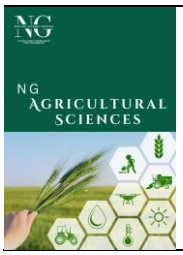

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Review Article

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Agricultural Extension Approaches and Rural Youth Engagement in West Bengal: A Comprehensive Review

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ABSTRACT

The ageing farm population and rising rural–urban migration threatens the sustainability of India's agrarian economy. Rural youth are vital for rejuvenating agriculture, yet they increasingly perceive farming as a low-status occupation and seek alternative livelihoods. West Bengal, home to over 9 million rural youths, provides a unique laboratory for analysing how extension systems can engage young people in agriculture. This review synthesises literature published between 2005 and 2025 to examine the evolution of agricultural extension approaches in West Bengal, the role of extension in youth skill development and employment, digital extension innovations, agripreneurship promotion, and institutional and policy support for rural youth. A conceptual framework anchored in the Agricultural Knowledge and Innovation System (AKIS), youth engagement theory, diffusion of innovations and human capital and sustainable livelihood frameworks guides the analysis. The findings reveal that West Bengal's extension system has transitioned from top-down public advisory to pluralistic and market-oriented services, with Krishi Vigyan Kendras (KVKs), Agricultural Technology Management Agency (ATMA) platforms, corporate and non-governmental organisations (NGOs) playing key roles. Programmes such as Attracting and Retaining Youth in Agriculture (ARYA), Skill Training for Rural Youth (STRY), Agri Clinic and Agri Business Centre (ACABC) and Diploma in Agricultural Extension Services for Input Dealers (DAESI) have fostered technical competence, employment and entrepreneurship. Digital tools—mobile phones, internet advisories and platforms like BigHaat and telecentres—enhanced knowledge access. Social enterprises and incubators such as ONganic Foods and Green College illustrate how social–ecological models can create livelihood opportunities and preserve ecological values. The review concludes with policy and research recommendations for strengthening youth centred extension by integrating inclusive digital platforms, tailoring training to differentiated youth typologies, supporting collective enterprises, and forging cross sectoral partnerships to build resilient and sustainable agricultural livelihoods.

1. INTRODUCTION

Agriculture contributes about one fifth of India's gross domestic product but employs nearly half of its workforce (Sen, 2025). Rural youth represent a demographic dividend; they are more literate than previous generations, eager to adopt innovations, and uniquely positioned to transform agriculture through entrepreneurship and technology (Kumar & Dhingra, 2024). Yet the farming population is ageing; many farmers are over 50 years old and young people increasingly migrate to cities seeking nonfarm jobs (Chakraborty et al., 2025). The government therefore emphasises engaging youth in agriculture to ensure

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food security, climate resilience and rural prosperity. Globally, the Food and Agriculture Organization identified six structural barriers—limited access to knowledge, land, finance, green jobs, markets and policy dialogue—that hinder youth entry into agriculture. Addressing these constraints requires reimagined extension systems that deliver timely information, build capabilities, and link youth to markets and institutions.

Historically, India's public extension system delivered production centred messages via frontline workers. From the 1990s, neoliberal reforms and decentralisation spurred shifts towards pluralistic advisory services, participatory approaches and market linkages. In West Bengal, the Agricultural Technology Management Agency (ATMA) platform and Krishi Vigyan Kendras (KVKs) coordinate research and extension across districts. Private firms, NGOs and producer organisations increasingly complement public services (Hossain & Mukhopadhyay, 2024). Extension is no longer confined to disseminating technologies; it now encompasses facilitating farmer groups, enabling entrepreneurship, value chain development and policy advocacy. Youth engagement demands yet another transformation: extension must be youth centred, digitally savvy and entrepreneurial. Empirical studies show that mobile phones, internet advisories and social media are the most utilised information and communication technology (ICT) tools among extension personnel, ranking above computers, television or projectors (Prasad & Pradhan, 2019). KVKs and ATMA, while essential, often lack sufficient resources and digital capacity to effectively engage youth, necessitating partnerships with corporate social responsibility (CSR) programmes and social enterprises (Indian Council of Agricultural Research, 2025). The COVID 19 pandemic further underscored the need for resilient digital extension strategies.

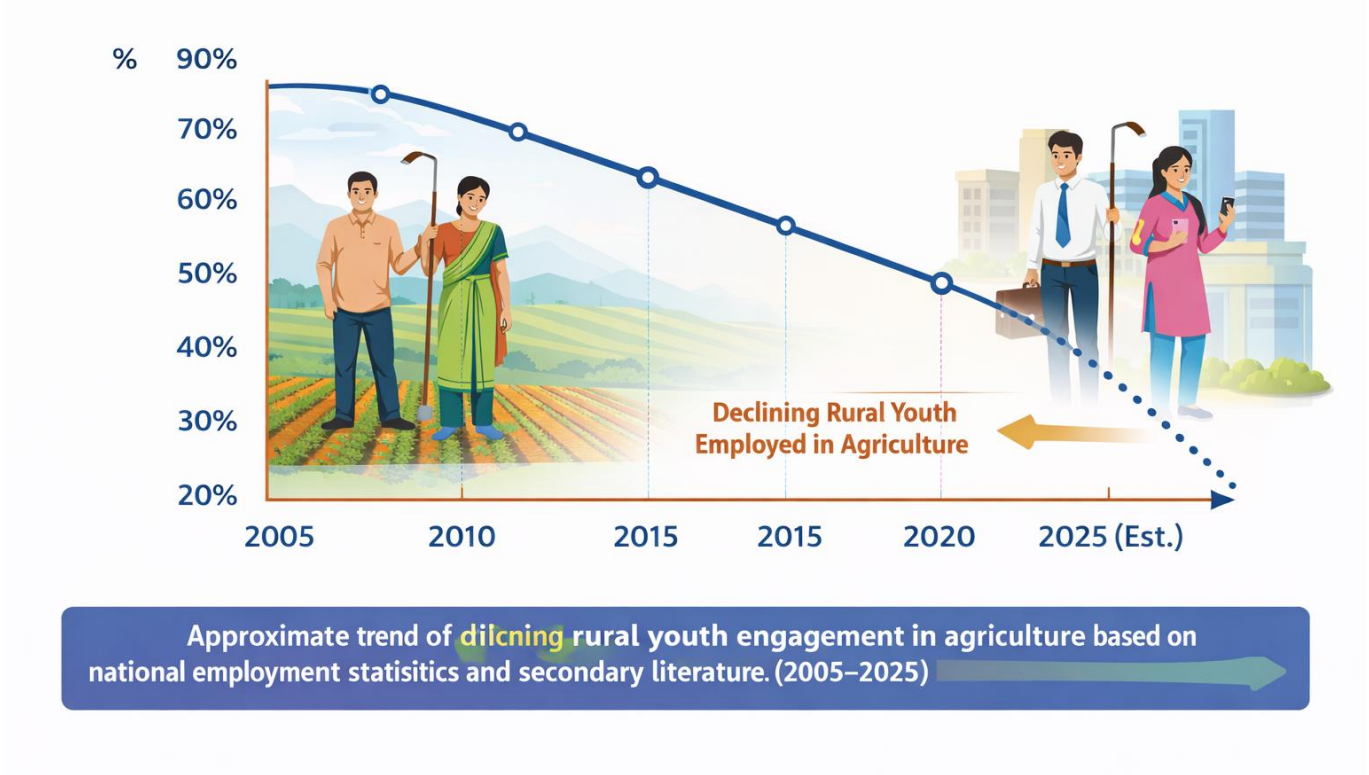

Figure 1. Trend in Rural Youth Participation in Agriculture. Using available data on workforce participation, the figure shows a declining trend in youth involvement in agriculture between 2005 and 2025. While approximate, it reflects national patterns of shrinking agricultural workforce and contextualises the urgency of youth engagement (Government of India, Ministry of Agriculture & Farmers Welfare, 2025).

