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Amrit Kaal and the Transformation of Indian Agriculture: Private Sector Engagement, Productivity, and Sustainable

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ABSTRACT

Agriculture plays a foundational role in India's economy by ensuring food security, supporting rural livelihoods, and contributing to national income. However, the sector faces persistent challenges, including low productivity, climate vulnerability, and infrastructure gaps. This study aims to examine how India's long-term development framework, known as Amrit Kaal, can transform the agricultural sector through private sector engagement and innovation. Using a qualitative and conceptual approach based on secondary data, the paper reviews policy documents, economic reports, and academic literature. The findings highlight key growth strategies centered on eight policy pillars, with particular emphasis on agricultural modernization, digital transformation, green energy integration, and improved infrastructure. Results suggest that public–private partnerships and technology-driven reforms are critical to enhancing productivity and resilience. The study concludes that agriculture must be repositioned as a dynamic growth engine to meet the goals of Viksit Bharat 2047 and the Sustainable Development Goals (SDGs), ensuring inclusive and sustainable national development.

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1. INTRODUCTION

Agriculture has long served as a cornerstone of the Indian economy, providing food security, employment, and raw materials for industry. Many reports regarding agriculture have been well-documented (**Table 1**). Despite technological advancements in various sectors, Indian agriculture continues to face structural challenges, including low productivity, climate vulnerability, resource constraints, and labor intensity. As the population grows and demands on food systems increase, the sector must evolve from subsistence to a more resilient, diversified, and technology-enabled model. Recent global crises (such as the COVID-19 pandemic and climate-related disruptions) have further underscored the urgency of building sustainable agricultural systems that can adapt to uncertainty while ensuring inclusive development.

Table 1. Previous studies on agriculture.

No	Title	Ref
1	High unemployment records of graduated students in the development of urban agriculture in the Gaza Strip	(Al-Najar *et al.*, 2019)
2	Pollutant emissions from brick kilns and their effects on climate change and agriculture	(Asif *et al.*, 2021)
3	Development of a solar-powered submersible pump system without the use of batteries in agriculture	(Bhosale, 2022)
4	Food security strategy through regenerative agriculture for capacity building of farmers with "integrated nutrient management training program"	(Febriani & Pasaribu, 2024)
5	Green skills understanding of agricultural vocational school teachers around West Java Indonesia	(Handayani *et al.*, 2020)
6	Influence of ICT availability, accessibility, and utilization on agriculture students' academic performance in universities	(Makinde *et al.*, 2023)
7	Biochar from agricultural waste for soil amendment candidate under different pyrolysis temperatures	(Mutolib *et al.*, 2023)
8	How to purify and experiment with dye adsorption using carbon: Step-by-step procedure from carbon conversion from agricultural biomass to concentration measurement using UV Vis spectroscopy	(Nandiyanto *et al.*, 2023)
9	Scientific research trends of flooding stress in plant science and agriculture subject areas (1962–2021)	(Nurrahma *et al.*, 2023)
10	Agricultural wastes as a source of silica material	(Permatasari *et al.*, 2016)
11	Techno-economic evaluation of the production of resin-based brake pads using agricultural wastes: Comparison of eggshells/banana peels brake pads and commercial asbestos brake pads	(Ragadhita *et al.*, 2023)
12	Characteristics of jengkol peel (Pithecellobium jiringa) biochar produced at various pyrolysis temperatures for enhanced agricultural waste management and supporting sustainable development goals (SDGs)	(Rahmat *et al.*, 2025)
13	Contributing factors to greenhouse gas emissions in agriculture for supporting sustainable development goals (SDGs): Insights from a systematic literature review completed by computational bibliometric analysis	(Soegoto *et al.*, 2025)
14	Microwave pyrolysis of agricultural and plastic wastes for production of hybrid biochar: Applications for greener environment	(Sridevi *et al.*, 2024)
15	Production and characterization of briquettes from agricultural wastes for sustainable energy solutions	(Umar *et al.*, 2025)

