Research Article

Impact of Digitalization on Agricultural Market Performance in India: A Time Series Analysis

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Received: 22 July 2026 | **Revised:** 20 September 2026 | **Accepted:** 22 September 2026

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ABSTRACT

This study analyses the effect of digitization on the performance of India's agriculture sector. The study uses time series data from 2005 to 2024. The measures of agricultural performance are: Agricultural GDP Price Index and Agricultural Exports. The proxy for digitalization includes UPI transactions and Internet penetration. Descriptive Statistics, Trend Analysis, Correlation Analysis, and Multiple Regression are used to examine the relationship between digital transformation and agricultural performance. Results reveal the essential function of digital infrastructure in improving market access and productivity, as it shows a robust and statistically significant positive effect of internet penetration on Agricultural GDP and Exports. UPI Transactions are highly negatively correlated with the Price Index, showing better market efficiency and price stabilization, and have a positive but relatively lower impact on agricultural growth. The results show that digitalization enhances agricultural performance primarily through improved connectivity and information sharing. This study addresses the existing gap in empirical evidence on the impact of digitalization on India's agricultural market performance by employing a time-series approach to examine the relationship between digital indicators and key agricultural outcomes, including agricultural GDP, price stability, and export performance. The findings contribute to the literature on digital transformation and agricultural economics while offering evidence-based insights for policymakers to strengthen inclusive and efficient agricultural market systems. The study emphasizes the necessity of digital infrastructure development and promotion of digital usage for the equitable and effective functioning of agricultural markets in India.

Keywords: *Digitalization, UPI, Internet Users, Agricultural GDP, Price Index, Agricultural Exports, Market Efficiency.*

INTRODUCTION

Digital technology has transformed the way economies are organized and run everywhere in the world. Emerging economies like India have witnessed a huge shift to digital banking systems. Digital platforms have improved access, efficiency, and openness in economic activity, particularly in sectors like agriculture, which have long been affected by information asymmetries. Development is the removal of different sorts of unfreedoms that leave people with little choice and little opportunity of exercising their reasoned agency (Sen 1999). In this sense, digitalization can be seen as a tool to reduce market inefficiencies and improve economic opportunities, especially for rural and agricultural markets. The popularity of

digital transactions and internet-based services in India has increased with the rise of Digital India and the growth of the Unified Payments Interface (UPI). Such developments can change agricultural markets through improved price discovery, lower transaction costs, and better market access. Douglass North (1990) said that "institutions are the rules of the game in a society"; digital platforms are emerging as a new form of institutional process shaping economic relationships. In this context, the present study aims to analyse the impact of digitalization on the performance of agricultural markets in India through the lens of payment systems and internet usage.

The existing studies indicate the increasing importance of digitalization for the improvement of market performance and economic efficiency. Digital banking systems are shown to lower transaction costs and enhance financial inclusion, especially in developing countries. The role of institutional structure in affecting economic outcomes was emphasized by Douglass North (1990). The importance of institutional and technological advances in expanding economic opportunities was emphasized by Amartya Sen (1999). Research has shown that digital platforms improve market integration and the sharing of information in agriculture. Recent empirical evidence suggests that digital payment systems and internet penetration are important for improving trade performance and agricultural output. Digitalization improves agricultural outcomes by enabling better price discovery and reducing market inefficiencies. But the scale and the nature of the impact are different across areas depending on the level of digital infrastructure and adoption. This study aims to build upon the previous research by providing a detailed empirical investigation into the relationship between digitalization and agricultural market performance in India.

Need and Significance of the Study

Agriculture is the backbone of the Indian economy and still remains a major source of employment and livelihood, especially in the rural areas. But the industry has been hampered by inefficiencies such as fractured marketplaces, price volatility, and lack of information. The growth of digital technologies makes it all the more important to understand whether digitalization can address these basic issues and improve market performance. Markets are incomplete, and information is imperfect (Joseph Stiglitz, 2002). Systems that can help to improve the flow of information are therefore very important, and digitization can make a revolutionary difference in this respect. Moreover, with the increasing availability of the internet and digital payment systems in India, there is a need for an empirical assessment of their impacts on major agricultural outcomes such as production, price stability, and exports. This interdependence is important for policymakers who want to build inclusive growth and market systems that work well. Technological change is at the heart of economic growth (Paul Romer, 1990), and therefore it is important to analyze digitalization as a driver of sectoral development. The significance of this study is that it provides empirical evidence on the extent to which digital transformation improves the agricultural markets.

