

Growth of MSMEs and Financial Inclusion: Evidence from India's Agri-Warehousing Industry

Shreya Singh¹, Rajesh Pal²

¹*Research Scholar, Department of Economics, Mahatma Gandhi Kashi Vidyapith, Varanasi, UP.*

²*Professor, Department of Economics, Mahatma Gandhi Kashi Vidyapith, Varanasi, UP.*

Abstract—Agri-warehousing is an integral part of the infrastructure for supporting agriculture, facilitating the storage, marketing, and financing of agricultural commodities in India. Several warehousing units are part of the service sector which is classified under Micro, Small, and Medium Enterprises (MSMEs), which supports the supply chain of the agriculture market. This study aims to analyse the growth of the Agri-warehousing sector and its association with financial inclusion. The storage capacity, e-NWR, and number of registered warehouses were selected as variables to measure growth, whereas institutional credit served as a proxy for financial inclusion. Trend analysis, correlation and regression were applied to establish the association between the growth of Agri-warehousing and financial inclusion in India. The findings show a strong positive correlation, that the expansion of Agri-warehousing infrastructure is associated with the growth of agriculture credit, which obtains loans through warehouse receipt financing.

Index Terms—Agri-Warehouse, Financial inclusion, MSME services, Agriculture credit, Warehouse receipt.
JEL: G21, Q14, O16

I. INTRODUCTION

Agriculture is an important sector in India since it employs a substantial proportion of the rural people. As a result, efficient post-harvest management systems are critical for increasing farm income and lowering farmer losses owing to seasonal changes, enabling producers to take advantage of intertemporal price differences and thereby arbitrage opportunities (Naik et al.). Warehousing is critical for storing agricultural products. In India, the majority of storage and logistics businesses are classified as micro, small, and medium enterprises. Small- and medium-sized warehouses serve as service providers in the agricultural value chains (MSME Act 2006).

Consequently, this system functions as agricultural infrastructure and also strengthens India's MSME sector. In addition, the warehouse receipt system enables farmers to obtain institutional credit that enhances farmers' access to the formal financial ecosystem and supports financial inclusion. Financial inclusion is the process of ensuring access to financial services and timely and adequate credit where needed by vulnerable groups such as weaker sections and low-income groups at an affordable cost (C. Rangarajan). The concept of financial inclusion is determined by both demand- and supply-side parameters. Supply-side drivers consider perceptions of financial providers, such as banks and other institutions that emphasize the availability of financial services, whereas demand-side determinants consider the perspectives of individual users, including enterprises and households that focus on the ability and capacity of farmers to access credit (Wang'oo, 2013).

The present study tries to find out how infrastructure like number of warehouses, capacity, Negotiable Warehouse Receipt (NWR), and electronic warehousing receipt (e-NWR) development influences demand and supply-side by reducing credit risk and collateral availability under a financial inclusion expansion mechanism.

In fact, for the expansion of warehouses to meet farmers' financial requirements, banks provide credit to the extent of 70 to 80 percent of the value of the stored products based on the security of the warehouse receipt. According to the Warehousing (Development and Regulation) Act, 2007, introduced by the government of India, it came into force in October 2010. However, the progress of loans against NWR is notified slowly because of more paperwork, which takes a long time and costs and has adequate accuracy. Therefore, WDRA launched e-NWR in September

2017, and after 2019 it was compulsory that registered warehouses only issue electronic NWR in place of NWR, which increases the digital ecosystem that sustains the goal of financial inclusion (Sharon, 2023). In India, agricultural warehousing is growing rapidly, with maximum growth in capacity across Central (CWC) and State Warehousing Corporations (SWC) key states such as Tamil Nadu, Madhya Pradesh, Maharashtra, Haryana, Punjab, Uttar Pradesh, and West Bengal. The study emphasizes the growth of warehousing infrastructure and its correlation with determinants of financial inclusion. Furthermore, articulate which determinant is affected by growth directly and indirectly.

The rest of the paper is divided into 4 sections. Section one deals with the introduction and existing literature related to the study reviewed in section two; section three deals with data criteria and methodological framework. Section four presents the results and discussion. At last, the study is concluded in section five.

