

# Artificial Intelligence and the Transformation of Sustainable Rural Consumers' Buying Behaviour: A Study in Andhra Pradesh, India

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## Abstract

*Artificial Intelligence (AI) can play a major role in transforming sustainable consumption in rural India, with Andhra Pradesh offering an important example. While the state has advanced digital initiatives at the policy level, many rural communities still struggle with limited digital literacy, low access to devices, and socio-economic barriers. This creates a paradox: strong readiness on paper, but real challenges on the ground. At the same time, AI in agriculture is already showing promise by helping farmers cut costs, reduce risks, and adopt sustainable practices naturally. However, a fully digital e-commerce model may not work in such settings; instead, a hybrid approach that combines AI with human networks is more effective.*

*The study underscores that purely digital models, such as e-commerce platforms, are less effective in rural contexts. More viable outcomes emerge from hybrid approaches that integrate AI technologies with local human networks. Ethical concerns, particularly data privacy and algorithmic bias, are more pronounced in rural areas where social and economic inequalities already exist. To overcome these challenges, policymakers must prioritize closing the digital divide through improved infrastructure and targeted training initiatives. At the same time, businesses should design AI solutions that address genuine rural needs and deliver clear, tangible value to consumers. Sustainability must be embedded into these solutions from the outset rather than treated as an afterthought. Ultimately, meaningful success depends on deploying AI in a deliberate, strategic, and people-centric manner.*

**Keywords:** Artificial Intelligence (AI), Transformation, Sustainability, and Rural Consumers' Buying Behaviour

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# 1. Introduction: The Link between AI, Sustainability, and Rural Transformation

## 1.1 Understanding the Key Ideas

Today, discussions about development often focus on how technology and sustainability work together. At the heart of this connection is Artificial Intelligence (AI), which can serve several vital roles. These roles are mentioned below:

AI can swiftly analyse and connect large amounts of data to spot new opportunities, such as emerging market trends or potential collaborations.

It can transform raw data into meaningful insights, helping managers and planners make informed and effective decisions.

AI can simulate strategies and “what-if” scenarios, aiding in testing options, reducing human errors, and identifying risks before execution.

It can create and adapt messages for different stakeholder groups, ensuring communication remains clear, consistent, and relevant.

AI goes beyond simple utility; it guides research, strengthens decisions, and disseminates knowledge to make development more impactful and sustainable.

In rural India, sustainable consumption extends beyond buying “green” items. It involves adopting methods that are financially sound, environmentally safe, and socially uplifting. For instance, biofertilizers offer a cleaner alternative to chemicals and support programmes like Community Managed Sustainable Agriculture (CMSA). CMSA is grassroots, collective agricultural approach that champions eco-friendly, affordable, and resilient farming practices. It focuses on reducing chemical dependence and improving farmers’ skills, autonomy, and income through shared efforts. These practices don’t just cut ties to expensive synthetics; they help farmers avoid debt traps while maintaining or increasing harvest productivity.

Alongside this is understanding rural consumer habits, shaped by wealth, access to data, and most importantly, trust in a product’s usefulness. Rural buyers, often managing small plots and modest budgets, are highly cost-conscious and bene-

fit-oriented. For them, a product's value isn't just in marketing but in its ability to deliver real outcomes, ensure financial returns, and solve the practical challenges of daily life.

## 1.2 A Glimpse into Andhra Pradesh

Andhra Pradesh serves as a strong case study for examining the role of Artificial Intelligence in driving sustainable rural transformation. Andhra Pradesh is referred to as the "Sunrise State" due to its renewed growth, development potential, and forward-looking vision, especially after Bifurcation from Telangana in 2014 (source of information). It has actively created a favourable environment for the IT business and digital growth. The Department of Information Technology, Electronics & Communications (ITE&C) leads this mission by applying AI in governance through tools such as real-time dashboards and predictive service delivery.

A landmark initiative is the Memorandum of Understanding (MoU) signed with the Tech Bharat Foundation to establish India's first AI Centre of Excellence (CoE) for Public Good in Visakhapatnam.

This Centre of Excellence (CoE) is envisioned as a national hub for innovation, focused on the co-development of AI tools for government-to-citizen (G2C) services and the generation of policy insights through a dedicated AI Fellowship Programme.