Statement of the problem

While India has witnessed fast development in digital infrastructure and payments, the degree of digitalization's impact on agricultural markets' performance has not been sufficiently studied. There is no empirical evidence on how digital platforms really affect agricultural GDP, price stability, and export performance, even if they are expected to increase efficiency, reduce price volatility, and improve market access. Therefore, a detailed analysis of the relationship between digital indicators and agricultural performance is necessary to fill the knowledge gap on whether digitalization has effectively translated into visible benefits in agricultural markets.

Scope of the study

This research employs time series data from 2005 to 2024 to analyze the impact of digitization on the performance of India's agriculture sector. It looks at key digitalization indicators like Internet Users (%) and UPI (Bn Transactions) and their impact on Agricultural GDP (₹ Lakh Crore), Price Index (Base = 100), and Agricultural Exports ($ Billion). The study is limited to a macro-level analysis and does not take into account micro-level differences between commodities or areas. Although the study uses time-series data, formal unit root tests were not conducted since the analysis is focused on investigating broad empirical relations with a very small sample size of 20 observations. Moreover, the study employs a simple OLS framework instead of sophisticated time-series modelling for exploratory and policy-oriented insights. Moreover, the study provides exploratory and policy-oriented insights using a simple OLS framework as opposed to sophisticated time-series modelling. Methods such as these are often used in applied economic studies. However, the presence of trending factors suggests that the results should be interpreted with caution.

Objectives of the study

The study aims, firstly, to examine the trends and growth patterns of digitalization indicators in India; secondly, to analyse the relationship between digitalization and agricultural market performance in India; thirdly, to assess the impact of digitalization on Agricultural GDP (₹ lakh crore); fourthly, to evaluate the effect of digitalization on the Agricultural Price Index (Base = 100); and finally, to analyse the influence of digitalization on agricultural exports (US$ billion) in India.

Hypotheses

H_{01}: Digitalization has no significant impact on Agricultural GDP (₹ Lakh Crore).

H_{02}: Digitalization has no significant impact on Price Index (Base = 100).

H_{03}: Digitalization has no significant impact on Agricultural Exports ($ Billion).

METHODS

The study includes secondary data from reliable sources such as the Reserve Bank of India, Ministry of Statistics and Program Implementation, World Bank, Agmarknet, Food and Agriculture Organization. The study period is 2005–2024. The tools used for analysis are Multiple Regression Analysis, Correlation Analysis, Trend Analysis, and Descriptive Statistics. Regression Models are estimated using EViews software to determine the impact of digitalization

variables on the agricultural performance indicators.

RESULTS

The descriptive statistics revealed that the mean values have shown significant growth in digital payment systems, especially UPI transactions (mean = 18.78 billion). But a high difference between the mean and median (0.05) shows that there has been a major structural change in recent years. Similarly, internet penetration (mean = 30.4%) and Mobile Banking (mean = 5.19 billion) also show consistent upward trends, indicating increasing digital usage. In the case of Agriculture, exports ($30.1 billion) and average Agricultural GDP (₹18.21 lakh Crore) show steady growth. The price index (mean = 111.8) shows relatively small changes over time. UPI transactions showed a large positive skewness (1.70) and high variability (standard deviation = 32.33) and exhibited a sharp acceleration in the last years of the data period. Contrary to Internet Usage, Agricultural Exports and Agricultural GDP exhibit almost symmetric distributions with moderate variability, indicating steady growth paths. The Jarque–Bera statistics reveal that most variables meet the normality assumptions ($p > 0.05$), except for UPI, which fails to do so due to its exponential growth pattern.