In response to these challenges, the Government of India introduced the Amrit Kaal development strategy, marking a 25-year roadmap (2022–2047) towards the centenary of independence. Anchored by the vision of Viksit Bharat by 2047, the strategy emphasizes eight

pillars of growth: inclusive development, productivity enhancement, infrastructure development, digital transformation, energy transition, global integration, good governance, and private sector participation. Within this framework, agriculture is no longer viewed merely as a legacy sector but as a strategic domain for innovation, investment, and sustainability. By leveraging public-private partnerships, digital tools, and renewable energy integration, Amrit Kaal offers an opportunity to reimagine Indian agriculture as a driver of long-term economic transformation.

This study aims to critically examine how agricultural productivity and private sector engagement are positioned within the Amrit Kaal framework. It adopts a qualitative, conceptual approach based on secondary data to analyze the intersection of policy, innovation, and investment. The novelty of this paper lies in its comprehensive synthesis of growth strategies across sectors, particularly agriculture, infrastructure, digital economy, and green energy. By identifying synergies and gaps, the study contributes to understanding how India can transition toward a sustainable, inclusive, and resilient agricultural system. Ultimately, this research provides strategic insights for policymakers, investors, and development practitioners seeking to align sectoral reforms with national development goals and the Sustainable Development Goals (SDGs).

2. LITERATURE REVIEW

India's developmental trajectory has been extensively analyzed in relation to the Viksit Bharat @2047 vision, which promotes inclusive growth, sustainability, and global integration as the foundation for long-term national progress. The introduction of the Amrit Kaal strategy marks a significant paradigm shift, aligning national policy with global Sustainable Development Goals (SDGs) through structural transformation across agriculture, infrastructure, and digital governance (Aliah, 2023).

Key policy innovations have been explored in recent studies. Programs such as the India Fintech Stack, National Logistics Policy, and Skill India Digital are shown to enhance productivity and facilitate technological leapfrogging when adequately supported by public and private investment (Smita, 2023). Within agriculture, initiatives like improved irrigation systems, farm mechanization, and the expansion of Farmer-Producer Organizations (FPOs) are identified as strategic tools for increasing rural incomes and fostering entrepreneurial ecosystems (Ashrit, 2023).

Historical data reveal mixed findings regarding the relationship between public and private investment. One study using ARDL analysis from 1970 to 2013 found that increased public investment can reduce private investment in the short term, indicating a crowding-out effect (Dash, 2016). Conversely, other findings suggest that public investment (particularly in infrastructure) can stimulate private participation in the long run (Muthu, 2017). These insights underscore the need for sector-specific investment strategies and targeted reforms to unlock synergies between public and private stakeholders.

India's push toward infrastructure development has been hindered by financing gaps, delays in project approvals, and regulatory inefficiencies. Studies recommend improving project feasibility, adopting modern financing models such as blended finance, and enhancing institutional transparency to address these barriers (Reena, 2020). Furthermore, climate-related studies emphasize the need to integrate renewable energy, agroforestry, and waste-to-energy systems to ensure agricultural sustainability (Singh, 2024).

While prior research has contributed significantly to understanding individual aspects of India's transformation, most studies address agriculture, infrastructure, and the digital

economy in isolation. There is a clear gap in comprehensive frameworks that analyze these domains in an integrated manner, particularly under the strategic lens of Amrit Kaal. This study addresses this gap by evaluating how private sector engagement, policy innovation, and technological modernization converge to support agricultural transformation within India's long-term development plan.

3. METHODS

This study employed a qualitative and conceptual research design, aiming to explore the structural transformation of the Indian agricultural sector within the framework of the Amrit Kaal development strategy. Rather than relying on primary data, the research is grounded in a critical synthesis of secondary sources, enabling a macro-level examination of policy directions, institutional frameworks, and sectoral trends.

The data were drawn from a wide range of secondary materials, including:

(i) Government reports and policy documents,
(ii) Budget statements and economic surveys,
(iii) Peer-reviewed journal articles and working papers,
(iv) Institutional publications from NITI Aayog and the Ministry of Agriculture,
(v) International databases and reports from multilateral agencies.