Such top-down initiatives highlight Andhra Pradesh's strategic commitment to AI, making the state a vital testing ground for understanding how digital policies can influence consumer behaviour at the grassroots level.

## 2. Objectives and Methodology

The Objective of this report is to present a comprehensive, data-driven examination of the relationship between Artificial Intelligence (AI), sustainability, and rural consumer buying behaviour in Andhra Pradesh. Specifically, the report aims to:

- Assess the socio-economic and digital landscape of the state.
- Examine the current application of AI in promoting sustainable consump-

tion practices.

- Identify the infrastructural, economic, and ethical challenges that hinder inclusive adoption of AI.

The methodology adopts a multi-source approach, drawing on academic literature, government policy documents, and industry reports. By integrating quantitative data with qualitative case studies, the study offers a balanced and in-depth perspective that captures both macro-level trends and grassroots realities.

### 3. The Socio-Economic and Digital Landscape of Rural Andhra Pradesh

#### 3.1 The Rural Consumer Profile

Rural Andhra Pradesh presents a classic paradox. On one hand, it has a large rural population—about 62.31% of the state’s total—with an economy still heavily dependent on agriculture. Between 60% and 62.17% of the workforce is engaged in farming and related activities, making the sector the backbone of rural livelihoods. This creates enormous potential for introducing sustainable products and services, especially in agriculture (source....?).

On the other hand, significant barriers remain. A majority of farmers are marginal or small-scale landholders, with a study in Guntur district revealing that 65% fall into this category. Limited land size translates into high financial pressure, which makes rural consumers extremely price-sensitive and value-conscious. They are cautious about adopting new technologies or sustainable products unless there is clear and immediate evidence of economic benefit.

The main obstacles are a lack of availability, limited awareness, and, most importantly, doubts about product effectiveness. These findings highlight that the challenge goes beyond information gaps—it is fundamentally about building trust. For AI-driven solutions to succeed in this context, they must do more than market products; they must demonstrate tangible, short-term economic value to overcome both the trust deficit and financial constraints of rural consumers.

#### Table 1: Socio-economic and Digital Indicators for Andhra Pradesh

S.no	Indicator	Metric
1	Rural Population	62.31% of total population
2	Workforce in Agriculture	60-62.17% of total workforce
3	Rural Wireless Tele-density	58.48%
4	Rural Internet Penetration	44.85% (India average)
5	Rural Computer Literacy	1.5%

Source: [https://eacpm.gov.in/wpcontent/uploads/2022/12/Social\\_Progress\\_Index\\_States\\_and\\_Districts\\_of\\_India.pdf](https://eacpm.gov.in/wpcontent/uploads/2022/12/Social_Progress_Index_States_and_Districts_of_India.pdf)

### 3.2 Digital Infrastructure and the Urban-Rural Divide

Andhra Pradesh's digital profile reveals a striking gap between macro-level ambition and micro-level reality. As per TRAI published on 24<sup>th</sup> April 2025, at the state level, Andhra Pradesh boasts one of the highest numbers of internet connections in India, second only to Maharashtra when combined with Telangana. Rural tele-density stands at 58.48%, reflecting a broad connectivity infrastructure. This digital readiness underpins the government's vision of "intelligent, inclusive, and iterative governance," showcased through initiatives like the newly launched AI Centre of Excellence.

Yet, these achievements mask a persistent digital divide. Studies show that only 1.5% of the rural population can operate a computer, compared to 11.6% in urban areas. Internet access is similarly uneven—just 10.5% of rural residents have access, against 29.5% in urban centres. Such disparities highlight a central paradox: while state-level infrastructure is strong, rural communities remain excluded due to low digital literacy and limited access to devices.

This imbalance makes it clear that top-down, tech-centric policies alone are insufficient. To bridge the gap, Andhra Pradesh must pair its infrastructure investments with capacity-building efforts, including localized, user-friendly digital platforms and large-scale digital literacy programs. Only by investing equally in human

capital can the state's vision of a digitally transformed and inclusive society truly materialize for rural citizens.

