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TOWARDS AGI-ENABLED ORGANIC SUPPLY CHAINS: A SYSTEMATIC REVIEW OF OPPORTUNITIES AND BARRIERS FROM FARM TO CONSUMER IN SOUTH TAMIL NADU

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Abstract

Artificial General Intelligence (AGI), systems theorized to generalize learning and reasoning across tasks without domain-specific retraining, remains an emergent, largely conceptual frontier, yet it is already shaping how researchers think about the long-term trajectory of supply chain management. This paper presents a systematic literature review examining the opportunities and barriers associated with the eventual integration of AGI into organic agricultural product supply chains, from farm gate to consumer, with specific reference to South Tamil Nadu. Following a PRISMA-informed protocol, forty-two sources were screened and twenty-seven retained for synthesis across three evidentiary tiers: documented applied artificial intelligence evidence, nascent conceptual AGI literature, and region-specific organic-farming evidence. Findings show that current applied-AI, generative-AI, IoT, and blockchain tools already address functions an eventual AGI system would generalize across, but fragmented data, connectivity gaps, certification-workflow rigidity, and low digital literacy constrain absorption of even current technologies in South Tamil Nadu. A staged readiness framework is proposed, positioning the Participatory Guarantee System as a strategic integration point for near-term digital tools.

Keywords:

Artificial General Intelligence, Organic Supply Chain, South Tamil Nadu, PGS-India, Systematic Review

1. INTRODUCTION

Supply chain management in organic agriculture is distinguished from conventional agri-food logistics by its dependence on provenance documentation, certification integrity, and trust mechanisms that must hold across multiple intermediaries, including input suppliers, farmers, certifying bodies, aggregators, processors, distributors, retailers, and consumers [9] [10]. Digital technologies, including Internet of Things sensors, blockchain ledgers, and machine-learning advisory systems, have been investigated as mechanisms to reduce the cost and fragility of this documentation chain [3] [6]. Parallel to this applied literature, a distinct conceptual literature has begun to theorize the implications of Artificial General Intelligence for sectors including healthcare, finance, energy, and agriculture [1] [2]. Lu et al. [1] explicitly outline prospective AGI applications spanning agricultural image processing, natural language processing, robotics, knowledge graphs, and infrastructure, arguing that AGI's defining advantage over narrow AI lies in its capacity to generalize and transfer learning across previously unseen situations without human intervention. Artificial General Intelligence (AGI) represents a future generation of intelligent systems capable of learning, reasoning, and adapting across diverse tasks with minimal domain-specific retraining. In agriculture and supply chain management, AGI could potentially integrate data from production, logistics, certification, markets, and consumer demand to improve end-to-end decision-making. Organic agricultural supply chains particularly require greater transparency, traceability, quality assurance, and coordination among farmers, intermediaries, certifiers, and consumers. In South Tamil Nadu, these requirements are accompanied by challenges such as fragmented farming systems, limited digital infrastructure, connectivity constraints, and varying levels of technological literacy. Although current AI, IoT, blockchain, and generative-AI technologies provide useful solutions, their adoption remains uneven across the region. Therefore, understanding the opportunities, barriers, and readiness requirements for future AGI integration is essential. This study systematically reviews existing evidence and proposes a staged framework for integrating intelligent technologies into organic agricultural supply chains in South Tamil Nadu.

This review addresses a specific gap: while applied AI and digital-traceability research in Indian and Tamil Nadu agriculture is reasonably developed, no existing study connects this literature, and the emerging conceptual AGI literature, to the specific institutional and geographic context of organic supply chains in South Tamil Nadu, comprising the districts of Madurai, Tirunelveli, Virudhunagar, Thoothukudi, and Dindigul. This region combines an active organic-farming base operating substantially under PGS-India certification [9], an emerging state-level agri-tech ecosystem [11], and structural smallholder constraints widely documented across the Global South [17] [19].

1.1 METHODOLOGICAL STANCE ON AGI

AGI, as defined in the computer science literature, does not currently exist as a deployed system in any domain, including agriculture and supply chain management [1]. Claims in this review are therefore tiered into: (i) deployed/empirical findings from applied AI, IoT, and blockchain technologies; (ii) conceptual/prospective findings from the nascent AGI-and-agriculture literature; and (iii) contextual findings specific to Tamil Nadu's organic-farming environment. This tiering is preserved throughout the synthesis in Section 4.

1.2 RESEARCH QUESTIONS

- RQ1: What does the conceptual literature claim about AGI's prospective role in agriculture and supply chains?
- RQ2: What applied AI, generative AI, IoT, and blockchain capabilities are already documented in organic supply chains?
- RQ3: What barriers characterize South Tamil Nadu's organic supply chains?
- RQ4: What staged framework can guide stakeholders along the AI-to-AGI trajectory?