Table 1: *Descriptive analysis- UPI, Price Index, Mobile Banking, Internet Users, Agricultural GDP & Agricultural Exports*

Descriptive Analysis	UPI	Price Index	Mobile Banking	Internet Users	Agricultural *GDP*	Agricultural Exports
Mean	18.78000	111.8000	5.195000	30.40000	18.21500	30.10000
Median	0.050000	112.0000	2.250000	26.50000	16.75000	29.00000
Maximum	110.4000	122.0000	20.00000	70.00000	37.00000	58.00000
Minimum	0.000000	100.0000	0.200000	5.000000	6.500000	10.00000
Std. Dev.	32.33710	6.574272	6.125656	21.15208	9.402535	14.88871
Skewness	1.700346	-0.121457	1.230415	0.456255	0.503216	0.302623
Kurtosis	4.752889	1.933705	3.256519	1.916314	2.109932	1.951961
Jarque-Bera	12.19777	0.996660	5.101239	1.672541	1.504271	1.220591
Probability	0.002245	0.607544	0.078033	0.433324	0.471359	0.543190
Sum	375.6000	2236.000	103.9000	608.0000	364.3000	602.0000
Sum Sq. Dev.	19868.07	821.2000	712.9495	8500.800	1679.746	4211.800
Observations	20	20	20	20	20	20

Source: *Author's compilation based on data from Reserve Bank of India (RBI), MOSPI, World Bank, Agmarknet, and FAOSTAT.*

The time series trend analysis indicates a significant acceleration in the use of digital payments in India, especially post-2016. Both UPI and mobile banking transactions are on a rising trend. However, the growth pattern of UPI is visibly exponential, while the growth pattern of mobile banking is more linear. Additionally, the estimated trend equations support this difference, as UPI has a higher slope ($y = 4.305x - 26.42$) than mobile banking ($y = 0.919x - 4.462$), which indicates a much higher rate of growth. The coefficient of determination ($R2 = 0.789$ for mobile banking and 0.620 for UPI) shows a better linear fit for

mobile banking, indicating that time explains a substantial amount of the variability in both series. Notably, the structural break between 2016 and 2017 is a significant turning point following a sharp increase in UPI transactions, reflecting the impact of technological dissemination and digital financial activities. The trend study demonstrates the pace of change in India's digital payment ecosystem, with UPI emerging as the main driving force of digitalization.

