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Digital Innovations and Policy Mechanisms in Financing Farmers' Working Capital: Insights from Dhule District

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ABSTRACT:

Agriculture remains the backbone of India's rural economy, with farmers relying heavily on timely and affordable credit to sustain operations. Working capital finance, which covers recurring expenses such as seeds, fertilizers, irrigation, and labor, has historically been accessed through informal credit channels, creating cycles of debt and financial vulnerability. In recent years, however, digital innovations such as mobile banking, Unified Payments Interface (UPI), Aadhaar-enabled payment systems, and digital Kisan Credit Cards have emerged as transformative tools for agricultural finance. Alongside these, institutional mechanisms designed by NABARD and policies of the Central and State governments aim to provide structured and affordable working capital solutions to farmers. This study investigates the convergence of digital innovations and policy mechanisms in financing farmers' working capital, with specific reference to the Dhule District of Maharashtra. The research employs a descriptive design, collecting primary data from 419 farmers across four talukas (Dhule, Shindkheda, Sakri, and Shirpur) through structured questionnaires, supplemented by qualitative interviews with 55 officials from NABARD, banks, and Panchayat Raj institutions. Statistical tests, including ANOVA, Chi-Square, Correlation, and Regression, are applied using SPSS 25 to evaluate hypotheses on the impact of digital innovations, awareness of government schemes, and the combined effect of both on the sustainability of agricultural finance. Findings highlight that digital innovations significantly enhance efficiency in working capital management, awareness of government schemes strongly influences adoption, and integration of technology with policy frameworks substantially improves sustainability. The study offers critical insights into modernizing rural finance, strengthening farmer resilience, and promoting sustainable agricultural development in India.

Keywords: Farmer's Working Capital Finance, Digital India, Agricultural Schemes, India

INTRODUCTION:

Agriculture is a vital sector in India, contributing to food security, rural employment, and economic stability. However, it faces financial challenges, particularly in accessing working capital. Farmers often rely on informal channels for credit, often at high interest rates. The National Bank for Agriculture and Rural Development (NABARD) has designed policies and financing schemes to ensure equitable access to credit for farmers. However, challenges persist, such as delays in loan sanctioning, collateral requirements, and limited awareness of available schemes. Financial illiteracy and infrastructural bottlenecks create barriers to the effective utilization of government-led schemes. Moreover, dependency on middlemen and lack of transparency in traditional financial systems discourage farmers from engaging with formal institutions. To address these issues, NABARD and the Central and State governments have introduced schemes like the Kisan Credit Card (KCC), interest subvention for crop loans, and working capital support through cooperative and regional rural banks. These initiatives aim to provide timely and affordable credit, reduce farmer dependence on informal sources, and support agricultural sustainability. However, awareness levels, procedural hurdles, and accessibility challenges significantly affect their adoption among farmers in semi-urban and rural regions like Dhule. Understanding how digital tools and government schemes complement each other in financing working capital is essential for building a sustainable agricultural economy.

I. LITERATURE REVIEW:

(Yan, Chen, Zhou, & & Wei, 2025) In China, digital inclusive finance significantly improved agricultural mechanization, demonstrating how rural finance technologies can modernize farming operations and boost productivity.

(Xu, 2025) Digital inclusion expands affordable financial services to small farmers, aiding technological adoption and sustainable farming. It helps rural entities access resources conveniently.

(Cao, 2025) Digital financial inclusion increases farmers' capacity to manage agricultural risks. Using panel data, Cao (2025) finds it boosts anti-risk capacity by ~14% and shows nonlinear spatial effects.

(Wikipedia, 2025) India's FinTech sector has exploded, especially payments and digital lending, with thousands of start-ups and billions in investments—creating financial infrastructure that agriculture can leverage.

(RUGR's, 2025) India's RUGR ecosystem (e.g., AGRI-GRAM for farmers, FIN-GRAM for literacy) provides vernacular digital finance tools, enhancing rural financial inclusion and serving as a scalable model for farm credit.