A literature triangulation approach was used to validate patterns and conclusions (Santos *et al*., 2020; Schlunegger *et al*., 2024; Pool *et al*., 2010; Gibson, 2017). This involved comparing findings across multiple sources to identify converging themes related to agricultural productivity, private sector investment, digital infrastructure, green energy adoption, and regulatory reform. Attention was also given to the temporal evolution of investment patterns and agricultural outputs, especially over the past seven decades, using macroeconomic indicators from national datasets.

The analytical framework used in this study is thematic and interpretive, focusing on how India's long-term growth strategy integrates agricultural modernization with cross-sectoral development. Key concepts such as inclusive development, energy transition, digital transformation, and public–private partnerships were used as thematic lenses through which the Amrit Kaal narrative was examined.

By relying on qualitative document analysis and policy synthesis, the study offers a comprehensive and multi-dimensional perspective on India's agricultural transition. Although the research does not involve empirical fieldwork or statistical modeling, it provides a robust conceptual foundation for future studies aiming to quantify policy impacts or develop sector-specific intervention models.

4. RESULTS AND DISCUSSION

4.1. Understanding the Growth Strategy

Over the last decade, the Government of India has introduced a wide range of policy changes that have collectively laid a strong foundation for consistent, moderate-to-high economic growth (Chandra & Rudra, 2015; Foot & Walter, 2013). These reforms (spanning infrastructure, digital transformation, social welfare, and financial inclusion) have not only strengthened macroeconomic fundamentals but also empowered citizens at the grassroots level (Djatmiko *et al*., 2025; Aluko *et al*., 2024). However, sustaining this momentum until 2047 and beyond, in line with the vision of Amrit Kaal, requires a growth model that is inclusive, resilient, and adaptive to both domestic challenges and global transitions.

To ensure long-term prosperity, reforms must be not only top-down but also bottom-up, emerging from the grassroots to address local needs while contributing to national goals

(Gargano, 2021). The Amrit Kaal framework emphasizes reforms that directly improve people's lives by enhancing productivity, creating opportunities, and fostering sustainable livelihoods (Singh, 2024). This vision is operationalized through an eight-pronged growth strategy, which serves as a roadmap for accelerating India's transformation. These eight pillars (**Figure 1**) include:

(i) Inclusive Development: ensuring that economic growth benefits all sections of society, particularly farmers, women, and marginalized groups.
(ii) Productivity Enhancement: driving innovation, technology adoption, and skill development to increase efficiency across sectors.
(iii) Energy Transition and Climate Action: promoting renewable energy, green growth, and sustainable agricultural practices to tackle climate challenges.
(iv) Infrastructure Development: building world-class physical and digital infrastructure to support urban and rural growth.
(v) Private Sector Participation: encouraging investment in critical sectors such as agribusiness, logistics, and green technologies.
(vi) Innovation and Digital Economy: harnessing technology-driven solutions to transform governance, markets, and service delivery.
(vii) Global Integration: positioning India as a competitive player in global trade, supply chains, and investment networks.
(viii) Good Governance: strengthening transparency, accountability, and efficiency in institutions to create a robust policy environment.

Together, these pillars represent a comprehensive reform agenda that balances economic growth with social equity, environmental sustainability, and institutional resilience (Singh, 2024). They underscore the importance of aligning national aspirations with grassroots empowerment, thereby enabling India to realize its vision of becoming a developed nation by 2047.