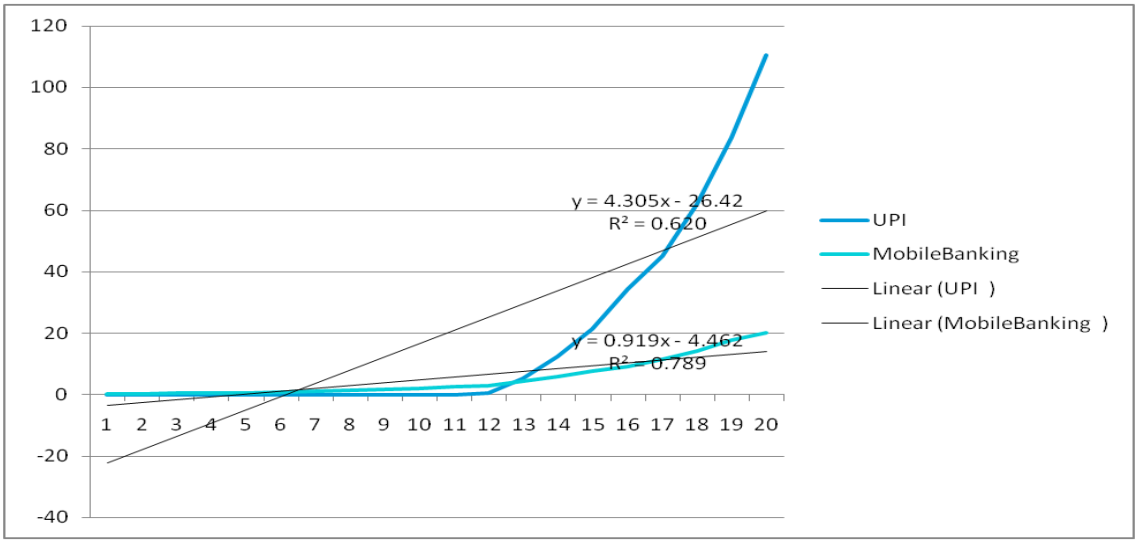


Figure 1: *Trend Analysis- UPI and Mobile Banking*

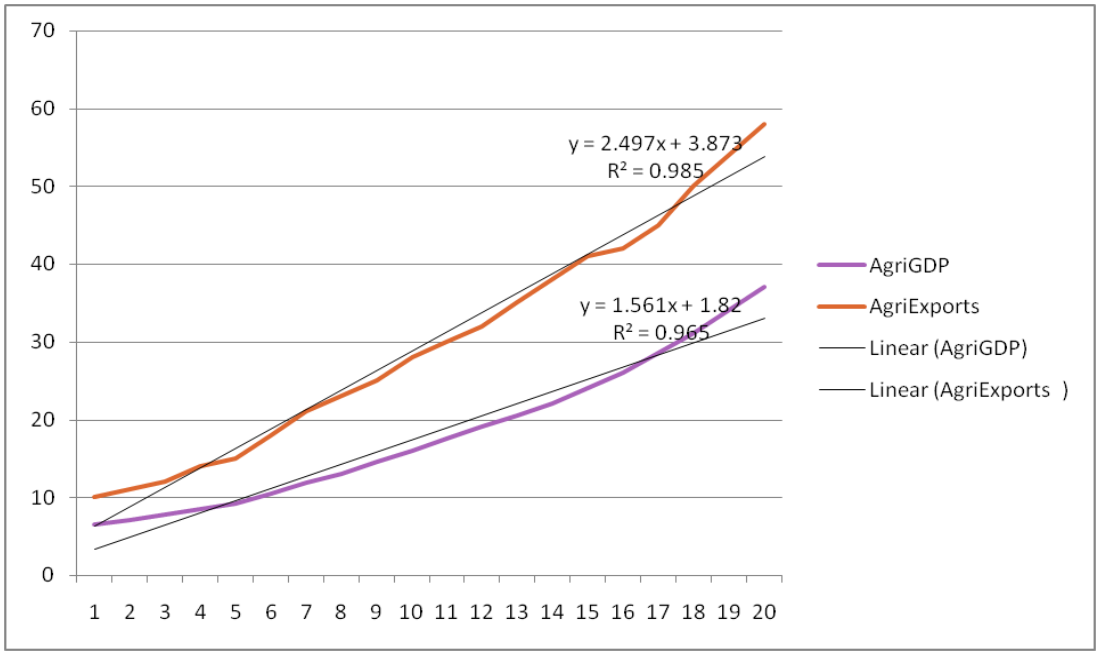


Figure 2: *Trend Analysis- Agricultural GDP and Agricultural* Exports

The time-series trend analysis of agricultural GDP and agricultural exports indicates a continuous upward trend throughout the study period, indicating continuous growth in the agricultural sector. The two variables show strong linear trends, with high coefficients of determination (R2 = 0.965 for agricultural

GDP and R2 = 0.985 for agricultural exports), suggesting that time explains a large portion of their variance. The estimated trend equations further indicate that agricultural exports (y = 2.497x + 3.873) have grown at a faster rate than agricultural gross domestic product (y = 1.561x + 1.82), implying that the integration of India's agriculture sector with international markets has increased over the years. In particular, in recent years, with better access to markets and better trade performance, exports have grown relatively fast, whereas agricultural GDP has grown steadily and progressively.