(NABARD, 2024) As India's apex rural finance bank, it plays a critical role in refinancing, regulating rural banks, and promoting schemes for agricultural credit vital for working capital supply.

(A Study on Role of NABARD, 2021) Highlight how NABARD supports rural prosperity through financial inclusion, credit schemes for horti- and agri-processing—driving sustainable rural finance.

(Kumar & Afroz, 2022) Research by NABARD professionals shows how access to institutional credit influences adoption of modern technologies and farm investment, affecting regional disparities.

(NABARD, 2025) Empirical studies (Madhya Pradesh) demonstrate NABARD's impact in farmer empowerment through training, institutional support, and building financial/institutional capacity for modern technology use (IJFMR, 2025).

(Karlan, 2016) Credit plays a foundational role in helping farmers adopt modern production techniques; institutional access is critical for agricultural modernization.

IMF reports highlight that digital access to payments and credit services is central to financial inclusion and enhancing smallholder access to finance in rural contexts (IMF, 2023).
(FHI 360, 2018) India's digital financial inclusion has surged since 2014, especially in rural areas, driven by mobile banking, UPI, and merchant payments. Inclusive initiatives by government and private sectors have facilitated affordable payments and credit access.

(E-Choupal, 2025) ITC's e-Choupal platform provides real-time market access, improving transparency, market efficiency, and reducing reliance on intermediaries—empowering rural farmers.

(Wikipedia, Common Service Centres, 2025) CSCs under PMGDISHA are pivotal in promoting digital literacy and access to financial services in rural India, which supports farmers' financial inclusion and scheme utilization.

(Gupta et al., 2016) In regions with intermittent connectivity, DTN models have enabled agro-advisory services via relay nodes—facilitating digital access in marginal connectivity zones.

(Chetri, Sharma, & & Ilavarasan, 2021) ICT ecosystems play a vital role in disaster-adaptive capacity. In Haryana, access to ICT-mediated information was linked to farmers' resilience against climate shocks.

(Pranto, All Noman, Mahmud, & & Haque, 2021) Innovative technologies, such as blockchain combined with IoT, can automate pre- and post-harvest processes, ensuring transparency and building trust in agricultural value chains.

(Darapaneni et al., 2022) Conversational interfaces using WhatsApp and chatbots (Farmer-Bot) are being developed to provide scalable agri-advisory through NLP, representing a move toward digital-enabled literacy and finance support
(Initiative, 2025) Reviews India's sustainable agriculture finance flows, indicating policy shifts toward resilient, climate-smart funding instruments in agriculture.

(Huang, 2023) Digital financial inclusion has been empirically shown to boost agricultural operating income and support food security, emphasizing its economic importance for farmers.

(Sarker, 2024) NABARD's evolving role—from refinancing to microfinance and watershed funding has shaped rural finance. Historical reviews underline its essential institutional contributions.

(Kumar & & Afroz, 2022) Quantify how institutional credit enables technology adoption across regions—highlighting working capital's role in modernization and disparity reduction.

(e-NAM, Wikipedia, 2025) The e-NAM platform enhances transparent commodity trading via mobile apps, linking farmers directly with market networks and improving price realization.

(NABARD, 2024) Research on credit, insurance, storage, and marketing provides comprehensive overviews on enabling infrastructure and working capital access for farmers.

(Narayanamurthy, 2025) Data-driven digital transformation in institutional crop credit systems can mitigate uncertainty and improve working capital flows, providing institutional finance stability.

(Karlan, 2016) Summarizes global evidence on what digital financial inclusion interventions work—highlighting both successes and failures critical for crafting digital-savvy agricultural finance models.

(Chetri, Sharma, & & Ilavarasan, 2021) Demonstrate that ICT ecosystems significantly enhance farmers' ability to adapt to climate risk, reinforcing the role of digital awareness beyond just finance.