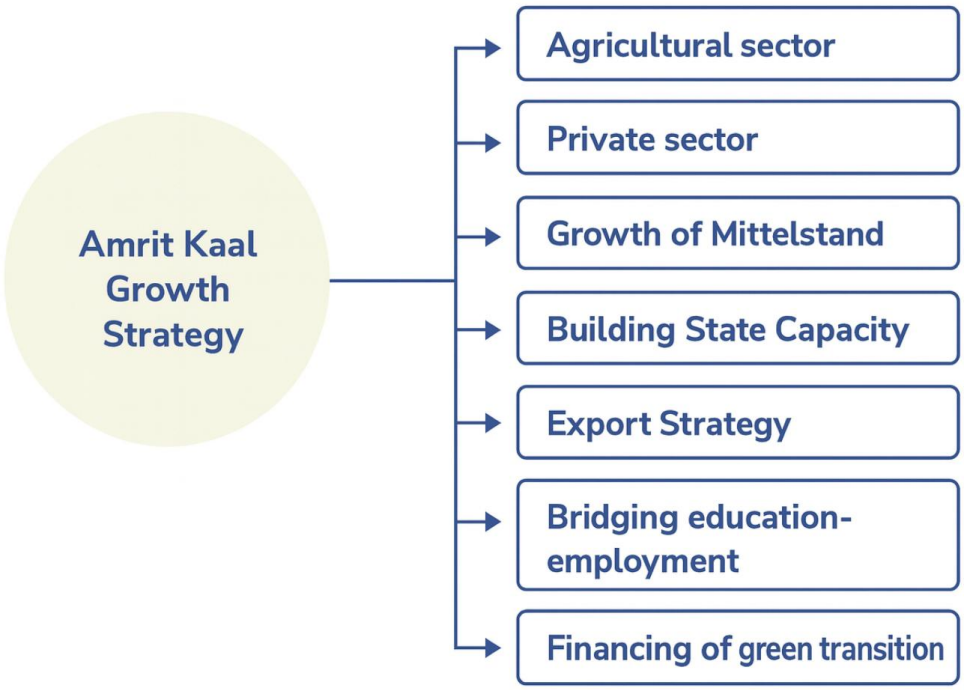

Figure 1. Strategic Pillars of the Amrit Kaal Growth Strategy, illustrating its core focus areas, including agriculture, private sector development, Mittelstand expansion, state capacity, export orientation, education-employment alignment, and green transition financing.

Global supply chains are thereby widening their growth opportunities. Strategic initiatives such as semiconductor manufacturing and high-value technology clusters further strengthen supply chains, reduce import dependence, and create spillover benefits for small and medium enterprises (SMEs) in related industries (Luo & Li, 2025). These initiatives not only generate business opportunities but also embed SMEs into India's broader vision of becoming a global manufacturing hub. Finally, SME growth depends not just on financial and policy support but also on entrepreneurial capacity building. Providing systematic training in business management, financial literacy, digital adoption, and innovation management equips entrepreneurs with the tools to increase productivity, scale sustainably, and compete internationally (Pansiri & Temtime, 2008).

Together, deregulation, institutional support, infrastructure upgrades, and capacity building form a comprehensive ecosystem for SME development, ensuring that the sector can fully contribute to India's economic transformation during the Amrit Kaal era.

4.2. The Export Strategy

An effective export strategy is fundamental for expanding India's manufacturing base and increasing its contribution to GDP. Strengthening exports not only enhances foreign exchange earnings but also creates employment, promotes innovation, and improves India's position in global supply chains (Prasanna, 2010). Within this framework, supporting India's Mittelstand (a network of highly specialized, innovation-driven small and medium enterprises (SMEs)) is crucial for long-term industrial competitiveness.

One of the flagship initiatives in this area is the Make in India Mittelstand (MIIM) program, launched in September 2015. This initiative encourages small and medium-sized German companies to invest, manufacture, and expand their operations in India. Since its inception, the MIIM program has successfully facilitated the entry of over 151 German companies, resulting in investments exceeding €1.4 billion. These investments have primarily strengthened strategic manufacturing sectors such as automotive components, industrial machinery, electrical and electronics, renewable energy, and environmental technologies (Valaskova *et al*., 2022).