2. CONCEPTUAL FRAMEWORK

Lu et al. [1] characterizes the distinction between artificial narrow intelligence, the task-specific AI systems currently deployed in agriculture, and AGI, whose theorized advantage is the ability to fuse multiple modalities and transfer learning across previously unseen agricultural contexts without retraining. Recent systematic reviews of generative AI and large language models in agricultural supply chain management provide the most empirically grounded bridge between current applied AI and the generalization properties theorized for AGI [3]. This review treats generative-AI literature as the most defensible empirical proxy currently available for reasoning about AGI-adjacent capabilities in organic supply chains.

This review organizes evidence along five farm-to-consumer supply chain stages relevant to organic products: input and conversion-period management, on-farm production and certification documentation, post-harvest handling and grading, logistics and traceability, and retail and consumer trust. Each stage is evaluated against current applied-AI capability and theorized AGI-level generalization.

3. METHODOLOGY

This systematic literature review adopts a PRISMA-informed methodology to identify, evaluate, classify, and synthesize existing evidence on the potential integration of Artificial General Intelligence (AGI) into organic agricultural product supply chains. Since AGI remains an emerging and largely conceptual field, the review incorporates both established applied-AI studies and early conceptual research related to AGI. The methodology was designed to accommodate differences in technological maturity, research objectives, geographical coverage, and empirical evidence. The review specifically focuses on the organic agricultural supply chain in South Tamil Nadu and examines the potential role of intelligent technologies across production, aggregation, certification, distribution, and consumer-facing activities.

3.1 SEARCH STRATEGY

Search strings combined four concept clusters: AGI terms; applied AI and digital-technology terms; organic and supply chain terms; and geographic terms restricted to Tamil Nadu and South India. Sources were drawn from indexed journals via Emerald, Springer, Elsevier, Frontiers, and MDPI platforms, arXiv preprints for the nascent AGI literature, and selected policy sources where peer-reviewed regional coverage was absent.

The search strategy combined four major concept clusters: (i) AGI and general intelligence, (ii) applied AI and emerging digital technologies, (iii) organic agriculture and supply chains, and (iv) geographical context. Boolean operators such as AND and OR were used to combine keywords and improve retrieval precision.

The search period was primarily restricted to studies published between 2018 and 2026, while AGI-specific literature was emphasized for the period 2023–2026 to capture recent developments. Reference lists of highly relevant studies were also examined through backward citation screening to identify additional sources that may not have been retrieved through database keyword searches.

3.2 ELIGIBILITY CRITERIA

Inclusion criteria were: published 2018-2026 (2023-2026 for AGI-specific sources); substantive engagement with AGI, AI, ML, generative AI, IoT, or blockchain in agriculture or supply chain management; situated in India, with priority to Tamil Nadu; and English-language availability. Exclusion criteria removed AGI safety papers without sectoral application, promotional material, duplicate datasets, and unsubstantiated use of the term AGI.

Studies involving Indian agricultural contexts were prioritized, with particular emphasis on Tamil Nadu and South India. Studies from other geographical regions were retained when they provided transferable technological or supply-chain insights relevant to the proposed AGI-enabled framework. Only English-language sources with sufficient methodological or conceptual information were considered.

Studies were excluded when they focused exclusively on AGI safety, philosophical discussions, or general AI development without a meaningful connection to agriculture or supply chains. Promotional webpages, commercial material, duplicate publications, studies with insufficient methodological information, and papers making unsupported claims regarding AGI were also removed. Articles that merely mentioned AI or AGI without discussing its application, implications, or relevance to the research problem were similarly excluded.

3.3 SCREENING AND SYNTHESIS

Of forty-two sources identified, twenty-seven were retained following title, abstract, and full-text screening, distributed across the three evidentiary tiers. Synthesis followed an inductive thematic approach coding findings against the five supply chain stages and the three evidentiary tiers. Initially, 42 potentially relevant sources were identified through database searches, supplementary searches, and reference-list examination. Duplicate and clearly irrelevant records were removed before detailed screening.

The titles and abstracts of the identified sources were initially examined to determine their relevance to the research objectives. Articles that appeared relevant or potentially relevant were subsequently subjected to full-text assessment. During full-text screening, studies were evaluated against the predefined inclusion and exclusion criteria. Following this process, 27 sources were retained for the final synthesis. The extraction process also recorded the type of digital capability demonstrated by each study, such as prediction, classification, optimization, traceability, automation, recommendation, anomaly detection, decision support, or natural-language interaction. A structured data-extraction framework was developed to ensure consistency across the selected studies. Information extracted from each source included author and publication year, geographical context, research objective, technology or algorithm used, agricultural or supply-chain application, dataset or study population where applicable, major findings, limitations, and relevance to AGI-enabled supply chains.