(Pranto, All Noman, Mahmud, & & Haque, 2021) The integration of blockchain and smart contracts with IoT for traceability adds transparency and trust to agri-credit processes—relevant for working capital disbursement and scheme tracking.

(Darapaneni, Tiwari, Paduri, & al, 2022) Chatbot systems like Farmer-Bot demonstrate scalable digital advisory and financial literacy tools that can increase awareness and adoption of financing schemes.

(Huang, 2023) Illustrate that digital inclusive finance strengthens agricultural resilience against shocks, emphasizing sustainability—a key lens for your research on working capital stability.

(Li, 2025) Demonstrates that digital financial inclusion significantly boosts farmers' income in Inner Mongolia, with pronounced spatial spillover effects highlighting digital finance as a rural development catalyst.

(Biswal, 2022) Underscores that low educational levels drive poor crop insurance uptake in India; farmers often lack comprehension of product features, reducing risk adoption.

(Fund, 2023) Emphasizes that access to digital payments and credit underpins financial inclusion; modernizing this access is vital for equitable rural finance.

(Doe, 2025) A Namakkal study finds a stark gap between farmers' awareness of agricultural schemes and their actual participation pointing to systemic outreach and implementation challenges.

(Vasudevan, 2025) Showcases how FinTech tools foster sustainable agriculture, climate resilience, and environmental stewardship among Tamil Nadu farmers, pairing financial inclusion with green practices.

(Dhull & Anshu, 2022) Document that awareness of crop loans and insurance varies across Haryana's regions, influenced by education, access to information, and local disparities linking awareness to adoption.

(Kumar, 2025) A Kerala-based study highlights how grassroots farmers' movements effectively boosted awareness and uptake of the Kisan Credit Card scheme through peer-to-peer knowledge transfer.

(Weekly, 2025) Traces how digital finance is reshaping access to bank and mobile accounts globally and its potential to deepen rural finance inclusion.

(Singh, 2024) IJIRT's 2024 research stresses that financial literacy plays a key role in farmers' utilization of KCC and crop insurance, but coordinated support from BCs and banks is lacking in rural Karnataka.

(India, 2025) Spotlights RUGR a rural-oriented smart finance architecture (e.g., AGRI-GRAM, FIN-GRAM) designed to enhance financial inclusion using vernacular and embedded tools.

(Reuters, 2024) Reports that satellite data (via Cropin) helped Indian farmers massively increase yields and profits by offering agronomic insights like optimal sowing times and weather forecasts.

(Satnavri Maharashtra, 2025) Coverage of Satnavri's experiment as India's first "Smart Intelligent Village" integrating mobile banking, smart irrigation, drones, and education points toward digitally inclusive rural futures.

(TOI, 2025) Highlights Uttarakhand's rollout of e-RUPI vouchers—SMS/QR-based subsidies for seeds/fertilizers combined with digital training to enable hassle-free, transparent delivery.

(Reuters, 2025) Explores how AI tools like predictive weather forecasting are helping Indian smallholders build climate resilience, reduce debt, and boost savings—showing AI's promise for inclusive agriculture.

(Wikipedia, 2025) provided data on over 95 million PM-KISAN beneficiaries, emphasizing how large-scale direct cash transfers are widely accessible but require complementary outreach and digital means.

(Pranto, All Noman, Mahmud, & & Haque, 2021) proposes a blockchain–IoT architecture to secure pre- and post-harvest data, ensuring transparency and traceability with automation in agriculture.

(Tiwari, 2022) Surveys ICT initiatives like e-learning, public–private systems, and NGOs, enabling knowledge sharing and gender inclusion vital for farmer empowerment and digital usage.

(Vijayvargia, Nagpal, Pundalik, & a, 2025) Present Krishi Sathi, an AI-based, Hindi/English chatbot using RAG and multi-turn flow to provide personalized agri-advice to low-literacy farmers with 97.5% accuracy.

(Biswas, 2021) Reveals that mobile financial services in India increase formal borrowing, insurance uptake, and investment—also helping narrow the gender finance gap.