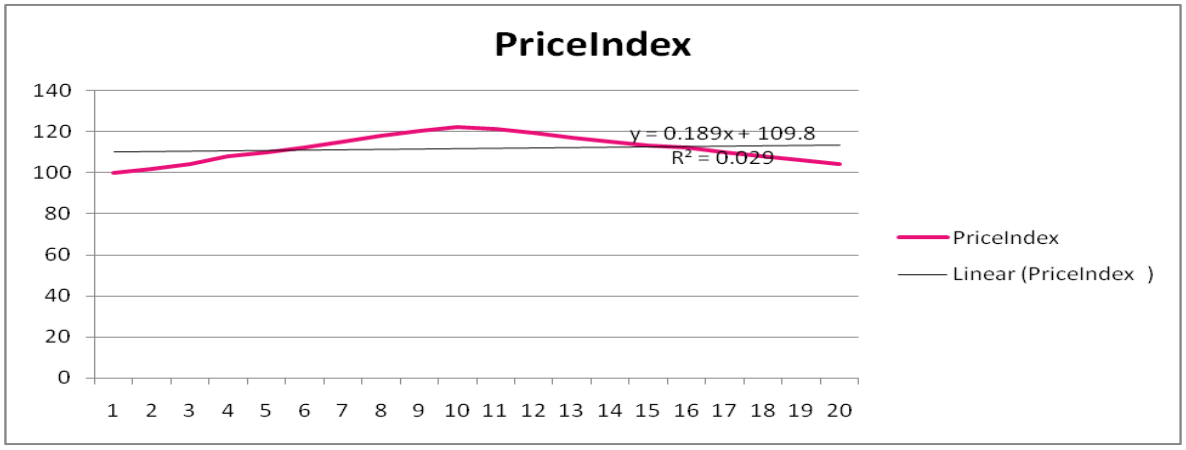


Figure 3: *Trend analysis- Price Index*

The price index shows a gradual decline in the later years, indicating a downward movement in price levels following an initial rise that peaked around the mid-period, as evidenced in the time-series trend analysis. The linear trend equation calculated (y = 0.189x + 109.8) has a small positive slope, but the coefficient of determination is very low (R 2 = 0.029), indicating that time explains very little of the variability of the price. This means that price dynamics are influenced more by external shocks and short-term swings than by a deterministic trend.

Table 2: *Correlation Analysis - UPI, Price Index, Mobile Banking, Internet Users, Agricultural GDP & Agricultural Exports*

Correlation Analysis	UPI	Price Index	Mobile Banking	Internet Users	Agricultural *GDP*	Agricultural Exports
UPI	1.000	-0.386	0.979	0.873	0.884	0.848
Price Index	-0.386	1.000	-0.264	-0.004	0.001	0.073
Mobile Banking	0.979	-0.264	1.000	0.952	0.956	0.932
Internet Users	0.873	-0.004	0.952	1.000	0.999	0.995
Agricultural *GDP*	0.884	0.001	0.956	0.999	1.000	0.996
Agricultural Exports	0.848	0.073	0.932	0.995	0.996	1.000

Source: *Author's compilation based on data from Reserve Bank of India (RBI), MOSPI, World Bank, Agmarknet, and FAOSTAT.*

The correlation study reveals positive and statistically significant relationships between digitalization indicators and agricultural market performance variables in India. The association of UPI transactions with agricultural GDP (r=0.884) and agricultural exports (r=0.848) is also strongly positive, implying that the increase in sectoral output and trade performance is closely correlated with the increased use of digital payments. The significance of digital financial inclusion for agricultural growth is further reinforced by the very strong positive correlations of mobile banking with exports (r = 0.932) and agricultural GDP (r = 0.956). Moreover, internet penetration is strongly associated with exports (r = 0.995) and agricultural GDP (r = 0.999), suggesting that digital infrastructure is essential for enhancing market access and efficiency. However, the price index exhibits a weak and negative correlation with the digitalization factors, particularly mobile banking (r = -0.264) and UPI (r = -0.386). Thus, increased digitalization might be beneficial for price stabilization.

The correlation matrix shows Severe Multicollinearity among the independent variables, particularly between Internet Users and Agricultural GDP (r=0.999) and Internet Users and Mobile Banking (r=0.952). Large correlations like these can skew regression estimates and make results less reliable. To tackle the issue of the substantial conceptual and statistical overlap between Mobile Banking and other digitalization indicators, the former was excluded from the analysis. Therefore, the study still considers internet users and UPI transactions as proxy measures of digitization. To handle Multicollinearity, we removed the highly correlated variables to ensure model stability. The regression models described below are therefore listed. Thus, the new model was created, shown below.