II. LITERATURE REVIEW

Agri-Warehousing and Financial Inclusion have been the subject of numerous studies in India and around the world. The first part of the review covers studies conducted by regulatory institutions, whereas empirical studies are discussed in the second part.

Regulatory Institutions

According to the Ministry of Micro, Small, and Medium Enterprises (2006), logistical and storage services are included in the MSME sector in the MSME Act of 2006. This categorization indicates that Agri-warehousing can be treated as a rural service enterprise that helps develop the MSME sector in India. Similarly, World Bank and Food and Agriculture origination. Likewise, the World Bank and Food and Agriculture Organization have highlighted the importance of the warehouse receipt system in enhancing farmers' access to formal credit. However, the Warehouse Development and Regulatory Authority explains that electronic warehouse receipts are used to enhance transparency and efficiency in storage.

Empirical Studies

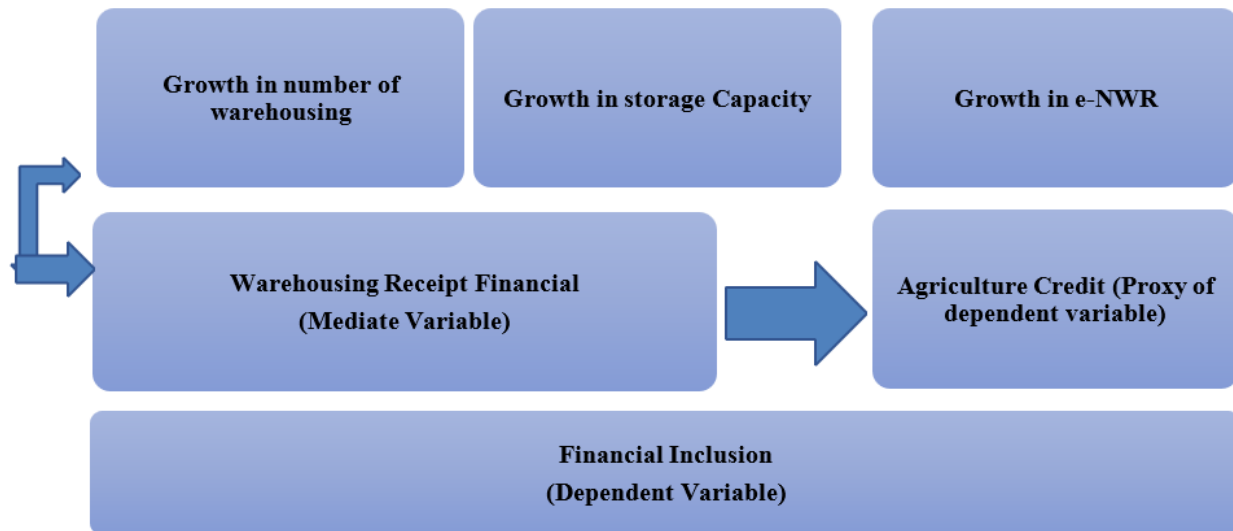
Sharon (2023) conducted a study to assess the growth and performance of warehousing. The results show that the growth in the number of Central Warehousing Corporations and State Warehousing Corporations increases by 102.42 percent with an average storage capacity of 10.6.78 lakh MT and 105.25 percent with an average storage capacity of 439.12 lakh MT. However, when it comes to growth in terms of warehousing receipts, e-NWR is more effective than NWR. Rangasamy (2013), critically examined the economic performance of Maharashtra State Warehousing Corporation using a tabular analysis method. The results show that net profit before tax consistently increased between 2005 and 2010, and other economic indicators such as capacity utilization, financial analysis ratio, gross profit to turnover, and net profit tax to turnover showed positive growth in Agri-warehousing in the state. Similarly, Singhal (2017) conducted a zonal analysis to determine the performance of storage and warehousing businesses in India. The analysis shows that overall productivity and resource usage efficiency in the S & W industry and its sub-sectors improved between 2005-06 and 2009-10. The zone-wise results show significant diversity in this sector's performance due to differences in resource usage efficiency, labour productivity, capital, and labour cost. On the other side, Shwartz (2024) discusses how warehouse receipt financing affects the trading terms for farmers with restricted access to finance and storage facilities. The results show that warehouse receipt financing has a positive and long-term influence on farmer prices, as well as a reduction in inter-seasonal price volatility as a result of treatment. Patil (2026) investigated the digital frontier of warehouse finance in India by exploring the evolution of the traditional negotiable warehouse receipt system to the current electronic negotiable warehouse receipt system, including the launch of the e-Kisan Upaj Nidhi (KUN) gateway. The study findings indicate that although the pledge has reached a record high of Rs. 3,300 crore per year, smallholders need attention. Likewise, Infravision Foundation (2023) debated the status of WDRA warehouse registration and the extension of the e-NWR granted. According to the findings of this study, strengthening warehousing facilities, upgrading regulatory frameworks, and boosting NWR can all improve market efficiency and agriculture financing.

