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Assessment of indigenous technical knowledge practices in diverse agro-ecological region of India

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Abstract

Indigenous Technical Knowledge (ITK) represents a valuable system of traditional knowledge developed by local communities through generations of interaction with their natural environment. This review examines the significance, application, and relevance of ITK practices across diverse agro-ecological regions of India and highlights their role in sustainable agricultural development and rural livelihoods. The study is based on a synthesis of secondary data from research articles, journals, and empirical studies focusing on indigenous practices related to soil fertility management, seed treatment, pest and disease control, crop protection, post-harvest management, and household health care. Evidence from different regions such as Telangana, Chhattisgarh, Tamil Nadu, and tribal farming systems shows that ITK practices are environmentally sustainable, low-cost, culturally acceptable, and locally accessible, making them particularly beneficial for small and marginal farmers. The review also examines farmers' awareness and adoption levels of ITK practices, which are generally moderate to high, though influenced by socio-economic characteristics, education, and access to extension services. Despite their effectiveness and ecological benefits, ITK practices face several challenges, including inadequate documentation, declining intergenerational knowledge transfer, uneven awareness among farming communities, and limited scientific validation and integration with modern agricultural systems. The review identifies significant research gaps related to systematic validation, policy support, and technological integration of indigenous knowledge. Overall, the study emphasizes that preservation, documentation, and scientific evaluation of ITK practices are essential for promoting ecological sustainability, enhancing agricultural resilience, and ensuring food security. Integrating indigenous knowledge with modern agricultural innovations can contribute significantly to sustainable development and improved farmer livelihoods in India's diverse agro-ecological regions.

Keywords: Indigenous technical knowledge (ITK), sustainable agriculture, agro-ecological regions, traditional farming practices, pest management, knowledge integration

Introduction

Indigenous Technical Knowledge (ITK), also known as Indigenous Knowledge (IK or TEK), is the accumulated knowledge, skills, and practices developed by local communities through generations of close interaction with their natural environment (Alam *et al.*, 2024; Sow & Ranjan, 2023) ^[1, 18]. This knowledge comes from experience, is passed down orally, and is deeply rooted in culture. It focuses on sustainability, ecological balance, and long-term resource management instead of short-term profit

(Alam *et al.*, 2024; Keerthana & Divakaran, 2021) ^[1, 9]. India's diverse agro-ecological areas have led to specific ITK practices related to crop production, soil fertility, pest and disease management, protection from wild animals and birds, and post-harvest and seed storage systems that suit local climate and culture (Sharma *et al.*, 2023, Borah *et al.*, 2023, Anitta Fanish *et al.*, 2025) ^[15, 4, 2]. In states like Telangana, Rajasthan, Assam, Tamil Nadu, Chhattisgarh, and tribal hill regions, farmers still depend on indigenous practices that are low-cost, eco-friendly, locally available,

and reduce risks for sustainable agricultural livelihoods (Alam *et al.*, 2024, Sharma *et al.*, 2023; Sow & Ranjan, 2023) [1, 15, 18]. However, many ITK practices are not well documented and are quickly disappearing because of modernization, less sharing between generations, and a greater reliance on external sources (Borah *et al.*, 2023; Keerthana & Divakaran, 2021) [4, 9]. This review brings together documented Indigenous Technical Knowledge practices from various agro-ecological regions of India. It aims to highlight their importance, conservation value, and potential integration with modern agricultural systems for sustainable development (Alam *et al.*, 2024; Sharma *et al.*, 2023) [1, 15].

Materials and Methods

This study adopts a systematic review design to synthesise documented evidence on Indigenous Technical Knowledge (ITK) practices across diverse agro-ecological regions of India. The review is based exclusively on secondary data collected from peer-reviewed journal articles and empirical studies retrieved primarily through Google Scholar. A structured search strategy was employed using combinations of keywords such as “Indigenous Technical Knowledge,” “ITK in agriculture,” “traditional farming practices,” “pest management,” “seed storage,” and “agro-ecological regions of India.” Inclusion criteria comprised studies conducted within Indian agro-ecological contexts that explicitly documented, evaluated, or analysed ITK practices in agriculture, livestock, natural resource management, and household applications. Studies lacking empirical evidence, methodological clarity, or regional specificity were excluded. The selected articles were screened for relevance, duplication, and conceptual alignment with the review objectives. The final corpus was subjected to thematic categorisation and qualitative synthesis to identify dominant practice domains, regional patterns, awareness and adoption trends, and research gaps, thereby ensuring methodological transparency, rigour, and consistency.