West Bengal is India's fourth most populous state and a major producer of rice, jute, vegetables and fish. However, farm sizes have declined—from 2 ha in 1976–77 to 1.08 ha in 2015–16—and about 180 000 rural people migrate daily, reflecting agrarian distress (Bardhan et al., 2014; Sen, 2025). Studies in Jalpaiguri district reveal that only 44 % of rural youth are involved in agriculture, 31 % work as labourers, 25 % pursue business and 14 % rear livestock; strikingly, merely 3 % depend exclusively on agriculture and 54

% are not engaged in farming activities (Chakraborty et al., 2025). Another survey in Purba Bardhaman district shows that most rural youth have medium occupational aspirations, with variables such as age, education, mass media exposure and landholding positively influencing their aspirations (Saha et al., 2022). These findings highlight the precarious participation of youth in agriculture and underscore the need for targeted interventions. The objective of this review is to synthesise evidence on agricultural extension approaches that engage rural youth in West Bengal, analyse their outcomes, and identify emerging trends and gaps. The review addresses five thematic questions: (1) How have extension approaches evolved in West Bengal? (2) What roles do extension systems play in youth skill development and employment? (3) How are digital tools transforming extension and youth participation? (4) What programmes promote agripreneurship and what are their outcomes? (5) How do institutions and policies support or constrain youth engagement? By integrating theoretical insights and empirical evidence, the review aims to inform scholars, practitioners and policymakers seeking to design youth centred extension systems.

2. CONCEPTUAL & THEORETICAL FRAMEWORK

2.1. Agricultural Knowledge and Innovation System (AKIS)

The concept of the Agricultural Knowledge and Innovation System (AKIS) emphasises the network of actors and knowledge flows that link research, education, extension, enterprises and farmers. The EU regulation defines AKIS as "the combined organisation and knowledge flows between persons, organisations and institutions who use and produce knowledge for agriculture and interrelated fields" (Council of the European Union, 2019). In this review, AKIS provides a lens to examine how universities, KVKs, ATMA, private firms, NGOs and farmer organisations interact to generate, adapt and disseminate innovations. A vibrant AKIS facilitates co creation of knowledge, feedback loops and inclusive learning. For rural youth, AKIS offers pathways to access scientific expertise, peer networks and market information. However, AKIS effectiveness depends on institutional coordination, policy support and resource flows. The pluralistic AKIS comprises public KVKs and research institutes, state extension agencies, private companies, NGOs, financial institutions and youth producer organisations.

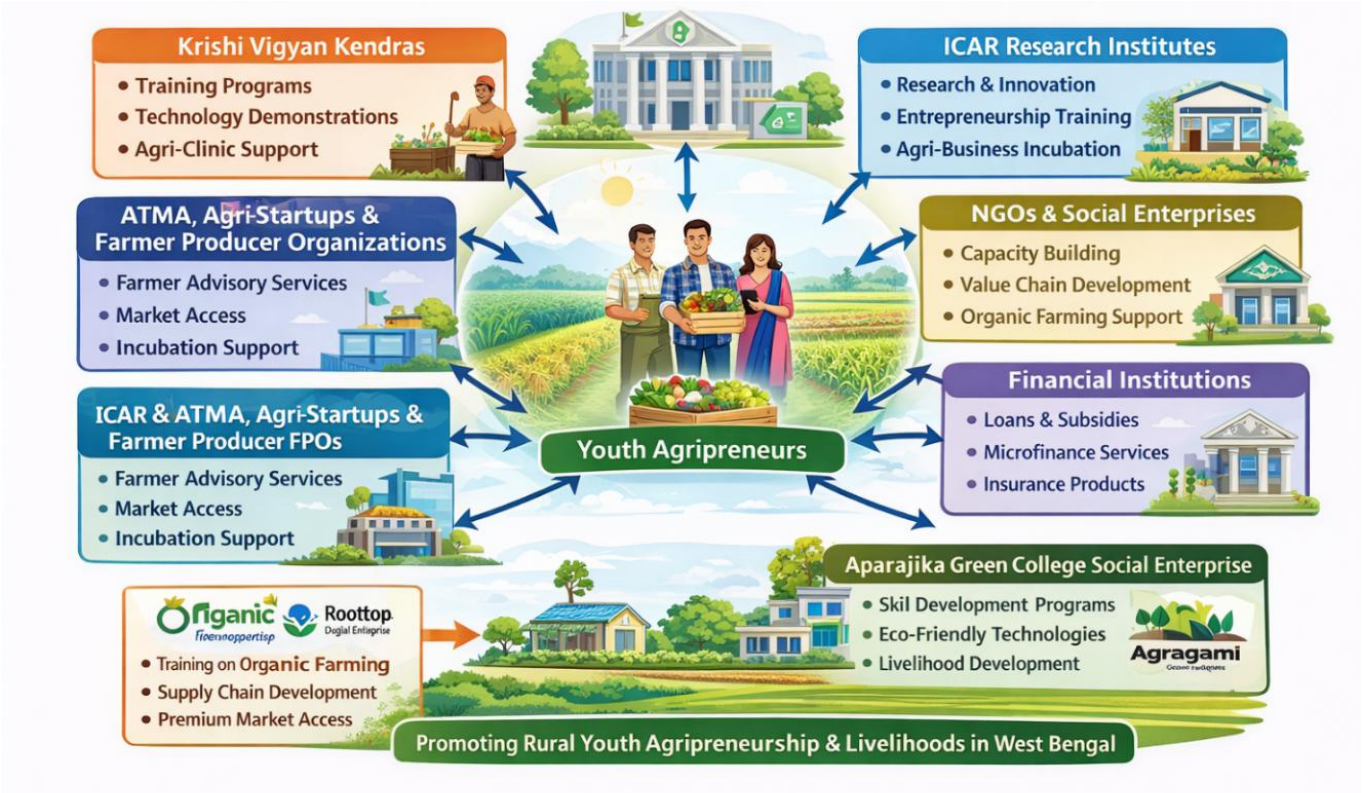

Figure 2. Institutional Ecosystem for Youth Agripreneurship in West Bengal. Rural youth agripreneurs are at the centre, connected bidirectionally to KVK/ATMA, government schemes (ARYA, STRY, ACABC), private enterprises (ONganic, BigHaat), NGOs (Green College), financial institutions and markets. The diagram highlights the need for coordination and partnerships

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2.2. *Youth engagement theory*

Youth engagement theory posits that young people are not merely beneficiaries but active agents who require meaningful participation, capacity building and supportive environments. The theory emphasises three dimensions: (1) cognitive engagement—acquiring knowledge, skills and aspirations; (2) behavioural engagement—participation in activities and decision making; and (3) emotional engagement—sense of belonging and motivation. Extension programmes that address these dimensions can empower youth and foster ownership. Empirical studies indicate that rural youth's occupational aspirations are influenced by education, access to information, landholding and family income (Saha et al., 2022). Programmes such as ARYA, STRY and ACABC attempt to enhance cognitive and behavioural engagement through experiential training and entrepreneurship. Emotional engagement is nurtured by recognising youth as innovators, providing mentorship and celebrating success stories.