III. RESEARCH GAP

The existing literature has broadly separately examined the importance of warehouses and storage infrastructure to strengthen the agriculture sector and former access to agriculture credit. Most of the studies conducted on only warehousing performance and growth variables with limited attention have been given to examine the relationship between Agri-

warehousing and financial inclusion. Although, there are lots of studies focusing on MSMEs while the role of Agri-warehousing as a service section of MSMEs which contribute to rural development and a part of farmers financial inclusion has limited attention. Therefore, this study attempts to bridge the gap and analyse the relationship between Agri-warehousing infrastructure expansion and financial inclusion.

Conceptual Framework



Note- e-NWR stands for Electronic Negotiable Warehouse Receipt.

Objective of the study

1. To analyze the growth of Agri-Warehousing in India.
2. To investigate the relationship between the growth of Agri-warehouses and agriculture credit.
3. To explore the role of Agri-Warehouses supporting financial inclusion.

Methodology

This study used descriptive research design. It is based on a secondary time-series data which involved a 14 years (2011-2023) dataset to examine the relationship between dependent and independent variables.

Variable Description

Independent Variables: Number of warehousing, storage capacity, e-NWR issued are the indicators which have been used to measure the growth of Agri-warehousing sector.

Mediating Variable: Warehousing receipt financing plays a mediating role in the study to connect the growth indicators and financial inclusion.

Dependent Variable: Agricultural credit has been used as a regressor to represent financial inclusion.

Analytical Techniques: The study employs descriptive statistics for analysis and trend analysis has been used to tackle the movement of variables over the taken time period. Correlation and regression analysis are performed to examine the relationship between Agri-warehousing indicators and financial inclusion.

Analytical Tool: In this study empirical analysis performed by R software.

Model Specification

$$\text{Agriculture Credit} = \beta_0 + \beta_1 \text{Warehouses} + \beta_2 \text{Storage Capacity} + \beta_3 \text{e-NWR} + \mu$$

IV. RESULTS

Table 1 shows the descriptive statistics for the variables considered in this investigation.

	Year	Warehouses	Storage Capacity (MT)	e-NWR	Agri-Credit (Cr)
MIN.	2011	68.0	112.4	6121	455290
1 ST QU.	2014	234.0	118.9	12313	845329
MEDIAN.	2017	337.0	152.8	19350	1162617
MEAN.	2017	612.5	154.3	45378	1278933
3 RD QU.	2020	610.0	166.2	88480	1575398
MAX.	2023	2184.0	246.3	138637	2548635

The descriptive statistics show that warehouses, storage capacity, e-NWR, and agricultural credit have considerable variation over the taken period. A high mean value of agricultural credit indicates a substantial increase in credit flow over the period. Storage capacity also shows positive and significant variation that highlights strong infrastructural expansion. On the other hand, electronic NWRs reflect moderate variation in the adoption of digital conversion in receipt systems in the replacement of paper-based NWRs. In contrast, the registration of the number of warehouses has been slow in India. This reflects that the quantity of warehousing does not take speedy growth in the study period.