Objectives of the Study

To identify research gaps, validation needs, and integration challenges in order to propose pathways for systematic documentation, scientific evaluation, and integration of ITK with modern agricultural systems for sustainable development.

Review of Literature

Barman *et al.*, (2024) [3] reported that Indigenous Technical Knowledge (ITK) plays an important role in promoting sustainable and climate-resilient agriculture. The study highlighted that several traditional practices such as green manuring, vermicomposting, traditional irrigation systems like Khadin and Zing, and ethnoveterinary practices contribute to improving soil fertility, conserving water, and maintaining biodiversity. The authors concluded that integrating indigenous knowledge with modern scientific technologies can enhance agricultural sustainability and help farmers cope with climate change.

Jayalakshmi *et al.*, (2025) [7] conducted a study on the adoption of Indigenous Technical Knowledge (ITK) for drought mitigation in groundnut cultivation in the semi-arid regions of Andhra Pradesh. The results revealed that farmers

who adopted ITK practices such as summer deep ploughing, sub-soiling with chisel plough, application of farmyard manure, sowing across the slope, and formation of dead furrows recorded higher groundnut yields compared to traditional farmer practices. The demonstration plots produced yields of about 1498–1511 kg/ha, which was 8.94–19.35% higher than the farmers’ practice, along with additional income ranging from ₹16,587 to ₹19,375 per hectare. Among the practices, summer deep ploughing showed the highest increase in adoption (79.17%), indicating that ITKs are effective in improving crop productivity and drought resilience.

Results and Discussion

• ITK Practices Across Regions

1. Indigenous Technical Knowledge in Agriculture

Indigenous Technical Knowledge (ITK) is a rich collection of traditional practices developed by farming communities through long-term interaction with their local environments. In agriculture, ITKs are widely used to improve soil fertility, manage seeds, protect crops, and handle storage. Studies in Telangana showed that most farmers depended on animal manure, poultry manure, and ash to enhance soil fertility and stimulate microbial activity. This process boosts soil health and crop productivity (Alam *et al.*, 2024) [1]. Common practices include soaking seeds before planting, using neem leaves for grain storage, penning sheep and goats before ploughing, and spraying neem-based solutions for pest control. These methods are low-cost, environmentally friendly, and locally accessible. They not only support sustainable agriculture but also reduce reliance on chemical inputs. This makes ITKs especially important for small and marginal farmers (Das, 2023; Yadav *et al.*, 2017) [5, 20].

2. Indigenous Practices at Household Level

At the household level, ITKs are vital for health care, food preservation, and sanitation. Households widely adopted traditional remedies using turmeric, tulsi, neem, ginger, garlic, amla, and lemon to treat wounds, cough, cold, throat infections, and inflammation (Alam *et al.*, 2024) [1]. Common remedies included turmeric paste to stop bleeding, turmeric milk for respiratory issues, and tulsi with honey for cough relief. Traditional food preservation methods reported include storing eggs in salt, using tamarind and salt in ghee, and utilizing neem leaves to prevent food spoilage. Copper vessels for storing drinking water were another important practice due to their antimicrobial properties. These household ITKs are deeply rooted in cultural traditions and passed down through generations. They highlight the importance of health security, food safety, and sustainability at the family level (Singh & Singh, 2019; Tesfaye, 2021) [17, 19].