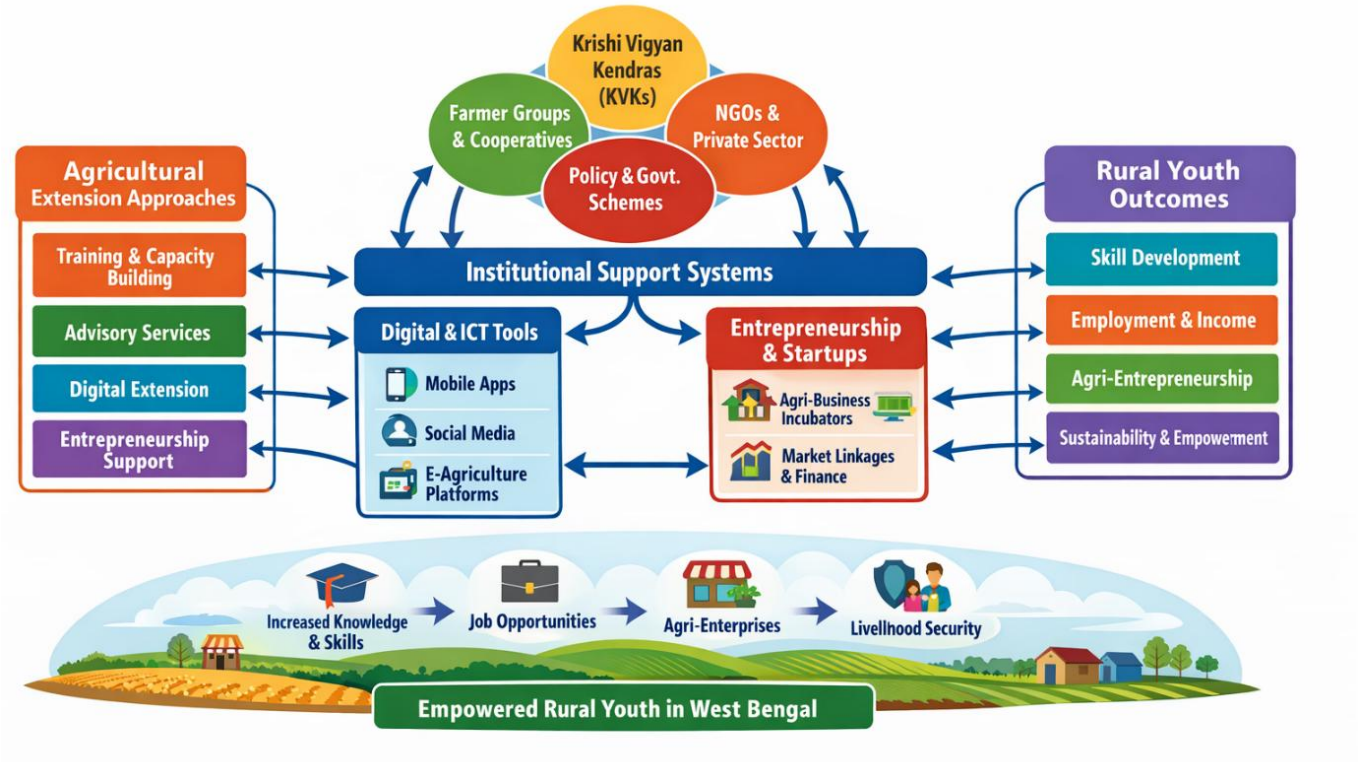

Figure 3. Conceptual Framework: Extension Approaches and Youth Engagement. This diagram illustrates how diverse extension approaches (public, private, digital, skill training, agripreneurship support) influence youth engagement and ultimately contribute to sustainable livelihoods. Arrows signify knowledge flows and interactions between elements.

2.3. *Diffusion of innovations*

Diffusion of innovations theory, developed by Rogers, explains how new ideas and technologies spread through social systems. In agriculture, diffusion involves phases of awareness, interest, evaluation, trial and adoption. Extension acts as a change agent facilitating diffusion by bridging research and farmers, demonstrating technologies and addressing constraints (Prajapati et al., 2025). Diffusion is influenced by relative advantage, compatibility, complexity, trialability and observability of innovations, as well as social networks and communication channels. For youth, digital tools (mobile advisories, social media) can accelerate diffusion by providing timely, customised information, whereas traditional extension may be too slow. Adoption also depends on socio economic factors—landholding, education, risk orientation—and institutional support. Studies in West Bengal highlight that social participation, aspiration towards cutting edge technology and higher income are positively associated with ICT usage among extension professionals (Prasad & Pradhan, 2019). Understanding diffusion dynamics helps design youth oriented extension strategies that prioritise peer learning, demonstration and digital engagement.

2.4. Human capital and livelihood frameworks

Human capital theory emphasises investment in education, skills and health to improve productivity and income. Sustainable livelihoods frameworks extend this by recognising five capital assets—human, social, physical, financial and natural—and their interaction to achieve livelihood outcomes. A recent modification tailored for youth adds psychological capital and proposes different livelihood pathways—business oriented, gender oriented, occupation oriented and livestock oriented—based on youth typologies (Madende et al., 2023). In the context of West Bengal, livelihoods are diversified; rural youth engage in agriculture, wage labour, business and livestock rearing (Chakraborty et al., 2025). Sustainable livelihood frameworks help assess how extension interventions enhance different capital assets: skill training builds human capital; farmer groups and producer organisations strengthen social capital; digital tools and infrastructure improve physical capital; access to loans and subsidies expands financial capital; and conservation practices maintain natural capital. The Modified Sustainable Livelihood Framework (MSLF) also highlights the importance of psychological capital—confidence, resilience and motivation—particularly for youth facing social stigma and risk aversion. Extension programmes must therefore adopt holistic strategies that not only transfer technology but also develop entrepreneurial mindset and social support networks.

These four frameworks collectively inform our review. Figure 3 presents a conceptual framework linking extension approaches (public, private, digital, skill training, agripreneurship support) to youth engagement and sustainable livelihoods. Arrows illustrate how extension modalities feed into youth engagement and subsequently into livelihood outcomes. The framework underscores the multiplicity of actors and channels, emphasising the need for integrative interventions.

3. REVIEW METHODOLOGY

This review employed a systematic scoping approach to identify, screen and synthesise literature on agricultural extension and rural youth engagement in West Bengal. The methodology comprised four stages: search strategy, inclusion and exclusion criteria, screening and quality appraisal, and synthesis. Electronic databases—including Scopus, Web of Science, Google Scholar and the Directory of Open Access Journals—were searched using combinations of keywords such as "West Bengal", "youth", "agriculture", "extension", "agripreneurship", "digital extension", "KVK", "ARYA", "skills", "ICT" and "policy". Additional sources were identified through the Indian Council of Agricultural Research (ICAR) repository (Krishi Kosh), Lok Sabha documents, state government reports and organisational websites (e.g., ATMA, BigHaat, ONganic, Green College). Because many West Bengal specific studies are published in national journals and conference proceedings, grey literature (e.g., working papers, policy briefs) was included when they provided empirical data. Searches were limited to publications between 2005 and 2025. The search was updated in December 2025 to capture the most recent studies and policy documents.