Table 2(Appendices) shows the annual growth rate, which reflects that the growth pattern of every variable is different and uneven. The number of warehouses has had a negative growth rate in several years due to the high investment requirement and the existence of regulatory challenges in the sector. Consequently, it shows fluctuations that limit the possible infrastructure expansion. Storage capacity has been relatively stable with few negative growth numbers. The fluctuations of e-NWR reflect its progressing nature, dependency on formal financial institutions for requirements, adoption of a digital ecosystem, and awareness among farmers.

Further the trend analysis supports the growth findings the continuity rising trend in storage capacity(figure-1) indicate establishment of strong qualitative based infrastructure of warehouses. Up word and down word slops in e-NWR (figure-2) present that it takes a time due to policy changes, implementation, awareness of new technology and emerging role in the financial environment. However, the upward trend in agriculture credit(figure-3) reflects that year-by-year farmers are more included in financial institutions which promote financial inclusion.

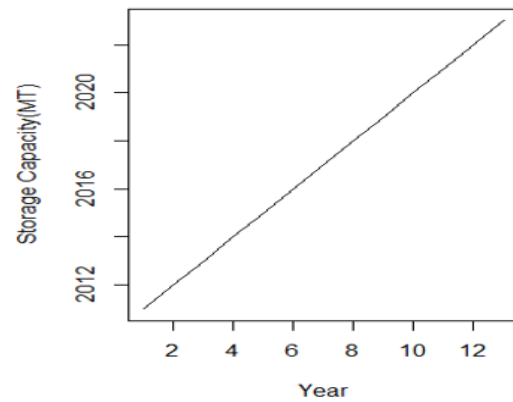
Trend of Agri Warehousing Capacity

Fig. 1. Trend of warehousing in India 2011-2023

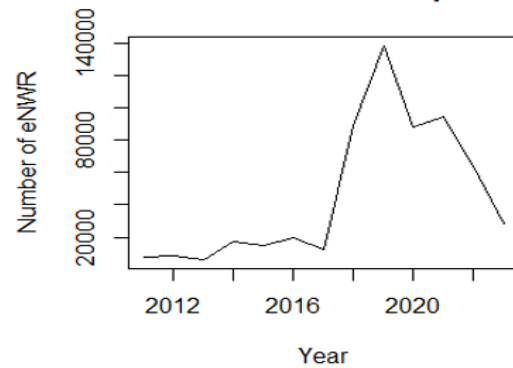
trend of Warehouse Receipts Issued

Fig. 2. Trend of warehousing Receipt issued in India

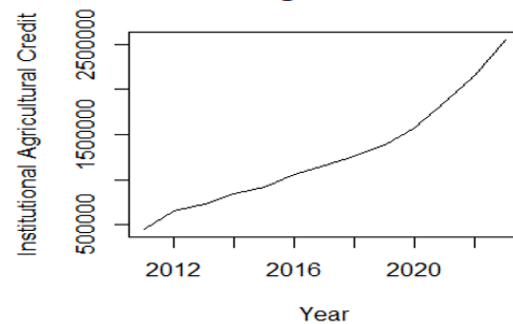
Trend of Agricultural Credit

Figure-3 Trend of Agriculture credit in India 2011-2023

Normalized Trends of Selected Variables

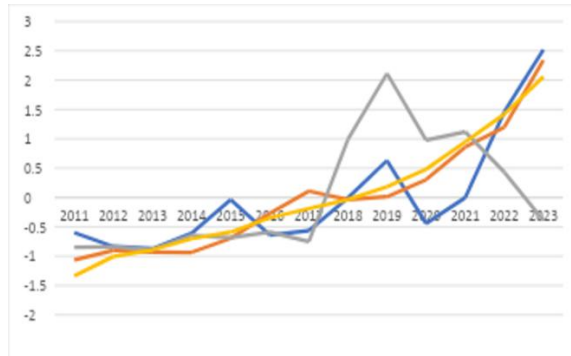


Figure-4

Selected variables have in different units the normalization method was applied to convert in standard values to present in combined in a single graph. This graphical representation shows the behaviour of all variables' simultaneous movement over the time period.