## **4. AI as a Catalyst for Sustainable Consumerism: Bridging the Gap from Awareness to Action**

### **4.1. The Agri-Tech Revolution: From Inputs to Insights**

The the low adoption of sustainable products in rural communities is often rooted in scepticism, risk-aversion, and the absence of immediate, visible proof of value. For small and marginal farmers, every purchase must translate into a tangible return. Artificial Intelligence (AI) has the potential to transform this dynamic—shifting the consumer journey from a “push” model of externally marketed products to a “pull” model where demand arises naturally from data-backed evidence of efficacy. In this sense, AI does not just encourage sustainability; it embeds it into the very logic of profitability and efficiency.

This transformation is already visible in the Agri-tech sector of Andhra Pradesh. A notable example comes from a pilot project by Farmonaut, which employs AI and remote sensing to provide early pest detection for rice farmers. By analysing satellite imagery, AI algorithms can predict potential pest outbreaks up to 10 days earlier than conventional practices. Farmers gain a critical head start, enabling proactive intervention, reducing crop losses, and, importantly, cutting down the dependence on chemical pesticides. Here, sustainability is not imposed but rather emerges naturally as an outcome of improved yield security and profitability.

Another successful case is the Hewlett Packard Enterprise (HPE) initiative in Chittoor district, which combined AI with Internet of Things (IoT) sensors to provide farmers with real-time insights into soil health, water availability, and weather fluctuations. With these data-driven decisions, farmers achieved nearly 40% water savings, demonstrating how precision agriculture not only reduces costs but also fosters environmental responsibility.

At the grassroots level, local innovations amplify this story. In Parvathi Puram-Manyam district, Gembali Gowtham, a young data science graduate, has developed affordable, small-scale technologies such as a mini solar-powered water pump and a millet dehuller. These tools reduce both the financial burden and physical strain on small and tribal farmers, while promoting energy efficiency and

crop diversification. Unlike abstract sustainability campaigns, such innovations solve immediate, practical challenges, ensuring adoption is both logical and desirable.

Together, these cases illustrate that AI's greatest contribution in rural India is not in persuading consumers to adopt sustainable practices but in making sustainability the most rational and profitable choice. By embedding environmental benefits into economic gains, AI can accelerate the shift from awareness to action in rural consumer behaviour.

## 4.2. E-Commerce and the Rise of the Hybrid Model

The expansion of e-commerce in India has been both rapid and extensive, with online retail penetration now covering nearly 100% of the country's pin codes. Importantly, a growing share of orders originates from Tier-2, Tier-3, and Tier-4 towns, reflecting the increasing integration of rural and semi-urban consumers into the digital marketplace. *As per Press Information Bureau Govt. of India did, 4<sup>th</sup> Jan 2024*, Initiatives such as the Open Network for Digital Commerce (ONDC) seek to democratize this ecosystem by enabling small retailers and local businesses to participate on equal footing with larger players. At the heart of this transformation lies Artificial Intelligence (AI), which drives key functionalities such as personalized product recommendations, demand forecasting, dynamic pricing, and supply chain optimization.

Yet, despite this momentum, a digital-first e-commerce model remains problematic in rural Andhra Pradesh and similar contexts. Barriers such as low digital literacy, language diversity, patchy infrastructure, and consumer mistrust of online platforms prevent full-scale adoption. The challenge is not simply technological but socio-cultural: rural buyers often value personal interactions, trust-based transactions, and cash-based systems over abstract digital interfaces.

This reality has given rise to a hybrid model that blends the efficiency of AI-driven insights with the credibility of human intermediaries. *As per moneycontrol.com published on 20<sup>th</sup> feb 2025*, A notable example is Hindustan Unilever's (HUL) "Shikhar" app, which equips rural sales representatives with AI-powered data on real-time inventory levels, consumer preferences, and purchasing patterns. Instead of replacing the human element, AI strengthens it—allowing the trusted

local sales agent to engage more effectively with consumers.

Such a model resolves two critical gaps simultaneously:

1. Trust Deficit – By retaining human intermediaries, the model ensures continuity in personal, relationship-driven selling.
2. Efficiency Deficit – By providing data-backed insights, AI enables sales agents to match supply with demand more accurately, reduce stockouts, and customize offerings.

