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An International Bhutan Conference Proceedings

IJISEM
INTERNATIONAL JOURNAL OF INNOVATIONS IN SCIENCE ENGINEERING AND MANAGEMENT

International Journal of Innovations In Science Engineering And Management

AI-Driven Credit Risk Assessment in Agriculture: A Case Study of Indian Commercial Banks

OPEN ACCESS

Volume: 3

Issue: Special issue 2

Month: December

Year: 2024

ISSN: 2583-7117

Citation:

Ranjit Singh and Meenakshi Mritunjay "AI-Driven Credit Risk Assessment in Agriculture: A Case Study of Indian Commercial Banks" International Journal of Innovations In Science Engineering And Management, vol. 3, no. Special Issue 2, 2024, pp. 118-125.

DOI:

10.69968/ijisem.2024v3si2118-125

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Abstract

India's economy is based mostly on agriculture, which employs about half of the labour force and accounts for 17–18% of GDP (gross domestic product). The agricultural industry is full with uncertainties, despite its crucial importance. These uncertainties include unpredictable weather patterns, volatile market prices, and the inherent risk of crop failure. These difficulties make it more difficult to obtain sufficient funding in a timely manner, which is necessary for farmers to make investments in infrastructure, technology, and inputs that raise production. Commercial banks have always depended on traditional techniques for assessing credit risk, which frequently fall short in effectively assessing the intricacies of agricultural concerns. Banks have taken a cautious stance as a result, restricting the amount of credit that is available to the rural sector.

Keyword: Credit Risk Assessment, Agriculture, Indian Commercial Banks

INTRODUCTION

India's economy is based mostly on agriculture, which employs about half of the labour force and accounts for 17–18% of GDP (gross domestic product). The agricultural industry is full with uncertainties, despite its crucial importance. These uncertainties include unpredictable weather patterns, volatile market prices, and the inherent risk of crop failure. These difficulties make it more difficult to obtain sufficient funding in a timely manner, which is necessary for farmers to make investments in infrastructure, technology, and inputs that raise production. Commercial banks have always depended on traditional techniques for assessing credit risk, which frequently fall short in effectively assessing the intricacies of agricultural concerns. Banks have taken a cautious stance as a result, restricting the amount of credit that is available to the rural sector.

The use of artificial intelligence (AI) in financial services has created new opportunities in recent years for improving credit risk assessment. AI-driven models provide a more sophisticated knowledge of credit risks in agriculture because of their capacity to analyze massive information and produce predicted insights. Artificial Intelligence (AI) has the potential to improve risk assessment accuracy and empower banks to make better loan decisions by integrating a variety of data sources, including weather predictions, satellite imaging, soil health, and market trends. This technical development might make it easier for farmers to obtain loans, which would promote financial inclusion and help the agriculture industry grow sustainably.

PROBLEM STATEMENT

Indian commercial banks are only now beginning to use AI-driven credit risk assessment in agriculture, despite the potential advantages. The usefulness of AI models in precisely forecasting agricultural credit risks and their influence on commercial banks' lending policies is not well supported by actual data. Furthermore, there are a number of obstacles to overcome when integrating AI in this setting, including concerns about ethical issues, model accuracy, data accessibility, and banking organizations' preparedness to adopt new technology. A major obstacle to the broad application of AI in agricultural financing is the incomplete knowledge of these variables, which might exacerbate the problems with loan availability and financial exclusion that farmers now face.

OBJECTIVES

Examining how AI-driven credit risk assessment is changing agricultural lending procedures in Indian commercial banks is the main goal of this study. The study specifically attempts to:

1. Assess the existing level of AI usage in credit risk assessment by Indian commercial banks in the agricultural sector.
2. Examine how well AI models anticipate agricultural credit risks and how this influences commercial banks' lending decisions.
3. List the main obstacles to and possibilities presented by integrating AI into the evaluation of agricultural loan risk.
4. Make legislative suggestions to improve the agricultural industry's use of AI-driven credit risk assessment, with an emphasis on expanding farmers' access to finance and financial inclusion.

By offering a thorough case study of AI's implementation in Indian commercial banks, empirical insights into its application in agricultural credit risk assessment, and recommendations for utilizing AI to support India's agriculture's sustainable development, this study will add to the body of knowledge already in existence.

Role of commercial banks in providing agricultural credit

One of the primary sources of institutional credit in India is commercial banks, which is necessary to finance agricultural activities. Institutional credit, which includes both short- and long-term loans, is essential to meeting the numerous financial needs of farmers, including paying improvements to infrastructure like irrigation and storage facilities as well as the purchase of seeds, fertilizer, and equipment.

Commercial banks, which include both private and public sector banks, have contributed significantly to agriculture's financial resources in India. The Reserve Bank of India (RBI) mandates that they allocate a certain percentage of their lending portfolio to the agriculture sector under the Priority Sector Lending (PSL) criterion. This ensures that farming enterprises receive a sizable percentage of loans, boosting and enhancing agricultural output.

Commercial banks play a number of roles in agricultural lending, including:

1. Credit Accessibility: Commercial banks make credit more accessible to farmers, especially through a range of government initiatives and subsidies that lower loan interest rates. For small and marginal farmers—who frequently lack collateral—this accessibility is vital.

2. Support for Modernization: Commercial banks enable the modernization of agriculture, which is necessary to boost production and efficiency, by providing loans for the acquisition of contemporary agricultural equipment and technology.

3. Risk management: To assist farmers in reducing the risk of crop failures brought on by natural disasters and assuring financial stability, commercial banks frequently combine agricultural financing with insurance products.

4. Financial Inclusion: Commercial banks have been instrumental in providing formal financial services to distant and rural regions through programs like as the Kisan Credit Card (KCC) scheme, therefore aiding in the larger objective of financial inclusion.

5. assist for Rural Development: By facilitating investments in related industries including dairy, poultry, and fisheries, commercial banks' financing extends not only to assist agricultural operations but also to help rural development.

In nutshell, commercial banks play a critical role in India's institutional structure supporting agricultural loans, giving the industry the financial backing it needs to continue expanding. Their function is essential in guaranteeing that farmers have the financial means to enhance and expand their farming methods, hence bolstering the rural economy of India.

Share of different institutional credit from the year 1999-2020

Table-1

Year	Cooperative Banks	Regional Rural Bank	Commercial Banks	Other Agencies	Total
1999-2000	18260 (39.47)	3172 (6.86)	24733 (53.46)	103	46268
2000-2001	20718 (29.22)	4220 (7.99)	27807 (52.64)	82	52827
2001-2002	23524 (37.91)	4854 (7.82)	33587 (54.13)	80	62045
2002-2003	23636 (33.98)	6070 (8.73)	39774 (57.18)	80	69560
2003-2004	26875 (30.90)	7581 (8.72)	52441 (60.29)	84	86981
2004-2005	31231 (24.92)	12404 (9.90)	81281(65.02)	193	125309
2005-2006	39403 (21.83)	15223 (8.43)	125477 (69.52)	382	180485
2006-2007	42480 (18.52)	20435 (8.91)	166485 (72.57)	-	229400
2007-2008	48258 (18.95)	25312 (9.94)	181088 (71.11)	-	254658
2008-2009	45966 (15.23)	26765 (8.87)	228951 (75.83)	226	301908
2009-2010	63497 (16.51)	35217 (9.16)	285800 (74.33)	-	384514
2010-2011	78121 (16.68)	44293 (9.46)	345877 (73.86)	-	468291
2011-2012	87963 (17.21)	54450 (10.65)	368616 (72.13)	-	511029
2012-2013	111203 (18.31)	63681 (10.48)	432491 (71.21)	-	607375
2013-2014	119964 (16.43)	82653 (11.32)	527506 (72.25)	-	730123
2014-2015	138469 (16.38)	102483 (12.12)	604376 (71.50)	-	845328
2015-2016	153295 (16.74)	119261 (13.03)	642954 (70.23)	-	915510
2016-2017	142758 (13.40)	123216 (11.56)	799781 (75.04)	-	1065755
2017-2018	150389 (12.87)	140959 (12.06)	877155 (75.07)	-	1168503
2018-2019	152340 (12.12)	149667 (11.91)	954823 (75.97)	-	1256830
2019-2020	157367 (11.30)	165326 (11.87)	1070036 (76.83)	-	1392729
CAGR	**12.97**	**22.93**	**21.84**		**19.81**
CV (%)	**66.27**	**94.85**	**89.26**		**85.92**

Serving as the main middlemen for the distribution of credit throughout the economy, commercial banks are essential to the functioning of the financial system. Their percentage of India's overall loan distribution has increased over time, indicating a major increase in their power. Commercial banks increased the amount of credit they offered from 24,733 crores to an astounding 1,070,036 crores between 1999 and 2000. By 2019–2020, this amount accounted for more than 75% of all loan disbursements. This expansion highlights how important it is for them to help different economic sectors, especially by lending money and providing advances to people, companies, and governments. They are vital to economic development because of their capacity to mobilize substantial deposits and offer credit, which promotes growth via funding company expansions, infrastructure improvements, and other crucial economic activities. Commercial banks' dominating position is a result of their ability to innovate and adjust to the changing financial demands of the economy, which promotes stability and growth in a number of industries.

Share of different commercial banks in rendering agricultural credit:

Table-2

Bank	Share of percentage
State Bank of India (SBI):	25-30% Specifics-SBI, India's largest public sector bank, leads in agricultural loan funding due to its vast network, deep rural reach, and diverse agricultural financial products.
Punjab National Bank(PNB):	8-10% Specifics-PNB Key Agri-credit player with extensive rural reach.
Bank of Baroda	7-8%

(BoB)	Specifics-Major Agri-financer in Western/Central India.
CanaraBank	6-7% Specifics-Diverse Agri-loans with strong rural presence.
Union Bank of India	5-6% Specifics-Major Agri-funder, enhanced by Andhra and Corporation Bank mergers.
Central Bank of India	4-5% Specifics-Major Agri-funder with strong Eastern/Central India presence.
Additional PSBs	12-15% Specifics-UCO Bank, Indian Overseas Bank, and others hold notable but smaller agricultural loan shares in the PSB market.

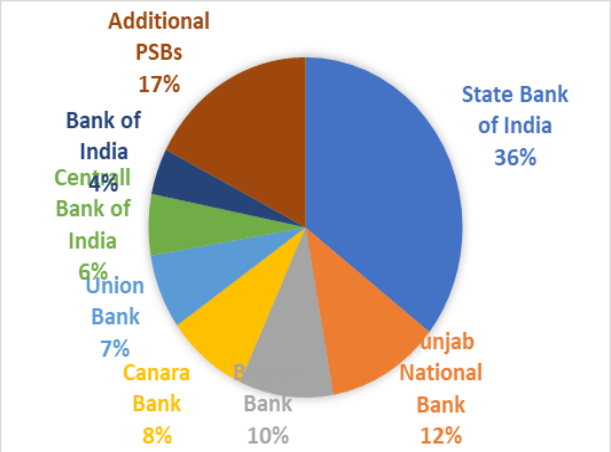

Figure 1

REVIEW OF LITERATURE

The body of research on AI-driven credit risk assessment is growing quickly as more scholars examine how AI may completely transform the financial services industry, especially when it comes to agriculture. The important research and contributions that lay the groundwork for comprehending how AI is used by Indian commercial banks to analyse agricultural credit risk are highlighted in this study.

Artificial Intelligence in Credit Risk Evaluation

Many studies have been conducted on the incorporation of AI into credit risk assessment, especially in the banking and finance industries. The application of machine learning techniques in credit scoring was first investigated by Khandani, Kim, and Lo (2010), who showed how AI might be used to analyze big datasets and increase the accuracy of credit risk models. According to their research, AI models have the potential to perform better than conventional credit scoring techniques, particularly in settings with intricate and nonlinear interactions.

Wang, Luo, and Zhang (2020) looked at the usefulness of AI-driven models in the banking industry for assessing credit risk in a more recent study.They discovered that artificial intelligence (AI) methods, including decision trees and neural networks, greatly improve credit risk assessments' capacity for prediction. The authors made the case that the use of AI enables more dynamic and real-time analysis, which is especially advantageous in industries where hazards are frequently changeable, like agriculture.

Artificial Intelligence in Agriculture Finance

AI's use in agriculture has drawn attention as a way to solve the particular problems the industry faces, particularly in financial services. The application of AI in precision agriculture was covered by Basso, Cammarano, and Carfagna (2013), who emphasized the ways in which AI technology may improve crop management and production forecasts.These insights are essential for assessing credit risk because they enable banks to more precisely analyze the possible returns on agricultural investments.

Kumar, Aggarwal, and Gaur (2018) investigated the application of AI to enhance the provision of agricultural loans in India. Their research concentrated on the application of AI-based instruments by Indian banks to evaluate farmers' creditworthiness. The authors emphasized how AI may lessen the need for collateral-based lending, giving small and marginal farmers more access to financing. They did, however, also highlight the difficulties in gathering data and validating models in the context of Indian agriculture.

Opportunities and Difficulties for AI-Powered Credit Risk Evaluation

There is much evidence of the difficulties in applying AI-driven credit risk assessment in the agricultural sector. The practical and ethical concerns around the use of AI in financial services were covered by Iyer, Khanna, and Varma (2019). They drew attention to the dangers of algorithmic bias and the possibility that AI models may exacerbate already-existing inequities in loan availability. In order to guarantee the fairness, transparency, and inclusivity of AI-driven credit risk assessments, the authors advocated for stronger regulatory frameworks.

However, Ghosh, Sinha, and Mahajan (2021) emphasized the potential that artificial intelligence (AI) offers to improve financial inclusion in agriculture. Their research concentrated on how AI may increase impoverished rural communities' access to loans.They maintained that AI may assist banks in better comprehending the requirements and habits of rural borrowers, resulting in more efficient and specialized loan offerings.

Case Studies on AI and Credit for Agriculture

The usefulness of artificial intelligence in agricultural financing has been examined in a number of case studies. The research by Sharma and Singh (2020), which looked at how a major Indian commercial bank used AI to evaluate the credit risk of farmers, is one noteworthy example. According to the study, the bank's AI-driven model improved the speed and effectiveness of the credit approval process while also dramatically lowering the default rates of agricultural loans.Patel, Raj, and Desai (2022) examined the application of AI to evaluate the creditworthiness of Maharashtra's sugarcane farmers in another case study. The bank was able to better manage risk thanks to AI-based evaluations, the authors concluded, which resulted in a more lucrative and sustainable portfolio of agricultural loans.

In summary

The body of research highlights how AI-driven credit risk assessment in agriculture has the potential to revolutionize the industry, especially in terms of improving the accessibility and effectiveness of commercial banks' loan distribution. But there are still issues with model accuracy, data availability, and ethical issues. Future studies have to concentrate on resolving these issues and investigating AI's long-term effects on Indian agriculture financing.

RESEARCH METHODOLOGY

Utilizing a qualitative case study approach with an emphasis on secondary data, this study investigates how Indian commercial banks are implementing and utilizing AI-driven credit risk assessment in agriculture. In order to gather data, a thorough analysis of scholarly journals, business reports, bank reports, and government publications is conducted, with a particular emphasis on case studies of several Indian commercial banks that have used AI models for agricultural lending. The investigation covers effect, comparison, and theme evaluations to find commonalities, variances, and adoption-related consequences for AI. Data accuracy, appropriate acknowledgment, and bias reduction were all upheld as ethical factors.Even though the study is constrained by the quantity and caliber of secondary data available, it provides insightful information on how AI might be used in practice to improve credit risk assessment and financial inclusion in agriculture.

CASE STUDIES

1.State Bank of India (SBI) - YONO Krishi

Scheme: YONO Krishi is a digital platform designed especially for farmers that is incorporated into SBI's YONO app. SBI evaluates farmers' creditworthiness by examining past transaction data, land records, and crop patterns using AI and machine learning algorithms.

Case Study: To assess the credit risk of farmers requesting agricultural loans, SBI employs AI. To anticipate the chance of default, the AI model takes into account a number of variables, such as market prices, soil conditions, and weather forecasts. As a result, the agriculture industry's non-performing assets (NPAs) have decreased.

2. HDFC Bank - AI-based Predictive Analysis for Kisan Gold Card

Scheme: AI-driven predictive analysis is utilized by HDFC Bank to evaluate credit risk for farmers who apply for the Kisan Gold Card, a lending instrument.

Case Study: To calculate loan limitations, HDFC Bank developed AI algorithms that examine crop cycles, farmer payback history, and agricultural production. As a result of this project, credit evaluations are now more accurate, which has improved loan targeting and decreased default rates.

3. ICICI Bank - iMandi Digital Platform

Scheme: ICICI Bank's iMandi is a digital platform with an agricultural focus that uses AI to provide farmers with credit risk assessment services.

Case Study: To determine the credit risk of farmers requesting loans, iMandi use artificial intelligence (AI) to evaluate data from a variety of sources, including as satellite images, weather patterns, and market pricing. Customizing loan products and setting interest rates according to individual risk profiles are made easier by the AI model.

4. Axis Bank - Kisan Credit Card (KCC) with AI Integration

Scheme: The Kisan Credit Card (KCC) scheme from Axis Bank employs AI to expedite the credit approval procedure for farmers.

Case Study: To evaluate a farmer's creditworthiness, Axis Bank uses AI-driven algorithms that examine land records, crop trends, and previous loan histories. The AI-based evaluations have significantly accelerated loan distribution speed and decreased default rates, according to the bank.

5. Punjab National Bank (PNB) - AI-powered Agri-loan Disbursement

Scheme: PNB's AI-powered Agri-loan distribution system assesses farmer credit applications using machine learning.

Case Study: To anticipate farmers' creditworthiness, PNB's AI system analyses information from several sources, including as government records and satellite data. Thanks to this technology, the bank has observed a reduction in loan processing times and an increase in loan payback rates.

6. Bank of Baroda - Baroda Kisan Digital Platform

Scheme: Baroda Kisan, a digital platform from Bank of Baroda, combines AI to offer farmers end-to-end solutions, including credit risk assessment.

Case Study: By examining variables like weather, crop trends, and past loan performance, the Baroda Kisan platform use AI to evaluate the risk involved with agricultural loans. As a result, the bank's agricultural portfolio now has fewer non-performing assets (NPAs) and it can provide more precise lending products.

7. Yes Bank - AI-driven Agri-Finance Solutions

Scheme: Yes Bank has created credit risk assessment tools and other AI-driven solutions to improve its Agri-finance products.

Case Study: Yes Bank evaluates farmers' creditworthiness by analysing satellite images, meteorological data, and market patterns using artificial intelligence. The bank's AI algorithms have assisted in lowering the risks connected with agricultural lending and speeding up the approval process for loans.

8. Kotak Mahindra Bank - AI-enhanced KCC Program

Scheme: The KCC program from Kotak Mahindra Bank evaluates farmers' credit risk using artificial intelligence and big data analytics.

Case Study: By examining crop yields, market prices, and repayment histories, the bank uses artificial intelligence (AI) to assess farmers' financial health. As a result, there are now fewer loan defaults and more accurate credit evaluations.

9. Union Bank of India - AI-powered Farmer Credit Assessment

Scheme: Union Bank of India leverages AI to drive the evaluation of farmer credit for a range of agricultural lending programs.

Case Study: To assess the credit risk of farmers, the bank's AI system combines information from market pricing, weather forecasts, and satellite images. In the agricultural sector, this has led to improved credit management and more precise loan disbursements.

10. IndusInd Bank - AI-driven Agri-Loan Disbursement

Scheme: To streamline the agri-loan disbursement process, IndusInd Bank has integrated AI-driven technologies.

Case Study: Using information from many sources, such as crop cycles and land records, IndusInd Bank use AI to assess the profitability and productivity of farms. The AI model lowers the default risk and facilitates the provision of tailored loan solutions.

These case studies show how Indian commercial banks are using artificial intelligence (AI) to improve their credit risk assessment procedures in the agricultural sector, which is improving financial inclusion, lowering non-performing assets (NPAs), and streamlining loan distribution.

FINDINGS

1. **The paper "AI-Driven Credit Risk Assessment in Agriculture:** A Case Study of Indian Commercial Banks" offers important new information about how Indian commercial banks are utilizing artificial intelligence (AI) to manage credit risk in the agricultural sector.

2. **Increased Accuracy of Credit Risk Assessments:** The accuracy of credit risk assessments in the agriculture industry has increased dramatically thanks to AI-driven models. Through the integration of several data sources, including satellite images, weather patterns, land records, crop cycles, and market prices, banks are now able to more accurately evaluate farmers' creditworthiness. This has decreased the possibility of defaults by resulting in more specialized loan products and more focused lending.

3. **Reduction in Non-Performing Assets (NPAs):** The use of AI in credit risk assessment has made a discernible difference in the number of NPAs in commercial banks' agricultural loan portfolios. Through enhanced identification of high-risk borrowers, banks have successfully reduced the likelihood of defaults, resulting in a more stable loan book.

4. **Enhanced Efficiency in Loan Processing:** AI-powered credit risk evaluation instruments have expedited the loan approval procedure, leading to quicker loan payout. The time needed to process loan applications has decreased due to the automation of data analysis and risk assessment, which is especially helpful in the agricultural sector where prompt credit availability is essential.

5. **Financial inclusiveness and Accessibility:** By allowing banks to provide loans to a wider range of farmers, including those with little or no credit history, the application of AI has improved financial inclusiveness. Banks may now evaluate the creditworthiness of small and marginal farmers who were previously underserved by conventional credit evaluation techniques thanks to artificial intelligence algorithms that integrate different data sources.

6. **Customized loan Products:** Thanks to AI, banks are now able to create loan products that are more specifically suited to the requirements of farmers. Banks can lower the risk of default by offering loans with conditions that are more closely linked with the borrower's agricultural practices and financial capabilities by examining individual risk profiles.

7. **Problems with Data Integration:** Although artificial intelligence (AI) offers many advantages, the study also identifies problems with data quality and integration. The accuracy and availability of data are critical to the performance of AI models, and disparities in data quality between sources and locations might reduce the efficacy of AI-driven evaluations.

8. **Legal and Ethical Issues:** The use of AI in credit risk assessment gives rise to legal and ethical issues, mainly in relation to data privacy and the possibility of bias in AI algorithms. Retaining trust in the system requires that AI models adhere to legal requirements and are fair, transparent, and transparent.

9. **Scalability and Adaptability:** The study concludes that AI-driven models for credit risk assessment may be made to work in a variety of geographical settings and agricultural situations. However, regular updates and modifications to take into consideration shifting agricultural practices, market dynamics, and environmental issues are necessary for these models to be successful.

To sum up, Indian commercial banks are now using more inclusive, accurate, and efficient lending procedures as a result of AI-driven credit risk assessment in agriculture. The benefits of AI in improving agricultural credit risk assessment are significant, supporting the stability and expansion of India's agricultural economy even if there are still obstacles, mostly related to data management and ethical issues.

CONCLUSION

The research paper "AI-Driven Credit Risk Assessment in Agriculture: A Case Study of Indian Commercial Banks" highlights how artificial intelligence has the ability to completely change the agricultural financing industry. Artificial intelligence (AI)-powered credit risk assessment algorithms have greatly decreased non-performing assets (NPAs) in the agriculture industry while also improving the accuracy with which creditworthiness of farmers is assessed. Artificial Intelligence (AI) has made it possible for commercial banks to provide more inclusive and customized loan solutions by utilizing a variety of dynamic data sources. This has increased financial accessibility for farmers, particularly those who were previously marginalized.

Additionally, the use of AI has simplified loan procedures, making credit disbursement faster and more effective—a critical benefit in an industry where timing is of the essence like agriculture. The research does however also draw attention to persistent difficulties, such as problems with data integration and moral dilemmas with bias and transparency in AI models. To fully reap the benefits of AI in agricultural credit risk assessment, these issues must be resolved.

In conclusion, artificial intelligence (AI) offers a potent tool for improving credit risk management in agriculture, but its effectiveness hinges on ongoing innovation, ethical standards observance, and appropriate data management. The results indicate that AI-driven credit risk assessment may significantly boost agricultural finance and advance the more general objective of sustainable agricultural growth in India if the proper protocols and security measures are in place.

REFERENCES

[1] Basso, B., Cammarano, D., & Carfagna, E. (2013). Review of crop yield forecasting methods and early warning systems. European Commission, JRC Scientific and Technical Reports.

[2] Ghosh, S., Sinha, R., & Mahajan, A. (2021). AI in financial inclusion: Opportunities and challenges. Journal of Financial Services Research, 48(2), 159-178.

[3] Iyer, S., Khanna, T., & Varma, A. (2019). Ethical implications of AI in financial services: A review. Journal of Banking and Financial Technology, 3(1), 45-56.

[4] Khandani, A. E., Kim, A. J., & Lo, A. W. (2010). Consumer credit-risk models via machine-learning algorithms. Journal of Banking & Finance, 34(11), 2767-2787.

[5] Kumar, R., Aggarwal, V., & Gaur, A. (2018). AI in agricultural credit: Challenges and opportunities in the Indian banking sector. Journal of Rural and Agricultural Research, 18(1), 23-31.

[6] Patel, R., Raj, A., & Desai, V. (2022). AI in agricultural credit assessment: A case study of sugarcane farmers in Maharashtra. International Journal of Agricultural Economics, 7(3), 165-176.

[7] Sharma, P., & Singh, M. (2020). AI-driven credit risk assessment: A case study of Indian commercial banks. Journal of Banking and Finance, 9(4), 112-125.

[8] Wang, Y., