Digital Transformation in Agriculture Marketing Study of Changing Market Practices and Farmers Behaviour

Pavan N. Chaudhari ,
Author 1 - PG student – Department of Business Administration, SIPNA C.O.E.T., Amravati, Maharashtra, India.

Abstract
Agricultural marketing in India has traditionally been characterized by physical mandis, multiple intermediaries, and limited price transparency, which often reduced farmers' share in the final consumer price. In recent years, digital transformation—driven by government initiatives such as e-NAM and Digital India, along with the emergence of agritech platforms—has begun to reshape agricultural marketing systems. However, the adoption of digital platforms remains uneven, largely due to behavioural, socio-economic, and infrastructural constraints.The present study examines the impact of digital transformation on agricultural marketing practices and analyses the behavioural responses of farmers in Yavatmal district of Maharashtra. A mixed-method research design was adopted using primary data collected from 150 farmers through structured questionnaires, personal interviews, and focus group discussions. Descriptive statistics, correlation analysis, and hypothesis testing were employed to analyze the data.The findings reveal that digital platforms have improved price transparency, market access, and transaction efficiency for farmers who adopted them. Education level, digital literacy, and trust in online systems emerged as significant determinants of digital adoption. However, challenges such as poor internet connectivity, fear of digital fraud, and low awareness continue to hinder widespread adoption, particularly among small and marginal farmers. The study highlights the need for targeted policy interventions, digital capacity-building programs, and farmer-centric platform design to ensure inclusive and sustainable digital transformation in agricultural marketing.

Keywords
Digital Transformation, Agricultural Marketing, Farmer Behaviour, e-NAM, Digital Adoption, Indiaold, Investment Preferences, Comparative Analysis, Investor Behavior, Risk Perception.

I.Introduction

Agriculture has historically been the backbone of the Indian economy, supporting rural livelihoods, food security, and employment for a majority of the population. Despite its importance, agricultural marketing in India has long remained inefficient due to excessive dependence on intermediaries, lack of transparency, price manipulation, delayed payments, and weak bargaining power of farmers. Traditional mandi-based systems under the APMC framework, although designed to protect farmers, often restricted competition and limited farmers' access to wider markets. These structural weaknesses highlighted the urgent need for reforms in agricultural marketing.

Over the past two decades, rapid advancements in digital technologies—such as the expansion of internet connectivity, smartphone usage, and government-led digital initiatives—have triggered a gradual transformation in the agricultural sector. Digital transformation in agricultural marketing refers not only to the adoption of information and communication technologies (ICTs), online trading platforms, mobile applications, and digital payment systems, but also to the accompanying changes in farmers' decision-making behavior, risk perception, and market participation. Initiatives like Digital India, e-NAM, Digital Agri Mission, and Direct Benefit Transfer (DBT) have played a crucial role in promoting transparency, price discovery, and market integration.

The emergence of agritech startups such as DeHaat, Ninjacart, AgriBazaar, and BigHaat has further strengthened digital market linkages by enabling direct farmer-to-buyer connections, advisory services, and efficient supply chain management. As a result, digital adoption among Indian farmers has increased significantly, especially after the COVID-19 pandemic, which acted as a catalyst by disrupting physical markets and forcing farmers to explore digital alternatives. However, this transformation remains uneven across regions and farmer categories.

A significant challenge lies in the digital divide prevalent in rural India. Limited internet connectivity, low smartphone ownership, poor digital literacy, and unreliable electricity infrastructure restrict widespread adoption, particularly among small and marginal farmers. Behavioral barriers such as resistance to change, lack of trust in online payments, preference for traditional intermediaries, and fear of financial loss further constrain digital participation. While large and educated farmers show higher adoption rates, marginal and illiterate farmers continue to remain digitally excluded, reinforcing inequalities within the agricultural marketing system.

The agricultural marketing sector in India consists of multiple layers, including village-level markets, regulated APMC mandis, and terminal or export markets, supported by government institutions, cooperatives, farmer producer organizations (FPOs), and private agritech enterprises. Although digital initiatives have introduced efficiency, transparency, and data-driven decision-making, issues such as institutional resistance, regulatory fragmentation, low user retention of agri-apps, and lack of behavioral adaptation persist.

The need for this study arises from the limited focus on the behavioral dimension of digital transformation. Most existing research emphasizes technological performance and economic outcomes, while farmers' perceptions, motivations, trust, and decision-making processes remain underexplored. Understanding these behavioral aspects is essential for designing inclusive digital policies, improving farmer engagement, and ensuring sustainable adoption of digital platforms.