This human–AI collaboration is particularly well-suited to rural contexts, where cultural norms favour face-to-face interaction but efficiency requires data-driven intelligence. Rather than bypassing existing social and commercial networks, the hybrid model augments them, creating a pathway for gradual and organic transformation of rural consumer behaviour.

**Table 2: AI Applications and their Impact on Rural Consumer Buying Behaviour**

AI Application	Corresponding Technology	Impact on Consumer	Link to Sustainable Behaviour
Precision Agriculture	Remote Sensing, IoT, Predictive Analytics	Reduces input costs, increases yield, provides tangible value	Less pesticide use, less water consumption, decreased soil degradation
Hybrid E-commerce Model	AI-powered sales apps, demand forecasting, supply chain optimization	Provides access to a diverse range of products, increases trust, offers competitive pricing	Promotes local, sustainable products by making their supply chain more efficient and visible
Community-Empowering Tech	Eco-friendly electric tools (solar pumps, dehullers)	Reduces labour and physical strain, lowers operational costs, increases income	Promotes adoption of sustainable, low-impact farming practices
Personalized Recommendations	Machine Learning, Data Analytics	Curates relevant products, enhances satisfaction	Guides consumers toward eco-friendly products and sustainable travel option

**Source:** <https://epale.ec.europa.eu/en/blog/role-artificial-intelligence-rural-development-human-centered-approach>

## 5. Challenges and Barriers to Inclusive AI Adoption: An Ethical and Infrastructural Deep Dive

### 5.1. The Infrastructural and Economic Hurdles

The adoption of AI in rural Andhra Pradesh is constrained by persistent infrastructural and economic limitations. As highlighted earlier, only a small proportion of rural households have access to broadband internet, in stark contrast to their urban counterparts. This digital gap undermines the deployment of cloud-based services, IoT-enabled devices, and real-time AI applications, which rely on consistent connectivity.

The challenge is further compounded by unreliable electricity supply. Frequent power cuts reduce the functionality and dependability of AI-driven equipment, particularly in sectors such as precision agriculture and digital financial services, where uninterrupted data flow is critical.

Equally pressing is the economic barrier. For the majority of smallholder farmers and rural entrepreneurs, the upfront investment required for smartphones, sensors, computers, and IoT devices remains prohibitively high. Even when affordable alternatives exist, the long-term maintenance costs and risks associated with adopting unproven technologies exacerbate the hesitation. Without financial support mechanisms—such as government subsidies, microfinance loans, or targeted incentives—the initial entry cost will remain a formidable barrier to inclusive AI adoption.

### 5.2. Human-Centric Barriers

While infrastructure forms the backbone, the human dimension determines whether AI can be successfully integrated into rural life. Low digital literacy levels remain one of the most significant obstacles: most rural residents lack the technical know-how to navigate digital platforms, interpret AI-generated insights, or troubleshoot errors. This often results in underutilization or abandonment of new tools, even when infrastructure is available.

Language and dialect diversity further complicates adoption. Andhra Pradesh, though linguistically dominated by Telugu, has numerous regional dialects and minority languages. AI interfaces that are not sufficiently localized risk alienating

end users or creating misunderstandings.

Finally, there exists a cultural resistance and scepticism toward new technologies. For many rural consumers, AI-driven solutions appear abstract and detached from traditional practices. This mistrust is heightened by past experiences with failed government schemes, ineffective products, or exploitative market interventions. Consequently, even when potential benefits are evident, adoption is often slow, cautious, and heavily reliant on trusted community intermediaries such as local cooperatives, sales agents, or peer networks.

Together, these infrastructural and human-centric barriers highlight that inclusive AI adoption is not simply a technological challenge, but a socio-economic and cultural one. Overcoming them requires holistic strategies that integrate infrastructure development, financial inclusion, capacity building, and trust cultivation.

### 5.3. Ethical Implications: Amplification of Risk in Rural Contexts

The ethical concerns surrounding Artificial Intelligence—data privacy, algorithmic bias, and job displacement—are widely acknowledged in global discourse. Yet, in the rural Indian context, these challenges are not merely replicated but intensified due to pre-existing socio-economic inequalities, low digital literacy, and limited regulatory oversight.