Studies were included if they: (1) focused on West Bengal or had relevant implications for the state; (2) addressed agricultural extension approaches, youth engagement, skill development, agripreneurship or digital extension; (3) were published between 2005 and 2025; and (4) were peer reviewed or high quality grey literature (reports, policy documents). Studies were excluded if they focused exclusively on other Indian states without transferable insights, targeted children under 18 years, or lacked empirical evidence. Duplicate records were removed. In total 236 records were screened and 56 articles/reports met the inclusion criteria. Titles and abstracts were reviewed for relevance. Full texts of eligible studies were assessed for methodological rigour and data quality. Data were extracted on study location, design, sample characteristics, extension approach, youth engagement strategies, outcomes and key findings. Thematic synthesis was applied: studies were grouped according to the five themes specified in the review objectives (evolution of extension approaches; skill development; digital extension; agripreneurship; institutional and policy support). Evidence was compared across contexts to identify patterns, divergences and gaps. Quantitative data (e.g., percentage of youth engaged, income changes) were tabulated and, where possible, summarised using descriptive statistics. Qualitative findings were synthesised through narrative integration. A meta analysis was not feasible due to heterogeneity in study designs and outcomes. The synthesis is illustrated by a review synthesis framework in Figure 4, which maps theoretical constructs, extension approaches, youth outcomes and enabling environments.

4. THEMATIC REVIEW OF LITERATURE

4.1. Evolution of agricultural extension approaches in West Bengal

Transition to pluralistic and demand-driven services: West Bengal's extension system evolved

significantly over the past two decades. In the early 2000s, public extension operated through the Department of Agriculture and its line departments. The ATMA model, introduced under the National Agricultural Technology Project (NATP), decentralised extension planning and encouraged convergence at district and block levels. ATMA committees include farmers, women's self help groups and private actors; they prepare Strategic Research and Extension Plans (SREPs) and Farmer Centric Extension Plans (FCEPs). Comparative research across Birbhum, Jalpaiguri and Nadia districts found that farmers perceived Farmer Producer Companies (FPCs) as the most effective extension providers, with ATMA/Department of Agriculture, input dealers and KVKs ranking second, third and fourth, respectively (Hossain & Mukhopadhyay, 2024). This suggests that farmer led organisations and private actors often deliver more responsive services than traditional public agencies. The shift towards pluralism allows youth to access a wider array of services, though coordination challenges persist.

Role of Krishi Vigyan Kendras (KVKs): KVKs are frontline extension institutions that conduct on farm trials, frontline demonstrations and capacity building. In West Bengal, KVKs at Nimpith, Hooghly, Uttar Dinajpur, Purulia, Howrah and other districts implement the ICAR programme Attracting and Retaining Youth in Agriculture (ARYA). The ARYA initiative aims to attract rural youth to agricultural enterprises by demonstrating climate smart opportunities, forming network groups, and curbing migration (Acharya et al., 2024). During 2018–19, nine KVKs across West Bengal and Odisha trained 310 youths and facilitated 90 micro enterprise units, including fishery units, betel vine gardens, nursery raising and goatery. The net income of ARYA participants increased from approximately ₹0.93 lakh to ₹2.3 lakh per year between 2017–18 and 2020–21, with the benefit–cost ratio rising from 1.89 to 3.28 and employment generation increasing from 272 to 352 person days (Chandre Gowda et al., 2024). KVKs also implement the Skill Training for Rural Youth (STRY) programme, which delivers seven day courses to rural youths aged 18 and above, with funding support of ₹400 per participant per day and 30 % theory and 70 % practical sessions (Department of Agriculture & Farmers Welfare, Government of India, n.d.). Such programmes build technical skills in mushroom cultivation, goat rearing, beekeeping and digital literacy. However, evaluation studies suggest that youth often require continued hand holding and market linkages after training.

Private and corporate engagement: The growing involvement of private companies and social enterprises marks a new phase in extension. BigHaat, an e commerce and advisory platform, provided timely fungicides and digital advisory to potato farmers in West Bengal during late blight outbreaks, preventing crop losses (FAO, 2024). ONganic Foods, a social enterprise operating in the Nadia district, facilitates organic producer groups under the Paramparagat Krishi Vikash Yojana scheme. A difference in differences impact assessment showed that farmers engaged with ONganic experienced a 41 % decline in yield after conversion to organic cultivation but received a 123 % price premium and a 177 % increase in net income (Amarnath & Sridhar, 2012; Laha et al., 2024). These findings highlight that eco social enterprises can compensate for yield penalties by securing higher prices and market access, thereby attracting youth to sustainable agriculture. CSR driven initiatives, such as the IRise programme conducted by Syngenta Foundation at Howrah KVK, offer 23 day training, internships and industry exposure, transforming 40 youths into agri entrepreneurs (Indian Council of Agricultural Research, 2025). Such collaborations demonstrate the potential of cross sector partnerships to enhance extension outreach.

Non-governmental organisations and social enterprises: NGOs fill gaps in public extension by providing intensive training and post training support. Green College, a programme implemented by Welthungerhilfe and DRCSC, offers three month courses followed by nine month implementation support in sustainable agriculture, backyard livestock, aquaculture, palm nectar processing, Sal leaf products and handicrafts. Youth graduates receive mentorship, marketing assistance and membership in producer groups. For instance, date palm processing training helped youth groups in Bankura produce jaggery and syrup, generating income and reviving a traditional value chain. Social enterprises emphasise ecological sustainability and community empowerment; their success underscores the need for long term accompaniment and value chain development rather than one off training (Cardella et al., 2021; Jarábková et al., 2022).

Limitations and challenges: Despite innovations, West Bengal's extension system faces persistent challenges. Many youths continue to view

farming as low status; an article described rural youth as "reluctant farmers" who perceive agriculture as downward mobility, although a small cohort of returnee agri entrepreneurs, supported by technology and finance, see agriculture as an eco profitable enterprise (Yadav, 2025). Extension institutions grapple with limited budgets, staff vacancies and bureaucratic hurdles (Chakraborty et al., 2023). KVKs often struggle to provide adequate follow up after training; ATMA committees may lack participation from youth or women. The pluralistic system sometimes results in overlapping mandates and uncoordinated efforts. In addition, training programmes may emphasise technical skills but neglect marketing, financial management and soft skills, which are critical for youth entrepreneurship. To address these gaps, integration across public, private and civil society actors is essential.

4.2. Role of extension in youth skill development and employment

Skill training and capacity building: Skill development is a cornerstone of youth engagement. The Skill Training for Rural Youth (STRY) programme provides short duration courses in agriculture and allied sectors. According to government guidelines, STRY targets rural youth aged 18 years and above with at least 5th grade education; training modules last seven days and emphasise 70 % practical content (Department of Agriculture & Farmers Welfare, Government of India, n.d.). ATMA and KVKs select participants and arrange placements within three months. The programme offers funding of ₹400 per participant per day and covers travel, boarding and material costs. Lok Sabha data show that during 2022–25, STRY trained 20 831 women in mushroom cultivation, goat rearing and other enterprises; the Diploma in Agricultural Extension Services for Input Dealers (DAESI) trained 2 853 women input dealers, and Extension Education Institutes (EEIs) trained 7 279 women extension officers (Government of India, Ministry of Agriculture & Farmers Welfare, 2025). These numbers illustrate gender inclusion and scalability.