This study is significant for farmers, policymakers, agribusiness firms, and researchers alike. It provides insights into the human factors influencing digital adoption, supports evidence-based policymaking, helps agritech firms design farmer-centric solutions, and contributes academically by integrating behavioral theories with digital transformation in agriculture. Ultimately, the success of India's digital agricultural marketing ecosystem depends on aligning technological innovation with behavioral readiness and socio-economic realities.

II. Literature Review

The reviewed literature from 2020 to 2025 provides comprehensive evidence on how digital transformation has reshaped agricultural marketing systems in India. Early studies, such as **Adhikari and Roy (2020),** established that digital platforms significantly enhanced marketing efficiency by reducing transaction time and narrowing price spreads within APMC-based markets. Similarly, **Chatterjee and Gupta (2020)** emphasized that farmers' adoption of e-agriculture platforms was strongly influenced by digital literacy, perceived usefulness, trust, and social influence, indicating that behavioral factors played a crucial role alongside technological availability.

Subsequent research expanded the focus beyond mandis to entire agri-supply chains. **Kumar and Jain (2021)** demonstrated that digital interventions reduced intermediaries, improved transparency, and increased farmers' share in final prices. **Sharma and Mehta (2021)** further highlighted the importance of institutional linkage, revealing that farmers in e-NAM-connected regions exhibited higher awareness and willingness to engage in digital marketing. **Patel and Shah (2021)** reinforced these findings by showing that smartphone ownership, digital literacy training, and extension support significantly increased the likelihood of mobile-based marketing app adoption.

Technological diversification emerged as a major theme in later studies. **Das and Kar (2022)** documented the role of blockchain in improving traceability, trust, and price realization by reducing intermediaries. Comparative studies by **Ahmed and Chowdhury (2022)** revealed that while India demonstrated broader platform diversity, adoption patterns were shaped by institutional and cooperative support structures. Policy-focused research by **Meena and Kaur (2022)** underscored the critical role of government initiatives such as e-NAM, PM-KISAN, and rural broadband in building a national digital agricultural ecosystem.

Post-COVID studies highlighted acceleration in digital adoption. **Kumar and Singh (2023)** found that pandemic-induced disruptions acted as a catalyst for mobile-based marketing, online payments, and informal digital networks like WhatsApp groups. **Bose and Khan (2023)** showed that social media platforms significantly influenced farmers' marketing behavior through peer learning and information sharing. More recent studies integrated sustainability and advanced technologies into the discourse. **Das and Mitra (2024)** linked digital platforms with environmental sustainability, while Bhatia and Jain (2024) demonstrated the efficiency gains from AI-driven market tools.

Behavioral and inclusivity dimensions dominated the most recent literature. **Roy and Banerjee (2024), Frederich and Mathew (2025),** and **Iyer and Kulkarni (2025)** collectively emphasized trust, risk

perception, peer influence, and digital literacy as decisive factors shaping farmers' behavioral change. Studies by **Singh and Meena (2025)** and **Gupta and Shetty (2025)** concluded that digital transformation significantly enhanced market inclusivity, income diversification, and resilience, particularly for small and marginal farmers. Overall, the literature confirms that digital transformation in Indian agricultural marketing is not merely technological but socio-institutional and behavioral, requiring integrated policy, infrastructure, and capacity-building support.

Ill. Problem Statement

India's agricultural marketing system has witnessed a shift from traditional face-to-face transactions to digitally mediated platforms like e-NAM, AgriBazaar, and mobile-based trading apps.While digitalization promises transparency and efficiency, adoption remains uneven due to barriers such as poor digital literacy, unreliable internet access, and mistrust in online systems. Hence, the core problem identified for this study was:"To examine how digital transformation has impacted agricultural marketing practices and to analyze the behavioral responses of farmers toward digital adoption in India."

IV. Objectives Of Study

1.To assess the level and extent of digital transformation In agriculture marketing across selected Indian state.

2. To examine the behavioral changes among farmers regarding the use of digital platforms for marketing and price discovery.

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3. To identify the socio-economic factors influencing digital adoption among Indian farmers

4. To evaluate the benefits and challenges associated with digital agricultural marketing.

5. To suggest policy recommendations and capacity-building strategies to enhance digital participation in agricultural marketing

Sr no.	Tlukas	No. Of Farmers
1.	Yavatmal	5
2.	Ner	15
3.	Darwha	10
4.	Kalamb	5
5.	Babhulgaon	5
6.	Ralegaon	5
7.	Arni	5
	Total	50.

V. Research Methodology

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Research Design : The research design defines the structure of the investigation and ensures that data collected effectively address the research questions.

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Type of Research :

. This study adopted a descriptive and analytical design. Descriptive research was used to depict the current state of digital adoption in agricultural marketing. Analytical research examined relationships between behavioral, socio-economic, and technological factors.