In addition to foreign investment attraction, India's export strategy also includes efforts to diversify export destinations, reduce dependency on a single market (such as China), and leverage regional agreements. For example, India is increasingly strengthening trade relationships with ASEAN countries, the European Union, and Africa. Bilateral and multilateral agreements, trade facilitation programs, and logistics corridor development are central to these efforts.

Export-related infrastructure is also being modernized under the National Logistics Policy, PM Gati Shakti, and multi-modal connectivity projects, which aim to reduce turnaround time, improve last-mile delivery, and increase port efficiency. These infrastructure reforms are expected to make Indian goods more competitive in international markets, thereby encouraging higher export participation among both large firms and SMEs.

4.3. Bridging the Education-Employment Gap

The Amrit Kaal strategy acknowledges that economic transformation is not solely a function of capital or technology; it also requires a robust human capital base. One of the core challenges in India is the mismatch between educational outcomes and industry needs, often referred to as the education–employment gap.

The National Education Policy (NEP) 2020 and the National Policy on Skill Development and Entrepreneurship (NPSDE) aim to bridge this gap by aligning education with employability.

The NEP focuses on flexible learning pathways, vocational training, multidisciplinary education, and digital integration across school and higher education. Simultaneously, NPSDE promotes apprenticeships, micro-credentials, online certifications, and institutional-industry linkages.

Programs such as Skill India Digital, Pradhan Mantri Kaushal Vikas Yojana (PMKVY), and Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY) are part of a national skilling ecosystem that seeks to upskill youth, especially in rural and underserved regions. A special emphasis is placed on future-ready skills such as artificial intelligence, robotics, renewable energy management, and digital agriculture.

Importantly, bridging the education–employment divide also requires public-private-academia collaboration, with industry partners co-developing curriculum and providing real-world exposure. The use of technology platforms (such as National Digital Education Architecture (NDEAR) and Skill India Digital Portal) further supports lifelong learning and upskilling in a scalable manner.

By investing in education and skill development, India is creating a workforce that can meet the complex demands of Industry 4.0 and lead innovation in critical sectors like agriculture, green energy, and advanced manufacturing.

The evolution lies in building state capacity by balancing the strengths of generalist administrators from the civil service with the expertise of specialists drawn from academia, industry, and the private sector. The integration of these complementary skill sets can foster better policy design, more effective implementation, and evidence-based decision-making (Cairney & Oliver, 2017). Recent government reforms, particularly the introduction of lateral entry at senior levels, represent a step toward diversifying perspectives within policymaking institutions. Such measures are crucial not only to fill knowledge gaps but also to inject new energy and global best practices into governance.

Looking ahead, enhancing state capacity requires:

(i) Institutional reforms to improve efficiency, transparency, and accountability.
(ii) Capacity-building programs that equip civil servants with modern management, digital, and analytical skills.
(iii) Collaboration with the private sector and civil society to co-create solutions in areas like health, education, energy, and sustainability.

By modernizing governance structures and fostering cross-sectoral collaboration, India can ensure that its administrative machinery remains agile, resilient, and capable of delivering on the ambitious goals envisioned for the Amrit Kaal period (Yadav *et al*., 2024).

The strategy toward bridging the education-employment gap is focused on innovation within the state. The First and Second Administrative Reforms Commissions (ARC) highlighted several structural weaknesses that limited the effectiveness of India's civil services. Among these were departmental silos where programs were implemented in isolation, weak channels of communication, rigid information boundaries, and insufficient collaboration. These issues often resulted in duplication of efforts and inefficient allocation of resources.

Underlying these structural problems was an outdated human resource management system that constrained incentives, limited motivation, and provided few opportunities for skill development and mobility. The lack of a performance-based career trajectory further discouraged innovation and risk-taking among civil servants (Stone & Deadrick, 2015).

To address these challenges, the government launched the Mission Karmayogi, a comprehensive reform of bureaucratic training and governance. At its core, Mission Karmayogi seeks to shift the paradigm from rule-based to role-based governance by linking

training, performance, and career advancement. The platform iGOT Karmayogi (Integrated Government Online Training) facilitates continuous learning through digital content, simulations, case studies, and interactive modules.

By introducing a competency framework, the initiative promotes:

(i) Greater specialization in domains such as health, education, technology, and sustainability.
(ii) Data-driven performance management aligned with organizational goals.
(iii) Leadership development through mentoring and exposure to global best practices.

Mission Karmayogi's impact extends beyond individual capacity to institutional transformation. It envisions a new governance culture characterized by collaboration, innovation, and adaptability, positioning India's public administration as a strategic enabler of national development.

This renewed focus on building state capacity complements other elements of the Amrit Kaal strategy. As India transitions toward a knowledge economy, the role of government shifts from a provider to an enabler, facilitating market development, coordinating complex projects, and ensuring equitable service delivery across geographies.

The first phase (1950–51 to 1961–62) was marked by steady growth at an annual rate of 2.77%, largely driven by the expansion of cultivated land. However, this growth was not sustainable, and the second phase (1961–62 to 1967–68) witnessed a slowdown due to food shortages, population pressure, and limited technological advancement.

A turning point came with the Green Revolution, initiated in 1966, which brought high-yielding varieties of wheat and rice, improved irrigation, and greater use of fertilizers. During the third phase (1967–68 to 1975–76), agricultural output grew at 2.27% annually, though the benefits were concentrated in resource-rich and well-irrigated regions such as Punjab, Haryana, and Western Uttar Pradesh.

In the fourth phase (1975–76 to 1979–80), agricultural output actually declined, reflecting the regional disparities and environmental limitations of the Green Revolution model. The fifth phase (1980–81 to 1990–91) saw diversification in agricultural output, with an increase in horticulture, livestock, and fisheries. However, productivity improvements remained modest.

The sixth phase (1991–92 to 2004–05), following economic liberalization, led to the globalization of Indian agriculture. Trade openness, better price discovery, and improved access to inputs helped some farmers, but also exposed them to market volatility and international price shocks.

The most recent phase (2005–06 onwards) has seen the emergence of technology-driven agriculture, supported by digital platforms, precision farming, and agri-tech startups. However, challenges persist in terms of access to credit, land fragmentation, declining soil fertility, and water stress.

These trends underscore the need for a next-generation agricultural strategy, one that balances food security with ecological sustainability and economic resilience. Key elements of this strategy include:

(i) Shifting from input-intensive to knowledge-intensive agriculture,
(ii) Promoting bio-based industries, including ethanol and compressed biogas (CBG),
(iii) Strengthening farmer cooperatives and producer companies,
(iv) Encouraging agroforestry and carbon farming as tools for climate adaptation.

The future of Indian agriculture depends on making farms more like "factories in the fields", where productivity is maximized not just through land use but through value-added processing, efficient logistics, and integration with downstream industries. This demands

seamless coordination between government policy, private investment, academic research, and farmer participation.

5. CONCLUSION

This study examined the transformative potential of India's Amrit Kaal strategy in reshaping the agricultural sector through private sector participation, technological modernization, and cross-sectoral policy integration. The findings reveal that agriculture must transition from a subsistence-based model to a productivity- and value-driven system that aligns with national priorities such as inclusive development, sustainability, and global competitiveness. The eight-pronged growth strategy (comprising infrastructure development, digital transformation, energy transition, and SME support) presents a comprehensive roadmap for revitalizing agriculture. Programs like Mission Karmayogi, Skill India Digital, and Make in India Mittelstand offer critical institutional and human capital support, while export diversification and renewable energy investments contribute to long-term resilience. However, unlocking the full potential of these reforms requires policy coherence, regulatory simplification, and sustained investment in innovation ecosystems. Public–private partnerships, agro-industrial clusters, and climate-smart agriculture should be prioritized to ensure inclusive rural transformation. Amrit Kaal provides a timely opportunity to reposition agriculture as a strategic pillar of India's development. A holistic, well-governed, and participatory approach is essential to achieving the vision of Viksit Bharat @2047 and meeting the Sustainable Development Goals (SDGs).

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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