Agripreneurship development through ARYA: The ARYA programme stands out for its focus on enterprise development. Launched in 2015 by ICAR, ARYA targets unemployed rural youth and encourages them to establish agri based enterprises (poultry, fishery, mushroom, apiary, nursery). The programme offers training, seed funding (₹50 000 to ₹1 lakh per enterprise), mentoring and market linkages. In West Bengal, KVKs at Nimpith and other districts have promoted enterprises such as Vanaraja poultry, duck farming, meat processing, fishery and horticulture (ICAR-ATARI, 2025). A national evaluation reported that functional enterprise units increased from 322 in 2017–18 to 841 in 2020–21; average net income rose from ₹0.93 lakh to ₹2.30 lakh and employment generation per enterprise increased from 272 person days to 352 (Chandre Gowda et al., 2024). A cross sectional study assessing livelihood improvement in Odisha (though outside West Bengal but relevant because of similar programme design) found a 21 % increase in livelihood status index among ARYA participants, with significant improvements in physical, social, financial and human assets. The mean physical asset score increased from 3.71 to 4.00 and financial assets from 2.53 to 2.85. Another study reported that average annual expenditure of ARYA enterprises amounted to ₹1.44 lakh and income to ₹2.90 lakh, yielding a return of 100.66 % (Mohanty et al., 2025). These findings confirm ARYA's efficacy in enhancing income and employment, though sustainability depends on market support and continual mentoring.

Agripreneurship through ACABC and other schemes: The Agri Clinic and Agri Business Centre (ACABC) scheme, launched by the Ministry of Agriculture in 2002, trains agricultural graduates to set up agri ventures and agri clinics. Trainees undergo 45 days of residential training, business planning and hand holding. Participants from scheduled castes and women receive a 44 % subsidy on loans up to ₹20 lakh (Government of India, Ministry of Agriculture & Farmers Welfare, 2025). A study evaluating the relevancy of ACABC training curriculum reported that communication skills (72.67 %), enterprise planning (78 %) and exposure visits (81 %) were the most valued modules, while problem solving and cash/fund flow were rated least relevant. Key challenges faced by trainees included social stigma (60 %), market fluctuations (59 %), pricing (40 %) and climate (33 %) (Afroz, 2022; Mohanty et al., 2025). These findings suggest that ACABC training must incorporate market analysis, risk management and digital literacy to enhance youth entrepreneurship. Complementary initiatives such as the Diploma in Agricultural Extension Services for Input Dealers (DAESI) and the Agri Enterprise Incubator at KVKs further widen employment avenues by certifying input dealers and incubating startups.

Impact on employment and income: Empirical studies yield mixed evidence on employment outcomes. The Jalpaiguri survey showed that only 44 % of rural youth were involved in agriculture, while 31 % engaged in casual labour and 25 % in business; 14 % combined livestock with other livelihoods (Chakraborty et al., 2025). When youth were trained through extension programmes, their income improved. For example, ARYA participants' net income more than doubled and employment days increased (Gowda et al., 2023). Green College graduates established small enterprises and formed producer groups that improved bargaining power. The ONganic case demonstrated that organic farmers' net income increased by 177 % despite yield declines (Laha et al., 2024). Yet, many youths still migrate due to seasonal unemployment and low returns. The gap between training and employment underscores the need for integrated value chain development, market linkages and financial services.

4.3. Digital extension and youth participation

Digital technologies have reshaped extension by enabling real time information, two way communication and broader reach. Mobile phones are the most widely used ICT tool among extension professionals, with a weighted mean score of 3.97 out of 5, followed by internet (2.62) and email (2.37). Farmers increasingly use WhatsApp groups, YouTube and voice advisories to access weather forecasts, pest alerts and market prices. However, digital divides persist: youth with higher education, social participation and income are more likely to use ICTs (Prasad & Pradhan, 2019).

Telecentres and community ICT models: A tele support experiment in Nadia district established telecentres and mobile telecentres that provided two way communication between farmers and experts via teleconferences and mobile phones. The project enabled rural women and youth to access crop and livestock information, yet sustainability was challenged by resource constraints and limited e readiness (Goswami et al., 2010). Telecentres highlight the importance of community based digital hubs but require long term funding and local capacity.

Digital platforms and private advisories: The BigHaat platform demonstrates how digital extension can integrate advisory services with input supply. During the 2019–2020 potato season, BigHaat provided timely fungicides and expert advice to West Bengal farmers facing late blight, allowing them to obtain inputs despite lockdown restrictions (Dixit et al., 2022). Users rated the platform highly for accessibility and reliability. Similarly, digital weather forecasting tools and precision agriculture systems-developed by start ups and research institutes-are emerging; one study introduced an IoT enabled weather forecasting system for precision farming in West Bengal, emphasising real time monitoring and personalised advisories.

Constraints and opportunities: Digital extension offers significant opportunities for scaling youth engagement. Yet adoption is hindered by poor internet connectivity, limited digital literacy, affordability issues and language barriers. Women and marginalised youth may be excluded if platforms are not gender sensitive or available in local languages. Successful programmes combine digital tools with face to face training and group formation. For instance, Green College uses digital resources but emphasises experiential learning and mentoring. Social enterprises like ONganic market organic produce through e commerce, linking youth farmers to premium markets (Laha et al., 2024). Public policies must invest in rural broadband, digital skills training and inclusive design to realise the potential of digital extension.

4.4. Entrepreneurship, startups and agripreneurship promotion

Entrepreneurship training and incubation: Agripreneurship programmes equip youth with business skills, risk management and market linkages (Bairwa et al., 2014; Nain et al., 2019). ARYA fosters micro-enterprises by providing start-up capital, equipment and training. Green College emphasises natural resource-based enterprises and supports youth for nine months after training, including marketing assistance. The IRise model, a collaboration between Syngenta Foundation and KVK, offers intensive 23-day skill development, internships and industry immersion, resulting in successful agri-entrepreneurs (Indian Council of Agricultural Research, 2025). ACABC graduates set up agri-clinics and agribusiness centres; training emphasises enterprise planning, case studies and exposure visits. Social enterprises like ONganic incubate organic farmers and link them with fair-trade markets, demonstrating an eco-social agribusiness model (Laha et al., 2024). However, studies caution that many start-ups require ongoing mentoring and support to navigate market volatility and policy changes (Mohanty et al., 2025).

Youth aspirations and livelihood diversification: Youth aspirations are diverse and influenced by socio-economic factors. Surveys in Purba Bardhaman show that 55.83 % of youth have medium occupational aspirations, 19.16 % high and 25 % low; variables such as education, landholding, income, risk orientation and extension participation positively correlate with aspirations (Gupta et al., 2023; Saha et al., 2022). Many rural youth seek non-farm employment due to uncertain agricultural incomes and lack of land. Studies note that 25 % of youth engage in business and 31 % in wage labour (Chakraborty et al., 2025). Extension programmes must therefore address livelihood diversification—combining farming with value-added enterprises, processing, agri-tourism or handloom. The Green College and ONganic models illustrate how diversification can retain youth in rural areas and reduce migration (Laha et al., 2024).

Challenges in entrepreneurship promotion: Youth entrepreneurs face barriers such as limited access to credit, land, markets and social networks. In the ACABC study, social stigma and market fluctuations were major challenges (Mohanty et al., 2025). Women often face patriarchal norms limiting mobility and ownership. While subsidies and grants help start enterprises, sustainability depends on market integration and value addition. The ONganic case revealed that organic farmers suffered a 41 % yield decline initially but overcame it through price premiums and collective marketing (Laha et al., 2024). Another challenge is the mismatch between training and job opportunities; many trained youth still migrate or remain unemployed due to weak linkages with value chains and financial institutions. Policy support for incubation centres, risk insurance and e-commerce platforms can mitigate these challenges.