4. RESULTS AND DISCUSSION

4.1 CONCEPTUAL AGI LITERATURE

Lu et al. [1] propose that AGI's prospective value in agriculture lies in unifying currently siloed AI capabilities, including computer vision, natural language processing, robotics, and knowledge graphs, into a single system capable of transferring knowledge across crops, regions, and tasks. The same source identifies infrastructure, data availability, and trust as central preconditions for any such generalization. Cross-sectoral AGI reviews extend this logic to other infrastructure-heavy domains [2]. Authors across this literature are consistent in framing AGI's agricultural applications as potential and future-oriented rather than current capability.

4.2 APPLIED AI MAPPED TO SUPPLY CHAIN STAGES

The Table.1 maps the five farm-to-consumer organic supply chain stages against documented applied-AI and digital-technology interventions.

Table.1. Stage-Wise Mapping of Documented AI/Digital Technologies

Stage	Documented AI/Digital Technology
1	IoT soil-moisture sensing; ML irrigation advisory [12]
2	Blockchain smart contracts for organic audit trails [6] [7]
3	AI image-recognition produce grading [13]
4	Generative AI/LLM predictive coordination [14]
5	Blockchain-anchored consumer provenance dashboards [6]

Generative AI and large language model-based systems are increasingly used for predictive analytics and automated workflow generation across agricultural supply chains, representing the most generalizable, AGI-adjacent capability currently observed empirically [3]. Every stage already has at least one documented intervention, but these remain siloed by stage and vendor, the fragmentation that AGI's theorized cross-modal generalization is positioned to address.

4.3 REGIONAL BARRIERS IN SOUTH TAMIL NADU

The Table.2 summarizes barrier categories conditioning any future absorption of general-purpose AI systems in South Tamil Nadu's organic supply chains.

Table.2. Structural Barrier Categories

Barrier	Description
Data fragmentation	Non-interoperable farm/chain data [16]
Infrastructure gaps	Connectivity, electricity limits [17]
Institutional rigidity	PGS vs. enterprise blockchain mismatch [9]
Human-capital gaps	Low digital literacy, trust deficits [19] [20]

Triangulating applied-AI evidence with regional barrier evidence shows that barriers limiting today's narrow-AI adoption are largely upstream of algorithmic capability, residing in data infrastructure, connectivity, institutional fit, and trust. AGI's theorized generalization advantage would not by itself resolve the region's primary adoption constraints.

To improve the reliability of the synthesis, conclusions were based on convergence across multiple sources rather than on isolated claims. Evidence from current applied-AI studies was distinguished from conceptual AGI projections, while region-specific findings were used to assess implementation feasibility. The review therefore avoids treating hypothetical AGI capabilities as established empirical outcomes.

The final synthesis integrates technological opportunity, supply-chain applicability, regional readiness, and implementation barriers to determine the conditions under which AGI could eventually contribute to organic agricultural supply chains in South Tamil Nadu. The resulting framework provides a structured basis for future empirical studies, pilot implementations, and longitudinal assessment of AI-to-AGI readiness in regional agricultural ecosystems.

4.4 STAGED AI-TO-AGI READINESS FRAMEWORK

This review proposes a three-stage readiness trajectory. Stage A, foundational digitization, involves closing data, connectivity, and trust gaps through lightweight, PGS-compatible digital logging tools [4]. Stage B, cross-functional applied AI and generative AI integration, involves linking already-piloted tools into unified, generative-AI-mediated workflows [3]. Stage C, AGI-level generalization, represents the long-term, currently conceptual absorption of generalizable, multimodal systems [1], contingent on Stages A and B being substantially resolved.

Based on the synthesis of the three evidentiary tiers, a staged AGI-readiness framework was developed. The framework does not assume immediate deployment of AGI. Instead, it proposes a progression from digital foundation and data readiness, through AI-assisted decision support and interoperability, toward integrated intelligent supply-chain coordination, and ultimately to potential AGI-enabled adaptive management.

Because PGS-India's certification model is designed around small-farmer trust and low cost [9], this review argues it is structurally better suited to Stage A and B interventions than to direct adoption of enterprise blockchain-AI architectures designed for export-oriented operations.

5. CONCLUSION

This systematic review finds that while AGI remains a theorized, non-deployed construct in agriculture and supply chain management, the conceptual literature on AGI's prospective role provides a coherent lens for organizing existing applied-AI, generative-AI, IoT, and blockchain evidence relevant to organic supply chains. Mapped against South Tamil Nadu's farm-to-consumer organic supply chain, every stage already shows documented applied-AI intervention, but binding constraints sit upstream of algorithmic capability. The staged AI-to-AGI readiness framework proposed here, anchored in the Participatory

Guarantee System's peer-review architecture, offers practical sequencing logic for researchers, certifying bodies, and policymakers. The most urgent next step is primary, field-based research engaging PGS Regional Councils and organic producer collectives across the five southern districts.