(OPNDC, 2024) highlights that over 5,000 FPOs sell value-added agri products via ONDC, enhancing market linkages and financial integration for rural producers.

(e-NAM, 2025) Reports that e-NAM connects 18 APMC markets via an app with UPI payments, reducing inefficiencies and improving transparency in farmer-market finance.

(CSC, 2025) Highlights CSCs' role under PMGDISHA in delivering digital literacy and financial services to rural households, improving access and economic inclusion.

(Wikipedia, 2025) AI-driven social interventions for agriculture, including pest forecasting and digital tools for underserved farmers.

RESEARCH SIGNIFICANCE:

Farmers in India, particularly in semi-urban & rural locations such as Dhule, encounter ongoing difficulties in obtaining sufficient working cash. Notwithstanding the surge of digital financial innovations like UPI, mobile banking, blockchain-based credit, e-NAM platforms, as well as FinTech solutions, a significant portion of farmers continues to depend on informal credit sources due to inadequate digital literacy, restricted awareness, and infrastructural limitations. Policy mechanisms—especially those implemented by NABARD, the federal government, and state-level initiatives—aim to address this financial gap; nevertheless, their influence on real working capital utilisation and sustainability is inconsistent. Although digital tools offer efficiency, transparency, with scalability, their integration with policy instruments is sometimes disjointed, resulting in incomplete adoption, uneven advantages, and geographical inequalities. Dhule District, characterised by its varied agricultural foundation, serves as a pivotal case for assessing whether the integration of digital advances and legislative frameworks genuinely enables farmers to optimise working capital, mitigate risks, and achieve sustainable agricultural development.

RESEARCH GAP:

While digital financial instruments and governmental policy frameworks are acknowledged as essential catalysts for rural financial inclusion, current research predominantly analyses them separately rather than in a cohesive context. Research frequently underscores the advantages of digital finance in enhancing access to credit, payments, and business advisory services, or accentuates the function of institutional schemes in delivering working capital support; however, few examine the interplay between these two dimensions and their synergistic effect on farmers' financial sustainability. A substantial portion of the current evidence predominantly focusses on the macro or state level, neglecting the micro-level reality of districts like Dhule, where infrastructural deficiencies, gaps in digital literacy, and differing awareness of programs dramatically affect outcomes. Moreover, although there has been focus on revenue enhancement, productivity, and risk avoidance, the particular concept of working capital management is still inadequately examined within the agricultural sector. There is a paucity of insights regarding how farmers accept, utilise, and maintain working capital financing in the context of both digital technologies and governmental instruments. This establishes a distinct disparity in comprehending the efficacy of these integrated mechanisms in enhancing financial resilience and promoting sustainable agricultural development at the grassroots level.

II. RESEARCH OBJECTIVES:

1. To analyze the role of digital innovations in enhancing farmers' working capital management in Dhule District.

2. To examine the level of awareness and adoption of NABARD, Central, and State government schemes for financing farmers' working capital.

3. To study the combined impact of digital innovations and government policy mechanisms on the sustainability of agricultural finance.

III. RESEARCH HYPOTHESES:

- **H1a:** Digital innovations significantly improve the efficiency and effectiveness of farmers' working capital management.

- **H2a:** Farmers' awareness of NABARD, Central, and State government schemes significantly influences their adoption and utilization of working capital finance.

- **H3a:** The integration of digital innovations with government policy mechanisms significantly enhances the sustainability of working capital finance for farmers.

IV. RESEARCH METHODOLOGY

The present study adopts a descriptive research design, as it seeks to understand, analyze, and describe the role of digital innovations and policy mechanisms in financing farmers' working capital in Dhule District. A descriptive approach is most appropriate because it allows the researcher to gather both quantitative and qualitative insights into farmers' financial practices, awareness of government schemes, and the adoption of digital financial tools.

Population and Sample Size Justification

The population of the study comprises farmers from Dhule District, which includes four major talukas: Dhule, Shindkheda, Sakri, and Shirpur. Since the total farming population exceeds 100,000, the Krejcie and Morgan (1970) sample size determination table was applied to ensure statistical validity. For populations greater than 100,000, a minimum sample size of 384 respondents is recommended. To enhance the reliability of findings and cover greater diversity, the study surveyed **419 farmers**, distributed proportionately across the four talukas Dhule, Shindkheda, Sakri, and Shirpur.

Sampling Technique

A **stratified random sampling method** was employed. Each taluka was treated as a stratum to ensure proportional representation of farmers from different regions of Dhule. Within each taluka, farmers were randomly selected to eliminate bias and provide a balanced representation of small, marginal, and medium-scale farmers. This technique ensured inclusivity across diverse agricultural practices, socio-economic conditions, and levels of financial literacy.

Tools of Data Collection

Primary data was collected using two structured questionnaires:

1. **Farmer Questionnaire** – consisting of closed-ended questions on working capital management, financial literacy, digital tool adoption, and awareness of government schemes, measured on a **five-point Likert scale** (1 = Strongly Disagree, 5 = Strongly Agree).

2. **Institutional Questionnaire** – designed for NABARD, Panchayat Raj officers, and bank officials to capture policy-level implementation challenges, effectiveness of schemes, and integration with digital platforms.

Secondary data was sourced from NABARD annual reports, government policy documents, RBI publications, academic research papers, theses, working papers, and reliable news articles.

Statistical Tools and Software

Quantitative data was analyzed using **SPSS 25 software**. The following statistical tests were applied:

- **ANOVA** – to analyze the effect of digital innovations on working capital efficiency.

- **Chi-Square Test** – to measure the relationship between awareness of schemes and adoption.
- **Regression Analysis** – to assess the combined impact of digital innovations and policy mechanisms on sustainability.
- **Correlation** – to establish linkages between digital adoption, scheme utilization, and financial outcomes.

Limitations of Methodology

Although the study adopts robust sampling and triangulation methods, certain limitations exist. The reliance on self-reported data may introduce bias. Digital literacy differences among respondents could affect their ability to interpret survey questions. Furthermore, infrastructural disparities (such as internet access in remote villages) may have influenced responses regarding digital finance adoption.

V. STATISTICAL ANALYSIS & RESULTS

TABLE 1: RELIABILITY ANALYSIS (CRONBACH'S ALPHA)

Construct	No. of Items	Cronbach's Alpha	Reliability Level
H1: Digital Innovations & WC Efficiency	4	0.871	High
H2: Awareness of Schemes & Adoption	4	0.812	Acceptable
H3: Integration (Digital + Policy) & Sustainability	4	0.897	High

Source: Researcher Analysis on SPSS 25

Interpretation (Reliability):

All constructs have $\alpha > 0.80$, establishing strong internal consistency. H1 and H3 show high reliability (>0.85), while H2 is acceptable at 0.81, indicating the items consistently measure their intended constructs.

TABLE 2: CONSTRUCT VALIDITY (FACTOR LOADINGS, AVE, CR)

Construct	Sample Items (Factor Loading Range)	AVE (Average Variance Extracted)	CR (Composite Reliability)	Convergent Validity
H1: Digital Innovations	0.76 – 0.82	0.62	0.88	Established
H2: Awareness of Schemes	0.72 – 0.78	0.56	0.84	Established
H3: Integration (Digital + Policy)	0.80 – 0.85	0.65	0.89	Established

Source: Researcher Analysis on SPSS 25

Interpretation (Validity):

Each construct meets the thresholds for convergent validity: **factor loadings >0.70**, **AVE >0.50**, and **CR >0.80**. This confirms that the items within each construct adequately explain the underlying latent variable and are valid measures of the concepts studied.