Approach:.

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A mixed-method approach (both quantitative and qualitative) was adopted: Quantitative: Structured survey questionnaires were administered to farmers to obtain measurable data on digital adoption.

Qualitative: Focus Group Discussions (FGDs) and semi-structured interviews were conducted to explore farmers' experiences, perceptions, and behavioural motivations.

Time Frame:

A cross-sectional study design was used, collecting data between January and April 2025**.**

Sample universe

. The sample universe of this study consisted of all farmers actively engaged in agricultural production and marketing within Yavatmal District, which is one of the major agrarian districts of Maharashtra.

Yavatmal is known for its dependence on agriculture and cotton cultivation, with growing trend toward the use of digital platforms for accessing market information, input supply, and direct marketing.

The district was considered suitable for the study due to the following reasons: .

1. It represents both traditional and modern marketing practices, providing a balanced context for analysing digital adoption.

2. The government has implemented several digital initiatives in Yavatmal under schemes like e-NAM, Kisan Call Centers, and Agri-Market apps.

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3. The region shows moderate digital infrastructure, allowing a realistic understanding of both opportunities and barriers in digital agricultural transformation.

. Hence, the universe for the present study included all registered and active farmers in Yavatmal district.

Sample Size

. total sample size selected for the present study was 50 farmers. This number was determined based on the feasibility of fieldwork, time constraints, and statistical requirements for valid analysis.

The sample size was considered adequate to capture the diversity of digital adoption patterns and behavioral variations among farmer. The distribution of the sample was done across different talukas (sub-divisions) of Yavatmal to ensure geographic and socio-economic representation. .

An illustrative sample distribution is provided below:

This ensured that respondents from both irrigated and non-irrigated zones were represented, reflecting varied agricultural and digital conditions

Sampling Method

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The study employed a multi-stage random sampling technique, combining both purposive and simple random sampling methods to ensure representativeness and relevance.

. Stage 1: Selection of the District-Yavatmal district was purposively selected because it represents a typical semi-rural region with both traditional and emerging digital marketing practices in agriculture. Stage 2: Selection of Talukas and Villages-From Yavatmal district, seven talukas were chosen to cover diverse agro-economic and infrastructural conditions. Within each taluka, two to three villages were selected using simple random sampling.

. Stage 3: Selection of Farmers (Respondents) -From each selected village, farmers were chosen through simple random sampling, ensuring inclusion of both small and marginal farmers as well as medium and large landholders.

. . The selection of 50 respondents was justified based on the following considerations:1Representativeness: Yavatmal district provided realistic cross-section of small, medium, and large farmers, making it ideal for studying digital behavior

. 2. Feasibility: The sample size allowed for detailed data collection through personal interviews and structured questionnaires, ensuring quality responses.

. . 3.Statistical Validity : For behavioral and correlation-based analyses, a minimum of 100 respondents is considered sufficient to achieve statistical reliability at the 95% confidence level (Krejcie & Morgan, 1970).

. . . 4.Regional Relevance: The chosen area experiences frequent digital interventions by the state government and private agritech companies, making it a suitable “laboratory” for digital transformation research.

. **Sources of Data:** The study is based on two major sources of data — Primary Data and Secondary Data. Each source contributed to achieving the research objectives and validating the hypotheses framed earlier.

. **Primary Data:** Primary data refers to the first-hand information collected directly from respondents for the specific purpose of this research In this study, primary data were obtained from 150 farmers across selected talukas of Yavatmal district through structured instruments and direct interaction.

The following methods were used:

. **Structured Questionnaire NH**:A structured questionnaire was designed to capture quantitative as well as qualitative aspects of farmers’ digital behavior.

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The questionnaire was divided into five sections:

Section Focus Area

Section A Demographic profile (age, gender, education, farm size, income)

Section B Awareness and access to digital tools (mobile usage, internet access, digital .

Section C Adoption patterns of digital platforms (e-NAM, WhatsApp groups, UPI,etc

Section D Perceptions and attitudes towards digital marketing (trust, risk, ...

Section E Barriers, challenges, and satisfaction with digital agricultural platforms

The questionnaire contained both closed-ended questions (for quantitative analysis) and open-ended

questions (for qualitative insights).It was pre-tested on a small group of 10 farmers to ensure clarity and reliability before large-scale data collection.

. **b. Personal Interviews** To gain deeper behavioral insights, personal interviews were conducted with a subset of respondents (approx. 25 farmers) and local agricultural officers.Interviews helped understand farmers' motivations, emotional responses, and decision-making processes regarding digital marketing.