Table 4

Variables	Warehouses	Storage Capacity	e-NWR	Agri Credit
Warehouses	1.00	0.87	0.31	0.86
Storage Capacity	0.87	1.00	0.37	0.98
e-NWR	0.31	0.37	1.00	0.47
Agri Credit	0.86	0.98	0.47	1.0

Relationship between Storage capacity and

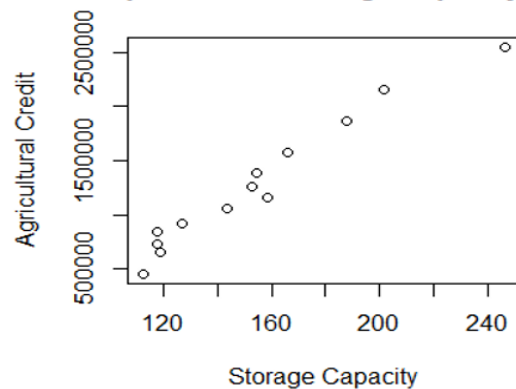


Figure 5- Relationship between storage capacity and Agriculture credit

The above scatter plot indicates a strong positive relationship exists between storage capacity and agriculture credit that follows an upward-sloping pattern. The pattern indicates that when the capacity of

storage is enhanced, it affects farmers' ability to access formal financial institutions by providing collateral in the form of stored produce.

Table 5

Value	Coefficient	Std. Error	t-value	p-value
Intercept	-993500	200600	-4.952	0.00078**
Warehouses	46.44	102.0	0.455	0.65956
Storage Capacity	1405004	165600	8.479	1.29005**
e-NWR	1.708000	0.767001	2.227	0.05297*

Note: Model Summary

R² = 0.9767, Adjusted R² = 0.96, F-statistics = 125.8 on 3 and 9 Df, p-value = 1.15e-06

Note: ***, **, and * denote significant levels at 1%, 5%, and 10% respectively.

The regression model is statistically significant at the 1 percent, indicating that independent variables jointly influence agriculture credit which is a proxy of financial inclusion. The high R² value represents 97.6 percent of variation in agriculture credit explained by the model.

In the model Storage capacity plays a key driver role according to find has a positive and highly significant ($p < 0.01$) impact on agriculture credit. This shows that an expansion in storage capacity substantially enhances the availability of agriculture credit. Whereas, the coefficient of e-NWR is positive and significant at the 10 percent level (0.0529), contributing to improving access to formal institutional credit and demonstrating the importance of digital financial mechanisms in the warehousing sector. However, the coefficient of warehouses is still positive but statistically insignificant which reflects that the number of warehouses alone does not influence agriculture credit.

V. DISCUSSION

The results highlight the important aspects of the role of Agri-warehousing infrastructure in promoting financial inclusion in India. Correlation and trend analysis clearly show that the different components have had an uneven growth pattern in the study time period. Storage capacity and agricultural credit have

relatively high growth rates. This defines that both are strongly policy supported; they increase investment and rising demands for financial services in the agriculture sector. In contrast, slow and rigid growth patterns in e-NWR and the number of warehouses is due to institutional constraints and stagnant structural frameworks. This indicates that in India capacity expansion and financial inclusion are more dynamic as compared to physical infrastructure and new digital technological adoption processes. The regression results show the importance of the e-NWR digital mechanism in strengthening the credit system.

Furthermore, the finding of the study reinforces that the supply-side dimension of financial inclusion is extended rather than the demand-side in the Agri-warehousing sector. The strong significant impact of storage capacity and moderate level of e-NWR on credit access reflects the role of infrastructural growth to enhance institutional supply-side factors like availability, accessibility, and affordability, focusing on the system capacity to deliver them. Similarly, the positive effect of electronic negotiable warehouse receipts reflects the digital mechanism's importance to reducing the transaction cost and improving credit delivery to farmers.

Overall, the empirical findings of the study suggest that Agri-warehousing plays an important role as an MSME in India. Over the last decade, with major acceleration occurring between 2010 and 2023, this expansion is driven by a shift from structural changes from traditional storage to modern, resisted by record agricultural production and high post-harvest losses. A structural shift is also seen in the financial system from paperwork to digital infrastructure changes.

VI. CONCLUSION

The study concludes that Agri-warehousing infrastructure growth plays a significant role in supply-side financial inclusion with different levels across measurable components. Storage capacity emerges as the most dominating component to access

agriculture credit; e-NWR is a second, moderate level and sometimes acts as a mediator to access financial institutions. In contrast, the number of warehouses does not grow significantly and does not alone support credit demand. Secondly, it highlights the supply-side factors by improving collateral-based lending and strengthening the credit delivery system of the financial sector, which is one of the major sources of financial inclusion.

Thus, the study emphasized that Agri-warehousing (MSME) growth directly impacts financial inclusion through strong capacity building and structural shifts from NWR to e-NWR, which reflect the dynamic nature of the digital ecosystem. Last but not least, empirical findings suggest that quality and capacity of infrastructure are more important than quantitative numbers.

VII. POLICY IMPLICATION

1. Policymakers should pay attention to expediting a larger number of Agri-warehouses across states in India.
2. Storage capacity plays a major role in the growth of Agri-warehouses, so the government should prioritize it.
3. There is a need for awareness toward accessibility and efficiency of digital mechanisms that strengthen the e-NWR system.
4. The government should adopt a coordinated approach to the robust development of integrated physical and digital infrastructure.

VIII. LIMITATION AND FURTHER SCOPE

This study is limited to aggregate-level analysis, which excluded a micro-level factor that varies across the states. The study suggests to future researchers that they use state panel analysis and advanced econometric tools to cover micro-level differences.

APPENDICES

Table-2

Year	Warehouses	Storage_ Capacity	e-NWR	Agri Credit	Credit Growth	Storage Growth	Warehouses Growth
2011	240	112.37	8056	455290			
2012	92	118.9	8242	659383	44.82703332	5.811159562	-61.66666667

2013	68	117.82	6121	730123	10.72821107	-0.908326325	-26.08695652
2014	234	117.52	16993	845329	15.77898518	-0.2546257	244.1176471
2015	588	126.96	15178	915510	8.302211328	8.032675289	151.2820513
2016	214	143.7	19350	1065755	16.41107142	13.1852552	-63.60544218
2017	261	158.52	12313	1162617	9.088580396	10.3131524	21.96261682
2018	607	152.76	89114	1256830	8.103528505	-3.633610901	132.5670498
2019	1005	154.82	138637	1392729	10.81283865	1.348520555	65.56836903
2020	337	166.2	88480	1575398	13.1159041	7.350471515	-66.46766169
2021	610	188.02	94736	1863363	18.27887302	13.12876053	81.00890208
2022	1522	201.36	64462	2155163	15.65985801	7.094989895	149.5081967
2023	2184	246.33	28231	2548635	18.25718055	22.33313468	43.49540079

Note: Warehousing development and regulatory authority.

Growth rate has been calculated by the authors.

Table-3 Normalise vale of agriculture warehousing indicators and agriculture credit in India (2011-2023)

Year	Warehouses	Storage Capacity	e-NWR	Agri-Credit
2011	-0.597747562	-1.065591643	-0.845827507	-1.33534973
2012	-0.835266419	-0.899451958	-0.841612185	-1.004459242
2013	-0.873782991	-0.926929884	-0.889680452	-0.889770384
2014	-0.607376705	-0.934562642	-0.643288093	-0.702989996
2015	-0.039257275	-0.694385209	-0.684421475	-0.58920743
2016	-0.639473847	-0.268477348	-0.589871354	-0.345619255
2017	-0.564045562	0.108580866	-0.749351029	-0.188579501
2018	-0.008764989	-0.037968075	0.991191607	-0.0358345
2019	0.629968155	0.014443525	2.11353237	0.184494891
2020	-0.442076418	0.303979455	0.976823252	0.480651224
2021	-0.003950418	0.859135342	1.118603108	0.947521129
2022	1.4596793	1.19853862	0.432502826	1.420608615
2023	2.52209473	2.34268895	-0.388601069	2.058534179

Notes: Authors Calculation.

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