A critical issue is data privacy. In rural areas, awareness of data rights is minimal, and consent is often neither informed nor voluntary. Farmers and small entrepreneurs may share personal information, financial records, or even biometric data without fully understanding the risks of surveillance, data misuse, or identity theft. The absence of robust cybersecurity frameworks in rural digital ecosystems further exacerbates this vulnerability, exposing individuals to risks that extend far beyond their immediate context.

Algorithmic bias represents a significant ethical concern in AI deployment. Models trained predominantly on urban-centric or globally sourced datasets risk embedding systemic biases that inadequately reflect rural realities, potentially producing unintended discriminatory outcomes:

- **Dynamic pricing systems** may inadvertently charge higher prices to rural

consumers by relying on geographic or socio-economic proxies.

- **Recommendation algorithms** could prioritize mainstream, mass-market products while underrepresenting local, sustainable, or artisanal goods, thereby undermining rural economies and cultural heritage.
- **AI-enabled credit scoring models** may fail to account for informal financial histories common among farmers, restricting access to affordable credit and financial inclusion.

Such biases do not occur in isolation but reinforce structural inequities, leaving rural populations more exposed to exploitation than their urban counterparts.

Moreover, the issue of job displacement cannot be overlooked. While AI may increase efficiency in agriculture, logistics, and retail, it also risks reducing the need for traditional labour roles, such as local middlemen, manual workers, or sales agents, who serve as critical links in rural supply chains. In contexts where alternative employment opportunities are scarce, the social cost of automation can be severe.

The strategy emphasises core principles such as fairness, accountability, transparency, inclusivity, and non-discrimination as foundational to responsible AI governance. In parallel, emerging draft regulatory discussions have proposed greater algorithmic transparency for digital and e-commerce platforms, with the objective of mitigating *digitally induced biases* and information asymmetries.

However, these interventions remain at a nascent stage, and their practical enforcement and contextual adaptation are still evolving. In the absence of context-sensitive ethical safeguards, there is a risk that rural communities may become passive recipients of AI-driven systems, rather than active participants and beneficiaries in the digital transformation process.

Ultimately, the ethical challenge is not purely technical but socio-technical: ensuring that AI systems are designed, implemented, and governed in ways that protect vulnerable populations while promoting inclusivity and equity. Addressing these risks requires embedding ethics into the design phase, rather than treating them as afterthoughts.

**Table 3: Key Barriers to AI Adoption and Proposed Mitigation Strategies**

Barrier	Associated Challenge	Proposed Mitigation Strategy
Infrastructural	Limited internet access, inadequate power supply, high hardware costs	Invest in subsidized hardware, expand public Wi-Fi hotspots, leverage community-level infrastructure (e.g., kiosks, community hubs)
Human-Centric	Low digital literacy, language barriers, cultural resistance	Implement targeted, community-based digital literacy programs in local languages, use voice-enabled interfaces and culturally sensitive designs
Ethical	Data privacy risks, algorithmic bias, lack of transparency	Embed ethical frameworks from the design phase, establish external oversight bodies, enforce policies on algorithm disclosure, and prioritize informed consent
Economic	High initial costs, consumer price-sensitivity	Offer subsidies and tax incentives for ethical and sustainable AI adoption, design solutions that offer clear, quantifiable economic value

## 6. Strategic Recommendations and a Forward-Looking Vision

### 6.1. Recommendations for Policy and Governance

To foster inclusive and sustainable AI adoption in rural Andhra Pradesh, policy frameworks must evolve from infrastructure-building alone to holistic digital empowerment. While broadband expansion, affordable devices, and reliable electricity remain critical, these efforts must be accompanied by localized digital literacy initiatives. Programs should be delivered in regional languages and facilitated through community-level engagement channels, such as self-help groups (SHGs), farmer cooperatives, and village knowledge centres.

This dual strategy ensures that rural populations not only gain access to digital platforms but are also equipped to navigate and trust them effectively.

The Andhra Pradesh government should further institutionalize ethical AI governance. The establishment of the AI Centre of Excellence (CoE) in Visakhapatnam offers a unique opportunity. This hub can serve as an “AI for Good” incubator, where models are developed and piloted with built-in safeguards around data privacy, algorithmic fairness, and cultural inclusivity. By introducing tax incentives, subsidies, or priority procurement benefits for firms that meet these ethical AI standards, the state can encourage responsible innovation and position itself as a

national leader in socially conscious technology deployment.