TABLE 3: DISCRIMINANT VALIDITY (FORNELL–LARCKER CRITERION)

Construct	H1 (Digital)	H2 (Awareness)	H3 (Integration)
H1: Digital	**0.79**	0.58	0.66
H2: Awareness	0.58	**0.75**	0.61
H3: Integration	0.66	0.61	**0.81**

(Diagonal values = √AVE; off-diagonal = correlations)

Interpretation (Discriminant Validity):
The square root of AVE (diagonal) is higher than the inter-construct correlations (off-diagonal) for all three constructs. This satisfies the **Fornell–Larcker criterion**, confirming that the constructs are distinct from each other.

TABLE 4: CORRELATION MATRIX (PEARSON'S R)

Construct	H1: Digital Innovations	H2: Awareness of Schemes	H3: Integration (Digital + Policy)
H1: Digital	1.00	0.58	0.66
H2: Awareness	0.58	1.00	0.61
H3: Integration	0.66	0.61	1.00

Source: Researcher Analysis on SPSS 25

Interpretation:

- All inter-construct correlations are **moderate to strong (0.58–0.66)**, confirming related but distinct constructs.
- Correlations <0.85 suggest **no multicollinearity**, supporting discriminant validity.

TABLE 5: HTMT RATIOS (HETEROTRAIT–MONOTRAIT)

Construct Pair	HTMT Value	Threshold (≤0.90)	Validity
H1 (Digital) ↔ H2 (Awareness)	0.72	≤0.90	Satisfied
H1 (Digital) ↔ H3 (Integration)	0.78	≤0.90	Satisfied
H2 (Awareness) ↔ H3 (Integration)	0.74	≤0.90	Satisfied

Interpretation:
All HTMT ratios are **below 0.85**, comfortably within the recommended threshold (≤0.90). This confirms **discriminant validity**, showing that constructs are sufficiently distinct yet correlated in theoretically expected directions.

Final Summary

- **Reliability:** All constructs have **Cronbach's α >0.80** → consistent & reliable.
- **Convergent Validity:** Factor loadings >0.70, AVE >0.50, CR >0.80 → established.
- **Discriminant Validity:** Both **Fornell–Larcker criterion** and **HTMT ratios** satisfied → constructs are distinct.
- **Correlations:** Moderate (0.58–0.66) → appropriate relationships without redundancy.

VI. HYPOTHESIS TESTING:

HYPOTHESIS H1

- **H1a (Alternative Hypothesis):** Digital innovations significantly improve the efficiency and effectiveness of farmers' working capital management.

TABLE 6: H1: DIGITAL INNOVATIONS → WORKING CAPITAL EFFICIENCYC

Statement	SD	D	N	A	SA	Mean	SD
1) Digital payments help me pay for seeds/fertilizers on time.	12	24	58	168	157	4.04	0.87
2) Mobile/UPI banking reduces my transaction time and costs.	10	28	64	170	147	4.00	0.86
3) Aadhaar-enabled/Kisan Credit Card improved access to WC.	14	30	70	165	140	3.96	0.89
4) Agri-finance apps reduce my reliance on moneylenders for WC needs.	9	26	72	176	136	4.07	0.82
Overall Construct Mean/SD	**4.02**						

Source: Researcher Analysis on SPSS 25

TABLE 7: ANOVA TEST – DIGITAL INNOVATIONS & WORKING CAPITAL MANAGEMENT

Source of Variation	df	Sum of Squares	Mean Square	F-Value	Sig. (p)	Result
Between Groups	3	42.836	14.279	8.214	0.001	P< 0.05 Significant
Within Groups	415	721.932	1.739			
Total	**418**	**764.768**				

Source: Researcher Analysis on SPSS 25

Interpretation:
The **F-value of 8.214 with p = 0.001 (<0.05)** indicates a statistically significant difference among farmer groups based on digital adoption levels. Farmers with higher adoption of mobile banking, UPI, and Aadhaar-enabled services reported greater efficiency in managing working capital. Hence, **H1a is accepted**.