Model 1: Agricultural Growth (Impact of digitalization on agricultural output)

Agricultural *GDP* = $beta_0$ + $beta_1$ UPI + beta $_2$ Internet Users +ϵ

Model 2: Market Efficiency **(**Effect on price stability**)**

Price Index = $beta_0$ + $beta_1$ UPI + beta $_2$ Internet Users +ϵ

Model 3: Trade Performance (Impact on exports)

Agricultural Exports = $beta_0$ + $beta_1$ UPI + beta $_2$ Internet Users +ϵ

Table 3*: Regression Analysis - UPI & Internet Users on Agricultural GDP*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UPI	0.014282	0.006919	2.064168	0.0546
Internet Users	0.424816	0.010578	40.16166	0.0000
C	5.032367	0.242044	20.79111	0.0000
Model Summary				
R-squared	0.997716	Mean dependent var		18.21500
Adjusted R-squared	0.997448	S.D. dependent var		9.402535
S.E. of regression	0.475034	Akaike info criterion		1.486621
Sum squared resid	3.836177	Schwarz criterion		1.635981
Log likelihood	-11.86621	Hannan-Quinn criter.		1.515778
F-statistic	3713.392	Durbin-Watson stat		0.517184
Prob(F-statistic)	0.000000			

Note. *Dependent Variable - Agricultural GDP*; *Method - Least Squares*

Source: *Author's compilation based on data from Reserve Bank of India (RBI), MOSPI, World Bank, Agmarknet, and FAOSTAT.*

The regression analysis reveals a high and significant correlation between digitization and agricultural output. The positive and highly significant coefficient of Internet Users ($\beta = 0.4248$, $p < 0.01$) significantly supports the growth of agricultural GDP due to increased internet penetration. "Digital infrastructure is crucial for enhancing market access, information sharing, and sectoral productivity. Likewise, UPI transactions have a positive coefficient ($\beta = 0.0143$), which shows a positive effect on agricultural output, but the p-value ($p = 0.0546$) shows marginal significance at the 10 percent level, suggesting that although digital payments support growth, their impact is comparatively smaller than that of internet penetration. The R-squared value of 0.9977 shows that the digitalization factors included explain almost all fluctuations in agricultural GDP. The F-statistic is very significant ($p<0.01$), which confirms the overall robustness of the model. However, the Durbin–Watson statistic (0.517) indicates the presence of positive autocorrelation, which is common in time-series data and may somewhat reduce the efficiency of the estimates.

Table 4: *Regression Analysis - UPI & Internet Users on Price Index*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UPI	-0.327586	0.062731	-5.222085	0.0001
Internet Users	0.436044	0.095902	4.546746	0.0003
C	104.6963	2.194495	47.70862	0.0000
Model Summary				
R-squared	0.616001	Mean dependent var		111.8000
Adjusted R-squared	0.570825	S.D. dependent var		6.574272
S.E. of regression	4.306900	Akaike info criterion		5.895795
Sum squared resid	315.3397	Schwarz criterion		6.045155
Log likelihood	-55.95795	Hannan-Quinn criter.		5.924952
F-statistic	13.63550	Durbin-Watson stat		0.271113
Prob(F-statistic)	0.000293			

Note. *Dependent Variable - Price Index*; *Method - Least Squares*

Source: *Author's compilation based on data from Reserve Bank of India (RBI), MOSPI, World Bank, Agmarknet, and FAOSTAT.*

The coefficient for UPI transactions is negative and statistically significant ($\beta = -0.3276$, $p < 0.01$), suggesting that a fall in the Price Index is associated with an increase in the use of digital payments. Digitalization enhances market efficiency by increasing price transparency, reducing transaction frictions, and improving market integration. In contrast, internet penetration has a positive and significant effect ($\beta = 0.4360$, $p < 0.01$), which indicates that more extensive digital access may be associated with higher price levels at the beginning, possibly indicating more market participation and demand-side expansion. The R-squared value of 0.616 indicates that the digitalization factors included account for approximately 61.6% of the variation in the Price Index. The F-statistic is statistically significant ($p < 0.01$) that supports the joint significance of the model. The Durbin-Watson statistic is

0.27, which indicates a strong positive autocorrelation, suggesting that time-series dependence may be affecting the estimations.