3. Indigenous Technical Knowledge for Pest Management

Indigenous pest management practices are an important part of ITK, offering cost-effective and environmentally friendly alternatives to chemical pesticides. Tribal farmers used cow dung ash mixed with water and kerosene oil to control the paddy caseworm. They also sprayed decoctions made from Sinduar (*Vitex negundo*) leaves to manage rice pests

(Manohari & Ratan, 2020) ^[11]. Farmers employed mechanical methods, such as dragging jute ropes soaked in kerosene oil across rice fields to physically remove insects. Biological methods included growing sunhemp as a trap crop in maize fields, which helped lower pest numbers. They commonly sprayed water soaked with tobacco leaves on solanaceous vegetables to control stem borers, taking advantage of nicotine's insecticidal properties. Perception studies showed that farmers considered most ITKs to be sustainable and affordable. In contrast, scientists evaluated some practices as highly productive and stable. However, concerns about the availability of inputs like kerosene affected fairness ratings (Manohari & Ratan, 2020) ^[11]. Overall, these findings highlight the scientific relevance and practical value of ITKs in promoting sustainable pest management and integrated farming systems.

• Awareness and Adoption Studies

Level of Awareness of ITK Practices

The study found that nearly half (46.66%) of the paddy growers in Bastar district had a high level of awareness of indigenous technical knowledge (ITK) practices. This shows that a significant number of farmers were familiar with traditional agricultural methods relevant to their area.

This high level of awareness means that farmers have substantial knowledge of traditional cultivation methods, pest control techniques, and other local practices that have been passed down through generations. However, the article does not list specific practices in the abstract.

The fact that nearly half of the respondents recognized ITK reflects farmers' understanding of the importance of indigenous knowledge in managing farming tasks like paddy production. This knowledge may include soil, water, pest, and crop management strategies suited to local conditions.

By reporting awareness levels quantitatively, the study emphasizes that traditional technical knowledge remains present in local farming communities, even with the arrival of modern technologies. (Jallarah *et al.*, 2023) ^[6].

• Adoption Levels of ITKs

The study in Kolli Hills found that most tribal farmers showed medium (55.56%) to high (25.10%) adoption of Indigenous Technical Knowledge (ITK) practices, indicating strong reliance on traditional farming methods. Only 19.34% had low adoption levels. High adoption rates were observed in crops like tapioca, ragi, banana, and paddy, with some paddy practices reaching 92% adoption (Nisha & Arunachalam, 2018) ^[12].

The study in Kolli Hills revealed that 55.56% of tribal farmers had medium knowledge of Indigenous Technical Knowledge (ITK), followed by 25.10% with high and 19.34% with low knowledge levels. The findings emphasize the continued importance of ITK in tribal farming systems and recommend its integration into formal extension programs for sustainable agricultural development (Keerthana & Divakaran, 2021) ^[9].

A study in Koraput district documented numerous Indigenous Technical Knowledge (ITKs) practices in agriculture and livestock, with over half of crop (55.55%) and livestock (61.53%) practices found to be rational. About 65.72% of rational ITKs were widely adopted, though some

non-rational practices persisted, highlighting the need for extension support to promote scientifically validated indigenous methods (Lenka & Satpathy, 2020) ^[10].

• Synthesis and Gaps

In Indian agriculture, indigenous technical knowledge (ITK) methods are closely linked to regional cultures and natural circumstances. They show a lengthy history of adjusting and learning from mistakes. ITKs are crucial for sustainable farming, according to studies from a variety of locations, such as the tribal districts of Himachal Pradesh, the paddy-growing regions of Chhattisgarh, and the pulse storage systems in Tamil Nadu.

Ecological appropriateness and sociocultural elements such as family structure and decision-making habits have an impact on the adoption of ITK in agricultural systems in Kangra. This illustrates how human and environmental factors in mountain habitats influence ITKs (Patil, H. 2025) ^[14].

In Bastar, farmer characteristics including education, landholding size, and media exposure are strongly correlated with paddy growers' knowledge of and adherence to traditional traditions. This suggests that availability to information and local expertise are key factors in ITK adoption (Jallarah *et al.*, 2023) ^[6].

Smallholder farmers in Tamil Nadu frequently store pulses using age-old techniques like combining red gram with red earth slurry and dusting with ash. These methods aid in the prevention of storage pests and emphasize the significance of ITKs in lowering post-harvest losses and enhancing food security in regions with limited resources (Fanish *et al.*, 2025).