Future research should focus on validating the proposed AGI-readiness framework through empirical field studies involving organic farmers, certification bodies, aggregators, logistics providers, retailers, and consumers in South Tamil Nadu. Pilot implementations can be developed using existing AI, IoT, blockchain, and generative-AI technologies to establish the digital and data infrastructure required for future AGI integration. Further studies should investigate interoperable data architectures capable of combining farm-level, certification, logistics, market, and consumer data while addressing privacy, security, and data ownership concerns. The role of the Participatory Guarantee System (PGS) as a digital integration point should also be experimentally evaluated through community-based pilot projects. Future work can additionally develop explainable and human-in-the-loop intelligent systems to ensure that AI-generated recommendations remain transparent and practically useful for farmers. Finally, longitudinal studies should assess technological readiness, economic feasibility, digital-literacy requirements, trust, regulatory compliance, and social acceptance as AI systems progressively evolve toward more generalized and autonomous capabilities.

REFERENCES

[1] G. Lu, S. Li, G. Mai and J. Sun, "AGI for Agriculture", *Proceedings of International Conference on Recent Trends in Artificial Intelligence*, pp. 1-7, 2023.

[2] Jimmy Xuekai Li, Tiancheng Zhang, Yiran Zhu and Zhongwei Chen, "Artificial General Intelligence (AGI) for the Oil and Gas Industry: A Review", *Proceedings of International Conference on Information Technology*, pp. 1-15, 2024.

[3] M. Li, A. Basit, A. Javed, X. Song and Y. Ge, "Generative Artificial Intelligence and ChatGPT in Agriculture Supply Chain Management: A Systematic Literature Review and Future Research Agenda", *British Food Journal*, Vol. 128, No. 13, pp. 121-141, 2026.

[4] A. Hussain and R. Rizwan, "Strategic AI Adoption in SMEs: A Prescriptive Framework", *Proceedings of International Conference on Recent Trends in Artificial Intelligence*, pp. 34-45, 2024.

[5] F.D. Davis, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology", *MIS Quarterly*, Vol. 13, No. 3, pp. 319-340, 1989.

[6] M.V. Hilten, G. Ongena and P. Ravesteyn, "Blockchain for Organic Food Traceability: Case Studies on Drivers and Challenges", *Frontiers in Blockchain*, Vol. 3, pp. 1-12, 2020.

[7] Y. Riouali, "A Blockchain-Driven Approach to Enhancing Transparency and Traceability in Organic Food Supply Chain Management", *Proceedings of International Conference on Applied Computational Intelligence and Soft Computing*, pp. 1-15, 2026.

[8] E.M. Rogers, "*Diffusion of Innovations*", 5th Edition, Free Press, 2003.

[9] Trace Assure, "PGS-India Certification", Available at: https://traceassure.global/services/pgs-india-organic/, Accessed in 2025.

[10] TraceX, "Organic Certifications in Agriculture", Available at: https://tracextech.com/organic-certifications-in-agriculture/, Accessed in 2025.

[11] TCI Cornell, "Bringing Intelligence to the Fields: Opportunities and Equity in India's AI-Driven Agriculture", Available at: https://tci.cornell.edu, Accessed in 2025.

[12] B. Jarinaa and M. Manida, "A Study on Pros and Cons of AI Technology used Agri Farming in Tamil Nadu", Available at: Recent *Trends in Data Mining and Business Forecasting*, Vol. 4, No. 2, pp. 1-13, 2023.

[13] TCI Cornell, "Intello Labs Image-Recognition Grading Case Reference", Available at: https://tci.cornell.edu, Accessed in 2025.

[14] K.B. Vedamurthy, Manojkumar Patil, V. Priyanka and L. Ajayakumar, "Unlocking AI's Potential in Agriculture: The Critical Role of Data", *Proceedings of International Conference on General Economics*, pp. 1-20, 2026.

[15] Down to Earth, "AI in Agriculture: How Smallholder Farmers Risk being Left Behind in the Global Digital Divide", Available at: https://www.downtoearth.org.in, Accessed in 2026.

[16] SkyQuest, "AI in Agriculture: A Strategic Blueprint for India's Smallholder Farmers", Available at: https://www.skyquestt.com, Accessed in 2025.

[17] V. Jayashree, M. Ramasubramanian, C. Karthikeyan, G. Gnanasanjevi and S.P. Kamali, "Agricultural Students' Perceptions of Artificial Intelligence: Challenges and Opportunities in Tamil Nadu, India", *Journal of Scientific Research and Reports*, Vol. 30, No. 12, pp. 255-262, 2024.