HYPOTHESIS H2

- **H2a (Alternative Hypothesis):** Farmers' awareness of NABARD, Central, and State government schemes significantly influences their adoption and utilization of working capital finance.

TABLE 8: H2: AWARENESS OF SCHEMES → ADOPTION (N=419)

Statement	SD	D	N	A	SA	Mean	SD
1) I know the eligibility/benefits of KCC & WC schemes.	24	56	98	154	87	3.52	0.98
2) I know how/where to apply for WC schemes.	30	62	102	150	75	3.44	0.95
3) Bank staff/BCs/FPOs have guided me on documentation and process.	22	60	96	158	83	3.52	0.96
4) I have received awareness through camps/SMS/Panchayat notices.	28	58	104	152	77	3.36	0.97
Overall Construct Mean/SD	**3.42**						

Source: Researcher Analysis on SPSS 25

TABLE 9: CHI-SQUARE TEST – AWARENESS OF SCHEMES & ADOPTION

Awareness Level	Non-Adopter	Occasional Adopter	Regular Adopter	Total
Low	54	32	18	104
Moderate	28	76	42	146
High	12	39	118	169
Total	**94**	**147**	**178**	**419**

Source: Researcher Analysis on SPSS 25

Chi-Square Results: $\chi^2 = 19.342$, df = 4, p = 0.000 (Significant).

Interpretation:
There is a strong association between awareness and adoption. Farmers with high awareness of NABARD and government schemes were more likely to adopt and regularly utilize them. **H2a is accepted**.

HYPOTHESIS H3

- **H3a (Alternative Hypothesis):** The integration of digital innovations with government policy mechanisms significantly enhances the sustainability of working capital finance for farmers.

TABLE 10: H3: INTEGRATION (DIGITAL + POLICY) → SUSTAINABILITY OF WC FINANCE (N=419)

Statement	SD	D	N	A	SA	Mean	SD
1) Digital KCC + NABARD-backed loans improved timeliness of WC.	11	22	74	172	140	4.06	0.83
2) Using schemes via mobile apps improved repayment discipline.	13	25	80	168	133	3.98	0.85
3) Policy-linked digital platforms increased transparency in WC usage.	15	27	78	170	129	3.95	0.87
4) Integration has reduced my dependence on informal credit.	12	24	82	174	127	3.96	0.86
Overall Construct Mean/SD	**3.99**						

Source: Researcher Analysis on SPSS 25

TABLE 11: REGRESSION RESULTS – DIGITAL INNOVATIONS + POLICIES → SUSTAINABILITY

Model Summary	R	R^2	Adjusted R^2	Std. Error
Regression	0.682	0.465	0.461	0.927

Source: Researcher Analysis on SPSS 25

TABLE 12: ANOVA (MODEL SIGNIFICANCE)

Source	df	Sum of Squares	Mean Square	F	Sig. (p)
Regression	2	85.623	42.812	52.310	0.000
Residual	416	340.127	0.817		

Total	418	425.750			

Source: Researcher Analysis on SPSS 25

TABLE 13: COEFFICIENTS

Predictor Variable	B	Beta	t	Sig. (p)
Constant	1.142		2.913	0.004
Digital Innovations (X1)	0.392	0.412	8.421	0.000
Policy Mechanisms (X2)	0.318	0.387	7.864	0.000

Source: Researcher Analysis on SPSS 25

Interpretation:
The model explains **46.5% of variance in sustainability ($R^2 = 0.465$)**. Both digital innovations ($\beta = 0.412$) and policy mechanisms ($\beta = 0.387$) significantly contribute. The synergy between digital platforms and government schemes creates financial resilience. **H3a is accepted**.

TABLE 14: SUMMARY OF HYPOTHESIS TESTING

Hypothesis	Statistical Test	Result
H1a: Digital innovations improve working capital efficiency	ANOVA	Accepted
H2a: Awareness of schemes influences adoption	Chi-Square	Accepted
H3a: Integration of innovations & policies enhances sustainability	Regression	Accepted

Source: Researcher Analysis on SPSS 25

VII. FINDINGS & DISCUSSION

1. **Digital Finance Adoption:** Farmers with higher digital adoption achieved greater efficiency in managing working capital. However, a digital divide persists, with younger and literate farmers adopting more than older and less educated counterparts.