ITK methods exhibit recurring themes of cultural relevance, cost-effectiveness, and ecological sustainability throughout agro-ecological zones. For example, tribal farmers in Jharkhand employ a variety of native pest-control methods that are deemed rational and successful by both farmers and experts. According to Lenka, S., and Satpathy, A. (2020) ^[10], this illustrates the profound ecological knowledge ingrained in ITKs.

Similar patterns may be seen in complementary studies from Punjab's home gardens, where regionally adapted pest management techniques including ash dusting, neem extract sprays, and plant-based mixes are still employed due to their eco-friendliness and cultural familiarity. These techniques are frequently chosen over chemical substitutes (Kaur *et al.*, 2025) ^[8].

Overall, the research shows that across India's many agro-ecological areas, maintaining and incorporating this particular knowledge systems into contemporary agricultural practices may promote sustainable agriculture, enhance resilience, and preserve biodiversity. Additionally, it keeps this knowledge from disappearing as a result of modernization (Patel *et al.*, 2025) ^[13].

• Identified Gaps

There are still significant gaps in current research and practice, despite the great diversity and efficacy of Indigenous Technical Knowledge (ITK) techniques reported in several agro-ecological areas of India. Numerous studies demonstrate that although farmers actively employ traditional cultivation and pest-management methods,

farming communities are not well-informed about the entire spectrum of ITKs, particularly in areas where local decision-making is dominated by contemporary agricultural inputs. For instance, study conducted in Haryana revealed that although farmers were aware of some ITK techniques, such as compost, neem leaves, and ash, many other traditional practices were either unknown or not utilized because of poor knowledge and the ease with which chemical inputs could be obtained. This suggests deficiencies in ITK exchange and documentation (Sindhu *et al.*, 2020) ^[16].

Paddy producers in Bastar, Chhattisgarh, have varying levels of knowledge depending on informational and socioeconomic circumstances. This demonstrates how ITK awareness is influenced by education, involvement in extension programs, and exposure to the media, exposing disparities in equitable access to information among various farmer groups (Jallaraph *et al.*, 2023) ^[6].

Additionally, there is a dearth of systematic scientific validation and integration with contemporary agricultural research frameworks, despite the fact that several studies have discovered and validated particular ITK techniques. This restricts how widely these approaches may be adopted and scaled. For instance, Jharkhand's recording of tribal pest-management techniques attested to the applicability and scientific foundation of conventional techniques. Few research, however, go beyond this to provide more comprehensive scientific validation or policy suggestions for widespread adoption (Lenka, S., & Satpathy, A. 2020) ^[10].

Similarly, Himachal Pradesh research revealed that sociocultural variables have a major impact on the adoption of ITK. It also highlighted the necessity of legislation that explicitly incorporate ITKs into sustainable agricultural initiatives in addition to documenting them. This implies that traditional knowledge and formal agricultural innovation systems are not well connected by existing frameworks (Patel *et al.*, 2025) ^[13]. In order to conserve, validate, and promote ITKs throughout India's diverse agro-ecological zones, future research and policy interventions should focus on these gaps in documentation, unequal awareness, and inadequate scientific integration.

Conclusion

Overall, the review highlights that Indigenous Technical Knowledge (ITK) remains an essential component of sustainable agriculture and rural livelihoods across India's diverse agro-ecological regions. Developed through generations of practical experience and close interaction with the natural environment, ITK practices contribute significantly to soil fertility management, pest and disease control, crop protection, seed treatment, post-harvest storage, and household health care. These practices are low-cost, environmentally friendly, culturally acceptable, and easily accessible, making them particularly beneficial for small and marginal farmers. The findings show that farmers possess moderate to high awareness and adoption of ITK practices, demonstrating their continued relevance and effectiveness in promoting ecological balance, biodiversity conservation, and resource sustainability. However, the study also identifies major challenges such as inadequate documentation, declining knowledge transfer between generations, uneven awareness among farmers, and limited

scientific validation and integration with modern agricultural systems. Therefore, the review emphasizes the urgent need for systematic documentation, scientific evaluation, policy support, and extension efforts to preserve and promote indigenous knowledge. Integrating ITK with modern agricultural innovations can enhance agricultural productivity, strengthen climate resilience, ensure food security, and support sustainable agricultural development while protecting valuable traditional knowledge systems for future generations.

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