Table 5: *Regression Analysis - UPI & Internet Users on Price Agricultural Export*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UPI	-0.040943	0.019986	-2.048644	0.0563
Internet Users	0.755213	0.030554	24.71742	0.0000
C	7.910457	0.699151	11.31437	0.0000
Model Summary				
R-squared	0.992401	Mean dependent var		30.10000
Adjusted R-squared	0.991506	S.D. dependent var		14.88871
S.E. of regression	1.372149	Akaike info criterion		3.608115
Sum squared resid	32.00749	Schwarz criterion		3.757475
Log likelihood	-33.08115	Hannan-Quinn criter.		3.637271
F-statistic	1109.997	Durbin-Watson stat		0.638424
Prob(F-statistic)	0.000000			

Note. *Dependent Variable -Agricultural Export*; *Method - Least Squares*
Source: *Author's compilation based on data from Reserve Bank of India (RBI), MOSPI, World Bank, Agmarknet, and FAOSTAT.*

Internet penetration has a positive and highly significant effect on Agricultural Exports ($\beta = 0.7552$, $p < 0.01$). This points to the fact that better digital infrastructure enhances market connectivity, access to information, and integration with global value chains. In contrast, UPI transactions present a negative coefficient ($\beta = -0.0409$) at marginal significance ($p \approx 0.056$), suggesting a weak and statistically less robust association with export performance. The very high explanatory power ($R2 = 0.992$) shows that the selected digitalization variables explain a significant proportion of variation in agricultural exports. The F-statistic was statistically significant ($p < 0.01$), supporting the overall validity of the model. However, the Durbin–Watson statistic (0.64) shows that there is positive autocorrelation, which is typical in time-series data and may affect the efficiency of estimates.

Table 6: *Regression Analysis Results* – Role of *UPI & Internet Users on Agricultural Export*

Variable	Agricultural *GDP*	Price Index	Agricultural Exports
UPI	+ (10%)	– (1%)	– (10%)
Internet Users	+ (1%)	+ (1%)	+ (1%)

Source: *Author's compilation based on data from Reserve Bank of India (RBI), MOSPI, World Bank, Agmarknet, and FAOSTAT.*

The comparative analysis of regression results shows that digitalization indicators play different but complementary roles in influencing agricultural market performance in India. The most pervasive and dominant factor is internet penetration, which exhibits a strong and statistically significant positive effect on all three dimensions: Agricultural GDP, Price Index, and Agricultural Exports, emphasizing the significance of digital infrastructure in augmenting productivity, market access, and trade integration. On the other hand, the effect of UPI

transactions on agricultural GDP at a marginal level is positive but has a significant negative relation with the price index, indicating their role in improving market efficiency and reducing price volatility. However, UPI exhibits a weak and marginally significant negative association with agricultural exports, indicating that transaction-based digital payments have limited direct effect on external trade performance.

Therefore, it is evident that digitalization affects agricultural markets through two different channels of infrastructure-driven effects and transaction-driven effects. Infrastructure-driven effects mainly through internet penetration increase growth and trade, and transaction-driven effects mainly through UPI improve market efficiency. This dual mechanism suggests that while digital payments can make transactions easier and prices more stable, broader digital connectivity is more important for structural transformation and long-term agricultural development.

DISCUSSION

The empirical analysis provides holistic evidence on the role of digitalization in determining the agricultural market scenario in India. Descriptive statistics point to significant growth in digital payment systems, particularly in UPI transactions, exhibiting high variability and positive skewness, indicative of the rapid expansion in recent years. In contrast, the agricultural GDP and agricultural exports are gradually increasing with moderate fluctuations. The price index is relatively stable with controlled price fluctuations. The trend analysis shows the structural change in the digital environment, especially after 2016, as a turning point in the adoption of digital payment systems. UPI transactions are growing exponentially, while mobile banking is growing linearly. Meanwhile, agricultural GDP and exports have been growing steadily, showing the sector is still expanding. But in recent years, the price index has been marked by mild fluctuations and a trend toward stabilization, pointing to an increase in market efficiency.