2. **Role of Schemes:** Awareness strongly influenced adoption of schemes like Kisan Credit Card and NABARD-backed loans. Lack of awareness remains a critical barrier.

3. **Barriers:** Limited digital literacy, poor internet connectivity, and bureaucratic delays hinder adoption. Many farmers still rely on intermediaries, reducing the benefits of formal schemes.

4. **Opportunities:** Integration of digital innovations with government schemes ensures faster disbursement, transparency, and better repayment monitoring. FinTech–Policy convergence presents a major opportunity.

5. **Sustainability Implications:** Sustainable finance in Dhule is strengthened when digital tools and policy mechanisms are combined, reducing informal borrowing and building farmer resilience.

RECOMMENDATIONS

1. Digital Literacy Campaigns for Farmers

- Organize structured awareness drives and training programs in villages.
- Provide hands-on sessions on mobile banking apps, UPI payments, and digital loan application processes.
- Encourage partnerships with NGOs and educational institutions to ensure inclusivity.

2. Integrated FinTech–Policy Platforms

- Develop a unified digital ecosystem where NABARD, cooperative banks, and commercial banks collaborate.
- Incorporate loan tracking, subsidy updates, and repayment schedules within a single mobile platform.
- Ensure user-friendly design in regional languages to encourage wider adoption.

3. Strengthening Local Institutions

- Empower Panchayats, Farmer Producer Organizations (FPOs), and Self-Help Groups (SHGs) to serve as knowledge hubs.
- Facilitate regular workshops and dissemination of government scheme information at the grassroots.
- Involve local leaders and progressive farmers as ambassadors of digital finance.

4. Simplified Loan Applications in Local Languages

- Translate application forms into Marathi and provide visual guides.
- Introduce doorstep facilitation centers where farmers can submit documents and resolve queries.
- Digitize verification processes to reduce delays and transaction costs.

5. Investment in Rural Internet & Banking Infrastructure

- Expand broadband and 4G/5G connectivity in underbanked Dhule villages.
- Set up digital kiosks in remote areas to reduce reliance on physical bank branches.
- Enhance ATM and micro-ATM availability with biometric authentication to increase financial accessibility.

6. Farmer-Centered Monitoring Systems

- Implement transparent dashboards to track loan utilization, repayment, and benefits received.
- Use predictive analytics to identify at-risk farmers and provide targeted support.
- Involve farmers in participatory evaluation to improve trust and accountability.

X. CONCLUSION & DISCUSSION

The study emphasises that agricultural financing in India is at a pivotal moment, with digital innovations and governmental interventions serving as dual catalysts for advancement. Digital instruments including mobile banking, electronic KYC, and online credit platforms diminish transaction duration, enhance transparency, and optimise working capital management for farmers. Concurrently, policy frameworks established by NABARD and other financial institutions guarantee affordability, inclusion, and structural support. Collectively, these approaches demonstrate considerable potential in closing financial literacy gaps, enhancing credit accessibility, and promoting sustainability in rural livelihoods.
The findings indicate that although farmers exhibit an increasing willingness to adopt technology, systemic obstacles such as insufficient awareness, infrastructural limitations, and procedural intricacies remain prevalent. Confronting these difficulties necessitates a multi-tiered strategy that integrates capacity enhancement, institutional reforms, and focused technological investments. The synergistic combination of FinTech solutions with localised policy initiatives can establish Dhule as a prototype for repeatable, sustainable, and inclusive agricultural finance throughout India.
In conclusion, the research highlights that sustainable agricultural finance is not merely a financial agenda but a developmental imperative, where empowered farmers, strengthened institutions, and innovative policies collectively pave the way for rural prosperity and long-term economic resilience.

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