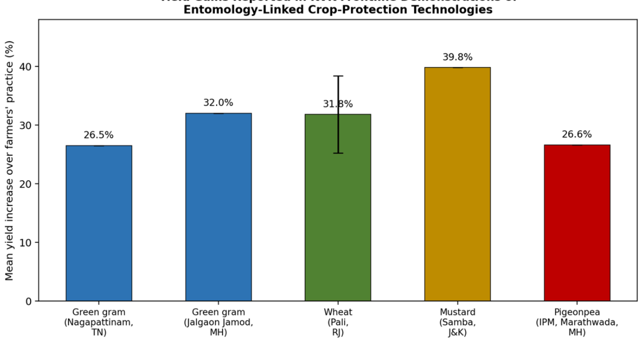

Figure 3. Mean yield increase (%) over farmers' practice reported across cited KVK frontline demonstrations of entomology-linked technologies.

• Staffing and resource constraints, including vacancies in the Subject Matter Specialist (entomology) cadre and inadequate budgetary allocation for critical IPM inputs (pheromone lures, bio-control agents, microbial formulations) at the district level.

• Weak feedback loops between farmers, extension functionaries and research systems, which slow the refinement of entomological packages to local pest complexes and agro-climatic conditions.

• Farmer risk-aversion and the higher information/skill intensity of IPM relative to routine calendar spraying, consistent with Rogers' complexity and relative-advantage constructs as barriers to adoption.

• Coordination gaps between the technology-validation role of KVK and the institutional scaling role of ATMA, particularly where Farmer Interest Groups are not well aligned with KVK-adopted villages.

WAY FORWARD

• Strengthen the entomology SMS cadre within KVKs and ensure dedicated, ring-fenced budget lines for IPM inputs under ATMA's annual district action plans.

• Expand ICT/SMS and mobile-advisory systems for real-time, threshold-based pest alerts, building on the demonstrated success of pheromone-trap-linked advisory models.

• Deepen convergence between KVK-validated entomological packages and ATMA's Farmer Interest Group and exposure-visit mechanisms to accelerate diffusion from early adopters to the majority of farmers.

• Institutionalise systematic monitoring and evaluation of FLD outcomes (yield, pest incidence, EIQ, net returns) to build a robust, cumulative evidence base for entomological extension, of the kind illustrated in Tables 1 and 2 of this review.

• Invest in participatory, farmer field school-style training to build farmer capacity for independent pest scouting and decision-making, rather than dependence on externally issued advisories alone.

CONCLUSION

KVKs and ATMA together constitute the operational backbone of entomology-based technology transfer in Indian agriculture: KVKs generate and locally validate crop-protection innovations through on-farm testing and frontline demonstration, while ATMA supplies the decentralised institutional architecture needed to organise farmers and scale validated packages district-wide. The evidence reviewed here — yield gains of roughly 25–40 percent, pest-incidence reductions of 25–50 percent, and pesticide environmental-impact reductions of 30–45 percent across cited frontline demonstrations and area-wide IPM programmes — supports the conclusion that this two-institution model, when adequately resourced and coordinated, can advance the productivity, environmental and economic dimensions of sustainable agriculture simultaneously. Persistent constraints in awareness, staffing and feedback mechanisms remain the principal barriers to realising the model's full potential.

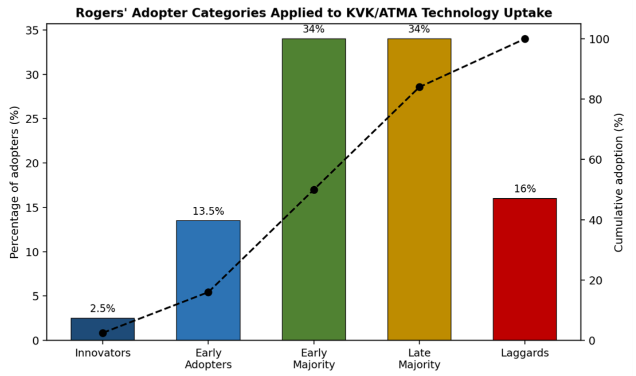

Figure 2. Rogers' adopter-category distribution (bars, left axis) with the corresponding cumulative diffusion curve (dashed line, right axis), illustrating the theoretical pathway along which KVK/ATMA-demonstrated entomological technologies are expected to spread.

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