According to the NITI Aayog Roadmap on AI Development (September 2025), multi-stakeholder collaboration is essential for the responsible deployment of AI in rural contexts. The report emphasizes that governments, academic institutions, civil society, and private sector actors should engage through public-private partnerships (PPPs) to co-develop AI solutions tailored to rural challenges, including sustainable agriculture, healthcare delivery, and supply chain resilience. Furthermore, the roadmap underscores the importance of transparent oversight mechanisms and participatory policy-making, actively involving rural communities to ensure that AI adoption is both legitimate and inclusive, fostering equitable access and socio-technical empowerment rather than passive reception.

## **6.2. Recommendations for Commercial Strategy**

For businesses and organizations, succeeding in rural Andhra Pradesh requires rethinking AI as an enabler, not a replacement. Instead of bypassing local networks, companies should augment them with AI-powered insights, creating a hybrid model where human trust and community presence remain central. For example, rural sales representatives or farmer advisors equipped with AI-driven apps can provide personalized recommendations, manage inventory efficiently, and forecast demand with greater accuracy. This approach simultaneously builds trust and enhances productivity.

Commercial innovation must be value-first and problem-oriented. AI solutions will gain adoption only if they provide clear, tangible benefits such as higher yields, reduced costs, or improved market access. Successful case studies already exist—Farmout’s pest detection system has demonstrated ROI through reduced crop losses, while inventor-led tools like Gembali Gowtham’s low-cost devices cut labour and operational expenses for smallholder farmers. Embedding sustainability as a co-benefit of economic efficiency ensures that adoption is not just technologically feasible but also socially desirable.

Businesses must also prioritize localization and cultural sensitivity. This means training algorithms on diverse, region-specific datasets that reflect Andhra

Pradesh's linguistic plurality, agricultural diversity, and cultural practices. Without such contextualization, AI risks alienating the very communities it seeks to serve. Moreover, companies should adopt a co-creation approach, engaging rural consumers directly in the design and testing phases to ensure usability, trust, and long-term adoption.

### **6.3. The Future Outlook**

Andhra Pradesh demonstrates significant potential to emerge as a pioneer in AI-enabled rural transformation in India, supported by a convergence of strategic vision, expanding digital infrastructure, and increasing momentum in digital adoption. The alignment of proactive government interventions, private sector innovation, and growing rural connectivity creates favourable conditions for scaling sustainable and inclusive consumption models in rural economies.

Nevertheless, the sustainability of this trajectory depends on the extent to which AI deployment is embedded within a broader socio-technical framework. Technological advancement alone is insufficient; AI must be operationalised as a tool for empowerment, capability enhancement, and participatory inclusion, rather than labour displacement or social exclusion. Addressing challenges related to digital literacy, algorithmic bias, data governance, and trust formation will be central to ensuring equitable outcomes.

If effectively implemented, Andhra Pradesh's approach could generate transformative impacts on its rural economy while offering a transferable model for inclusive AI adoption. Such a model holds relevance not only for other Indian states but also for developing economies seeking to reconcile technological progress with social development. The ultimate objective extends beyond efficiency-driven consumption toward human-centred, sustainable consumption systems that integrate innovation with equity and long-term resilience.

## **7. Conclusion**

Artificial Intelligence (AI) has the potential to significantly transform sustainable rural consumer buying behaviour in Andhra Pradesh by delivering economic value, enhancing access to information, and fostering more sustainable choices. The

state's forward-looking policies, welfare initiatives, and the establishment of an AI Centre of Excellence in Visakhapatnam provide a strong institutional framework to harness this potential.

However, realizing this transformation is not automatic. Structural barriers—such as limited digital literacy, poor infrastructure, and socio-economic inequalities—pose major challenges, alongside ethical risks like algorithmic bias and data misuse. A human-centric, socio-technical approach that embeds fairness, transparency, and accountability is essential. By combining technology with cultural sensitivity, ethical governance, and community empowerment, Andhra Pradesh can set a global example of how AI can drive inclusive and sustainable rural development.

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