4.5. Institutional and policy support for rural youth

National programmes and schemes: India's government has launched several schemes to engage rural youth. ATMA ensures at least 30 % resources are allocated to women farmers and collects gender-disaggregated data. STRY and DAESI provide short-term training and certification; EEIs train extension officers, emphasising gender inclusion. ACABC offers a 44 % subsidy for women and scheduled castes on loans up to ₹20 lakh, enabling them to establish agri-clinics and agribusiness centres (Government of India, Ministry of Agriculture & Farmers Welfare, 2025). National Rural Livelihood Mission (NRLM) and Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY) also provide skill training and micro-finance. However, multiple schemes sometimes operate in silos, causing duplication and limited impact.

State initiatives and policies: West Bengal's Department of Agriculture implements state schemes such as Matir Katha (a mobile advisory), Farmer Producers Company (FPC) support, and convergence with the state's skill development mission. The state has adopted digital tools like the Agricultural Marketing Department's e-NAM platform and emphasised paddy procurement through FPCs. A 2024 working paper by Laha et al. (UNRISD) highlights how ONganic Foods collaborates with the state to promote eco-social agriculture, with the Paramparagat Krishi Vikash Yojana supporting organic clusters and Participatory Guarantee System (PGS) groups (Laha et al., 2024). West Bengal also promotes agri-tourism, food processing clusters and start-up incubators. Yet, youth-specific policies are limited and coordination between departments remains weak.

Role of farmer collectives and producer organisations: Farmer Producer Companies (FPCs), cooperatives and self-help groups are crucial for youth engagement. The comparative effectiveness study noted that FPCs were perceived as the most effective extension providers because they offer market access, collective bargaining and peer learning (Hossain & Mukhopadhyay, 2024). ONganic formed organic producer groups in Nadia district, improving price realisation and incomes (Laha et al., 2024). Youth groups under ARYA create peer support and facilitate risk-sharing. However, FPCs often struggle with governance, capitalisation and management skills. Capacity building for group management and digital marketing is essential.

Integration of indigenous knowledge and climate resilience: Indigenous knowledge forms part of the cultural capital of rural youth. A 2025 study on the Toto tribal community in Alipurduar district reveals that intergenerational farming knowledge is eroding as younger generations shift to modern techniques and formal education. Knowledge erosion is attributed to reduced social participation, changing family aspirations and modernisation. Socio-economic factors such as family educational status and material possessions positively influence agricultural livelihoods. Integrating traditional knowledge with modern practices enhances climate resilience and sustainability (Aswani et al., 2018; Vardhan et al., 2021; Suman et al., 2025). Extension programmes should therefore promote elder-youth knowledge exchange and value local wisdom.

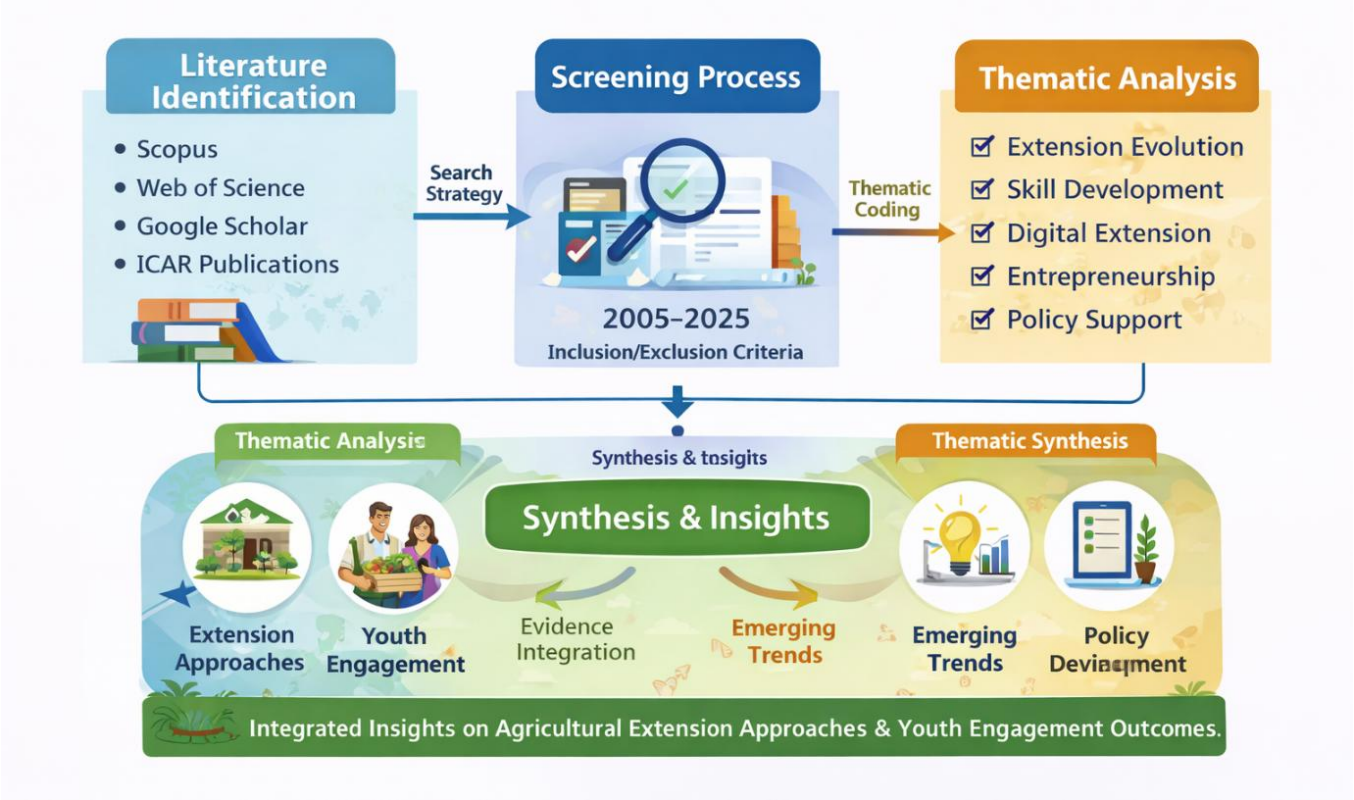

Figure 4. Review Synthesis Framework. The framework integrates theoretical constructs, extension approaches, youth outcomes and enabling environments. It shows how AKIS, diffusion of innovations and human-capital frameworks inform extension interventions, which shape youth outcomes, while enabling environments and emerging trends feed back into theory and practice.

5. SYNTHESIS OF EVIDENCE AND EMERGING TRENDS

5.1. Integrating extension approaches and youth outcomes

The evidence reveals that multi modal extension approaches—combining public services, private platforms, NGOs and producer organisations—are more effective in engaging youth. Public programmes like ARYA and STRY provide foundational training and seed funding; NGOs and social enterprises offer intensive mentoring, incubation and market linkages; digital platforms facilitate timely information and e commerce; FPCs enable collective action. When these elements converge, youth outcomes are enhanced: skills development, income growth, employment generation, innovation adoption and livelihood diversification. Figure 3 illustrates the institutional ecosystem with rural youth at the centre and arrows connecting KVKs, government schemes, private enterprises, NGOs, financial institutions and market actors. The network underscores the interdependence of actors and the need for coordination.

5.2. Emerging digital ecosystems

Digitalisation is transforming extension and agribusiness. Youth are enthusiastic adopters of mobile technology, though digital divides persist. Platforms like BigHaat and Matir Katha demonstrate the potential of digital advisories, e commerce and supply chain integration. Telecentres and community ICT hubs provide inclusive access but require sustained support. Digital innovation also enables precision farming, remote sensing and decision support systems, which can attract tech savvy youth. However, digital extension must be accompanied by digital literacy training, affordable devices and reliable connectivity. Gender responsive design is critical to ensure women's access. The trend towards digital service delivery will likely accelerate, especially in post pandemic contexts.