The correlation analysis shows positive relationships between the digitalization indicators and the agricultural performance variables. The high correlation between UPI transactions and internet users with agricultural GDP and exports indicates a strong link between digital adoption and better sectoral outcomes. In contrast, the price index is weakly to moderately negatively correlated with the digitalization variables, which indicates that increased digital adoption may stabilize prices and improve market efficiency. The regression results indicate that the model of agricultural GDP reveals that internet penetration has a strong and statistically significant positive effect, while UPI transactions have a positive but weakly significant effect. It implies that the role of digital infrastructure in agricultural growth is more important than the role of digital payments in transactions. In the price index model, UPI transactions have a significant negative impact, indicating that digital payments help in reducing price volatility and improving market efficiency. Internet penetration, however, is positively associated; perhaps indicating increased market participation and demand-side effects. Table 5: Export Model. Again, internet penetration is a

dominant factor with a strong positive effect on exports, while UPI has a weak, marginally significant effect.

Policy Implications

The findings of the study have important policy implications when considering the ongoing challenges faced by Indian farmers, such as indebtedness to formal banking institutions and informal moneylenders, instability of income, and distress-induced outcomes like farmer suicides. The focus should be on enhancing the digital infrastructure, particularly in rural areas, to ensure equal access to market information, fair price discovery, and timely financial services, which in turn reduces the dependence of the farmers on exploitative sources of credit. Simultaneously, it is important to build farmers' digital proficiency to ensure that they use digital platforms effectively and are able to make informed choices regarding production and marketing. Digital payment systems like UPI increase the efficiency of the market and reduce transaction costs, but the growing usage of digital payments in agricultural transactions will help make payments more transparent and faster, and will help ease the liquidity constraints of farmers. Moreover, integration of digital platforms like e-NAM with local agricultural markets can help bridge the gap between producers and buyers in those markets by enhancing market access and bargaining power. In a broad sense, digitalization should be seen not just as a technological intervention but also as a socio-economic support mechanism that can address structural vulnerabilities in agriculture. Strengthening digital ecosystems along with institutional support can help policymakers reduce financial distress, stabilize farm incomes, and ultimately reduce the socio-economic conditions that lead to farmer distress and suicides.

CONCLUSION

The research finds that digitalization plays a vital role in improving the performance of agricultural markets in India, and the penetration of the internet is the most significant driver of agricultural growth and export performance. The results clearly demonstrate that digital infrastructure leads to better market access, efficient information flow, and better integration with wider economic systems and thus plays a significant role in sectoral development. In contrast, the effect of digital payment systems, especially UPI, is more subtle as it leads to enhanced market efficiency with less price volatility, instead of directly influencing output or export growth. Digitalization operates through multiple channels, with infrastructure-led impacts dominating growth and trade results and transaction-based mechanisms underpinning market stabilization. The insights underscore the critical need to strengthen the digital ecosystems to foster sustainable, efficient, and inclusive agricultural development in India.

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Acknowledgements: The authors express their sincere gratitude to the institutions that provide publicly accessible datasets used in this study, including the Ministry of Agriculture and Farmers' Welfare, Reserve Bank of India (RBI), National Statistical Office (NSO), and other Government of India sources. The authors also acknowledge the valuable support and encouragement received from TKM Institute of Management during the course of this research.

Author Contributions: All authors contributed substantially to the conception, design, and execution of the study.

Funding: The authors received no financial support or funding for the research, authorship, or publication of this article.

Declaration of Conflicting Interests: The authors declare that there are no conflicts of interest associated with this research, authorship, or publication of this article.

Data Availability Statement: The data supporting the findings of this study are derived from publicly available secondary sources, including official publications and databases of the Government of India, the Reserve Bank of India (RBI), the Ministry of Agriculture and Farmers' Welfare, and the National Statistical Office (NSO). The compiled dataset and analytical procedures used in this study are available from the corresponding author upon reasonable request.

Artificial Intelligence (AI) Usage Disclosure

The authors declare that generative artificial intelligence (AI) tools were used only to assist with language editing, grammar improvement, and manuscript formatting where necessary. All research activities, including study design, data collection, statistical analysis, interpretation of results, and scientific conclusions, were performed solely by the authors. The authors have carefully reviewed and take full responsibility for the accuracy and originality.