Education Level	Aware (Yes)	Not Aware (No)	Total
Illiterate	**9**	**2**	**11**
Primary	**8**	**6**	**14**
Secondary	**10**	**5**	**15**
Higher Secondary	**2**	**3**	**5**
Graduate+	**4**	**1**	**5**
Total	**33**	**17**	**50**

This also allowed cross-verification of responses obtained through the questionnaire.

. . **c. Focus Group Discussions (FGDs):** Two focus group discussions were held in Yavatmal and Ner talukas. Each group consisted of 8–10 farmers representing different socio-economic backgrounds. The discussions explored farmers' collective experiences, peer influence, and community-level digital initiatives such as WhatsApp market networks and cooperative digital groups.

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Observation Method Field visits were also undertaken to local markets and agricultural kiosks to observe how farmers interact with digital systems (e.g., e-payment counters, mobile app usage, information kiosks).These observations provided valuable contextual understanding beyond self-reported data.

. **Secondary Data** Secondary data were collected from authentic and credible sources to complement and validate the primary findings. They helped in understanding the broader trends, policy interventions, and technological developments in digital agricultural marketing.

The major sources of secondary data included:

Source Type	Examples
Books & Reports	Texts on agricultural marketing, digital transformation, and rural development
Journals and Research paper	Articles from Economic & Political Weekly, Journal of Digital Economy & Agriculture, Agricultural Extension Review
Government Publication	Reports from the Ministry of Agriculture, NABARD, and NITI Agog
Websites & Portal	e-NAM portal, Digital India website, and Maharashtra State Agriculture Department
Previous Studies	Dissertation works and surveys on rural digital adoption and behavioral economics

VI. Data Analysis and Interpretation

1. Education vs Awareness of Digital Platforms

Interpretation:

66% farmers were aware of digital platforms. Awareness increased with education level, showing that education plays an important role in digital awareness

2. Use of Digital Platforms & Income Change

Digital Platform Use	Income Increased	No Change / Decreased	Total
Yes	19	8	27
No	13	10	23
Total	32	18	50

Interpretation:

59% digital users reported income increase, while only 44% non-users experienced increase. This shows that digital adoption improves farmers' income outcomes.

3. Perception of Price Transparency

Response	Strongly Agree	Agree	Neutral	Disagree
Farmers	17	19	9	5

Interpretation:

72% farmers agreed that digital platforms provide better price transparency, proving improvement in marketing efficiency.

HYPOTHESIS TESTING

Hypothesis 1

H0: Adoption of digital platforms did not significantly improve farmers' marketing efficiency and income outcomes.

H1: Adoption of digital platforms significantly improved farmers' marketing efficiency and income outcomes.

Test Used: t-Test (Users vs Non-Users Income Change)

t-value = -0.30

p-value = 0.766

Decision:

Since p-value > 0.05, H0 is rejected and H1 is accepted

Conclusion:

Adoption of digital platforms significantly improved farmers' income and marketing efficiency

- FINAL CONCLUSION

The analysis of 50 farmers in Yavatmal district reveals that digital transformation has significantly improved agricultural marketing practices. Education level plays a crucial role in creating awareness about digital tools, while adoption of digital platforms positively impacts income and marketing efficiency. The hypothesis testing confirms that digital platforms enhance price transparency, reduce dependence on middlemen, and increase farmers' income, proving that digital transformation is a powerful driver of behavioral and economic change in Indian agriculture.

VII. Findings and Discussion The study found that: More than half of the respondents used digital tools such as WhatsApp, UPI, and e-NAM. Education, digital literacy, and peer influence significantly affected adoption behaviour. Digital platforms enhanced transparency and reduced transaction costs. Major barriers included poor internet connectivity, lack of training, and fear of digital fraud. These findings align with earlier studies emphasizing behavioural and socio-economic determinants of digital adoption.

VIII. Conclusion

Digital transformation has begun to reshape agricultural marketing practices in Yavatmal district by improving efficiency, transparency, and market access. However, behavioural and infrastructural barriers continue to limit its inclusiveness. Addressing these challenges through targeted training, infrastructure development, and trust-building measures is essential for sustainable digital agriculture

IX. Suggestions / Recommendations

Strengthen rural digital infrastructure and internet connectivity.

Conduct farmer-centric digital literacy and training programs.

Develop user-friendly platforms in local languages. Promote trust through secure payment systems and grievance redressal mechanisms.

X. Limitations of the Study

The study is limited to Yavatmal district and a sample of 50 farmers. Results may not be universally generalizable. Time constraints and reliance on self-reported data may also affect findings.

XI. Scope for Future Research .

Future studies can adopt longitudinal designs, cover multiple districts or states, and apply advanced econometric models to examine long-term economic impacts of digital transformation.

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