5.3. Diversification and sustainable agripreneurship

Youth engagement is moving beyond primary production towards value addition, organic farming, agro processing, agri tourism and climate smart enterprises. Social enterprises like ONganic

illustrate a shift towards eco social agribusiness models that integrate environmental and social objectives (Laha et al., 2024). Green College demonstrates the viability of natural resource based enterprises and local craftsmanship. These models reduce migration and revive local economies. However, success requires supportive policies, infrastructure (storage, processing), and marketing channels (e commerce, niche markets). Youth entrepreneurship is also linked to psychological capital; aspirational youth who perceive farming as innovative and profitable are more likely to invest in agripreneurship. Programmes should therefore cultivate entrepreneurial mindsets and resilience.

Table 1. Key extension approaches and youth outcomes in West Bengal

Extension approach	Description and scope	Youth outcomes (evidence)
Attracting and Retaining Youth in Agriculture (ARYA)	Implemented by KVKs under ICAR; promotes enterprises like poultry, fishery, mushroom, apiary and nursery raising; provides training, seed funding and mentorship (ICAR-ATARI, 2025).	310 youths trained and 90 micro-enterprises established in 2018–19 (ICAR-ATARI, 2025); functional enterprise units increased from 322 to 841 (2017–21) and net income rose from ₹0.93 lakh to ₹2.3 lakh per year (Chandre Gowda et al., 2024).
Skill Training for Rural Youth (STRY)	Short-term (7-day) training delivered by KVKs/ATMA; 30 % theory and 70 % practical; aims to build skills in agriculture and allied activities (Department of Agriculture & Farmers Welfare, Government of India, n.d.).	20 831 women trained between 2022–25; programmes emphasise mushroom cultivation, goat rearing and horticulture (Government of India, Ministry of Agriculture & Farmers Welfare, 2025).
Agri-Clinic and Agri-Business Centre (ACABC)	45-day residential training to develop agri-clinics and agribusiness centres; participants receive subsidies (44 % for women/SC) on loans up to ₹20 lakh (Government of India, Ministry of Agriculture & Farmers Welfare, 2025).	Communication skills (72.67 %) and enterprise planning (78 %) rated most relevant; trainees identified market fluctuations and social stigma as major challenges (Mohanty et al., 2025).
Digital extension (BigHaat, telecentres)	BigHaat digital platform supplies inputs and advisory services; telecentres and mobile telecentres facilitate two-way communication with experts (Goswami et al., 2010; Dixit et al., 2022).	BigHaat prevented crop losses during late blight and improved fungicide access; telecentres empowered youth and women but faced sustainability issues due to resource constraints (Goswami et al., 2010; Dixit et al., 2022).
Social enterprises and NGOs (ONganic, Green College, IRise)	ONganic facilitates organic producer groups and market linkages; Green College offers 3-month training and 9-month support; IRise provides 23-day skill development with corporate partnership (Laha et al., 2024)icar.org.in.	ONganic farmers received 123 % price premium and 177 % increase in net income despite 41 % yield decline (Laha et al., 2024); Green College trainees established enterprises and revived traditional value chains; IRise transformed 40 youths into agri-entrepreneurs through internships and industry exposure (Indian Council of Agricultural Research, 2025).

Table 2. Major youth-focused agricultural programmes and impacts

Programme	Target group and components	Reported impacts
ARYA	Unemployed rural youth (18–35 years); enterprises in poultry, fishery, mushroom, apiary, nursery; training, seed funding (₹50 000–1 lakh), mentorship.	21 % improvement in livelihood status index; annual income ≈ ₹2.90 lakh with 100.66 % return (Mohanty et al., 2025); employment generation increased by 80 person-days per enterprise (Chandre Gowda et al., 2024).
STRY	Rural youth ≥ 18 years; 7-day courses delivered through ATMA/KVK; 70 % practical, 30 % theory; funding of ₹400 per participant per day (Department of Agriculture & Farmers Welfare, Government of India, n.d.).	Over 20 000 women trained in 2022–25; enhanced skills in mushroom, goat rearing, horticulture and digital literacy (Government of India, Ministry of Agriculture & Farmers Welfare, 2025).
ACABC	Agricultural graduates; 45-day residential training to establish agribusiness centres; includes business planning, banking linkages and subsidy (44 %) (Government of India, Ministry of Agriculture & Farmers Welfare, 2025).	Trainees rated communication skills, enterprise planning and exposure visits highly relevant; key challenges include social stigma and market fluctuations (Mohanty et al., 2025).
DAESI	Input dealers; one-year part-time diploma covering extension services, seed and fertiliser management.	2 853 women input dealers trained, enhancing service quality and employment (Government of India, Ministry of Agriculture & Farmers Welfare, 2025).
IRise Skill Development Programme	Rural youth (18–35) at Howrah KVK; 23-day course with corporate collaboration (Syngenta Foundation); combines training, internships and industry exposure (Indian Council of Agricultural Research, 2025).	Transformed 40 youths into agri-entrepreneurs; replicable model linking corporate CSR with KVK extension (Indian Council of Agricultural Research, 2025).
Green College (Welthungerhilfe & DRCSC)	Rural youth; 3-month training and 9-month implementation support in sustainable agriculture, aquaculture, livestock and crafts.	Empowered youth to establish enterprises; revived date palm and other local value chains, reduced migration.
ONganic Eco-Social Agriculture	Smallholder organic farmers; social enterprise forms producer groups, provides training and links to markets (Laha et al., 2024).	Price premium increased by 123 % and net income by 177 %; yield declined by 41 % (Laha et al., 2024).

Table 3. Comparative summary of reviewed studies

Study (year)	Location & sample	Methodology	Key findings
Jalpaiguri youth involvement (Chakraborty et al., 2025)	Jalpaiguri district; cross-sectional survey of 240 rural youths.	Descriptive statistics and livelihood analysis.	44 % youth involved in agriculture, 31 % in labour, 25 % in business and 14 % in livestock; only 3 % depend exclusively on agriculture; 54 % not engaged in farm activities; highlights livelihood diversification and limited youth interest in farming.
Occupational aspiration study (Saha et al., 2022)	Purba Bardhaman district; 120 rural youths.	Survey with Likert scale; correlation analysis.	55.83 % youths had medium occupational aspiration, 19.16 % high and 25 % low; aspirations positively correlated with education, landholding, income and extension participation; constraints include low family income and lack of timely information.
ICT usage among extension professionals (Prasad & Pradhan, 2019)	80 extension professionals from universities, KVKs, state departments, input dealers.	Structured interviews; weighted mean score analysis.	Mobile phones ranked highest (3.97) for ICT use, followed by internet (2.62) and email (2.37); social participation and aspiration towards technology associated with ICT usage; emphasises need for digital capacity building.
ARYA impact evaluation (Chandre Gowda et al., 2024)	Multi-state including West Bengal; 322 enterprise units (2017–18) to 841 (2020–21).	Survey and financial analysis.	Net income per enterprise increased from ₹0.93 lakh to ₹2.30 lakh; benefit–cost ratio rose from 1.89 to 3.28; employment generation increased from 272 to 352 person-days; group enterprises performed better than individual ones.
Livelihood status improvement through ARYA (Mohanty et al., 2025)	Puri and Nayagarh districts; 120 ARYA participants.	Exploratory sequential design; livelihood index before and after programme.	Livelihood status improved by 21 %; physical asset mean score increased from 3.71 to 4.00; financial assets from 2.53 to 2.85; annual income ~ ₹2.90 lakh; return ~ 100.66 %.
Relevancy of ACABC training (Kumari et al., 2025)	Varanasi training institute; 100 ACABC trainees.	Ex-post facto design; relevancy index calculated.	Communication skills (72.67 %), enterprise planning (78 %) and exposure visits (81 %) rated most relevant; problem solving (54.34 %) and cash/fund flow (55 %) least relevant; challenges include social stigma and market fluctuations.
Toto tribe intergenerational knowledge study (Suman et al., 2025)	120 Toto family farms; mixed methods.	Focus groups, interviews, surveys and correlation analysis.	Younger generations shift towards modern techniques; knowledge erosion due to reduced social participation and changing aspirations; socio-economic factors (education, material possessions) positively influenced livelihoods; emphasises integrating traditional knowledge and elder–youth exchange.
ONganic eco-social agriculture case (Laha et al., 2024)	133 farmers engaged with ONganic; difference-in-differences analysis.	Mixed methods: survey, impact assessment.	Organic farmers saw 41 % yield decline but 123 % increase in farmgate price and 177 % rise in net income; cooperative marketing and price premiums compensated yield loss; highlights eco-social enterprise's role in sustainable agripreneurship.

Table 4. Policy initiatives supporting youth engagement in agriculture

Policy/initiative	Description and provisions	Youth relevance
Agricultural Technology Management Agency (ATMA)	District-level autonomous bodies develop strategic research and extension plans, promote convergence of line departments, and ensure farmer participation. Mandates that at least 30 % of resources target women (Government of India, Ministry of Agriculture & Farmers Welfare, 2025).	Provides institutional platform for youth to influence extension planning; funds Farmer Friends, Farm Schools and Block Technology Teams.
Skill Training for Rural Youth (STRY)	Seven-day courses with 70 % practical content; rural youth aged ≥ 18 years; per-trainee funding of ₹400/day (Department of Agriculture & Farmers Welfare, Government of India, n.d.).	Builds specific skills in mushroom cultivation, nursery raising, goat rearing and digital literacy; emphasises rapid skill acquisition.
Attracting and Retaining Youth in Agriculture (ARYA)	Implemented by KVKs; targets youth < 35 years; provides enterprise training, seed funding and mentoring (ICAR-ATARI, 2025).	Encourages youth entrepreneurship; reduces migration; fosters group enterprises; extends technical and marketing support.
Agri-Clinic and Agri-Business Centre (ACABC)	45-day residential programme for agri-graduates; provides loans with 36–44 % subsidy; emphasises business planning (Kumari et al., 2025).	Creates self-employment opportunities for educated rural youth; complements public extension by providing consultancy services.
Diploma in Agricultural Extension Services for Input Dealers (DAESI)	One-year diploma for input dealers; covers seed, fertiliser, pesticide regulations and extension services.	Enhances knowledge and regulatory compliance among youth input dealers; fosters employment in agricultural supply chain.
Paramparagat Krishi Vikash Yojana (PKVY)	Promotes organic farming through cluster approach; supports Participatory Guarantee System (PGS) groups; encourages social enterprises like ONganic (Laha et al., 2024).	Provides opportunities for youth to engage in organic farming and join producer groups; offers certification and market linkages.
National Rural Livelihood Mission (NRLM) & DDU–GKY	Provide self-help group formation, skill training and micro-finance; focus on women and youth.	Supports youth in forming enterprises, accessing credit and diversifying livelihoods.
State digital initiatives (Matir Katha, e-NAM)	Mobile advisory and e-trading platforms implemented by West Bengal government; provide weather forecasts, pest alerts and market prices.	Enhance access to timely information and markets for youth; facilitate digital extension and e-commerce.

5.4. Gender inclusivity and social equity

Gender disparities persist in access to land, credit, training and technology across Indian agriculture (Pradhan et al., 2024; Prusty et al., 2021). Women constitute a significant share of rural youth, yet cultural norms often restrict their mobility and decision making, particularly in accessing extension services and digital platforms (Saha et al., 2025). Government schemes have attempted to address this by reserving resources (e.g., 30% for women under ATMA) and providing higher subsidies (44% in ACABC) (Government of India, Ministry of Agriculture & Farmers Welfare, 2025). Nonetheless, women remain underrepresented in farmer organisations and agri-entrepreneurial networks (Das et al., 2025). Intersectional factors—caste, ethnicity and socioeconomic status—compound exclusion. The Toto case emphasises how indigenous communities face knowledge erosion and economic vulnerability (Ghosh et al., 2025). Extension must therefore adopt inclusive strategies, including gender-sensitive training, safe spaces for women and youth, digital inclusion and recognition of indigenous knowledge systems (Prusty et al., 2021; Saha et al., 2025).

5.5. Institutional coordination and policy coherence

Effective youth engagement requires coordination across ministries (agriculture, rural development, skill development), state agencies, research institutions and private actors. Currently, programmes operate in silos; duplication and inefficiencies occur, limiting their outreach and impact (Pradhan et al., 2024; Kumar et al., 2025). Theoretical frameworks (AKIS, diffusion, human capital) underscore the need for systemic approaches. Policy coherence is also crucial: organic farming promotion should align with market infrastructure; digital initiatives need broadband investment; youth entrepreneurship requires credit policies and risk insurance (Amar et al., 2025; Das et al., 2025). Evidence from Odisha demonstrates that coordinated extension systems significantly improve adoption of AI-enabled advisories and market participation (Kumar et al., 2025; Amar et al., 2025). The review synthesis framework (Figure 4) integrates these elements, showing that theoretical insights inform extension approaches, which in turn influence youth outcomes; enabling environments (institutions, policies, finance) shape both approaches and outcomes, while emerging trends and gaps feed back into theory and practice.

5.6. Remaining gaps and future research

Despite the proliferation of programmes, youth participation in agriculture remains modest, with migration continuing to draw rural youth away from farming (Sai et al., 2024). Research gaps include: longitudinal studies tracking youth trainees to assess long-term impacts; gender-differentiated analyses of digital adoption and entrepreneurship (Saha et al., 2025; Pradhan et al., 2024); evaluations of social enterprise models (Das et al., 2025); understanding psychological factors such as motivation and risk tolerance; and analyses of indigenous knowledge integration (Ghosh et al., 2025). Data on state-specific indicators (e.g., youth employment rates in agriculture) remain scarce. Future research should employ mixed methods (surveys, case studies, experimental designs) and participatory approaches to capture youth voices and inform responsive extension policies (Amar et al., 2025; Kumar et al., 2025).

6. CONCLUSIONS

Rural youth are central to West Bengal's agricultural transformation but face multifaceted barriers—limited access to resources, weak market linkages, social stigma and digital divides. Agricultural extension, when reimagined as an inclusive, pluralistic and innovation driven system, can unlock youth potential. Evidence from West Bengal shows that programmes like ARYA, STRY and ACABC, and initiatives by KVKs, social enterprises and NGOs, have improved skills, employment and incomes. Digital platforms, collective enterprises and eco social agribusiness models offer promising avenues for youth engagement. However, sustainability depends on institutional coordination, gender inclusivity, integration of indigenous knowledge and adaptation to climate change. Policymakers should strengthen AKIS linkages, invest in digital infrastructure, tailor training to diverse youth typologies, support incubators and producer organisations, and ensure credit and insurance access. Future extension strategies must recognise youth as innovators and partners rather than passive beneficiaries, fostering a resilient and sustainable agricultural sector.

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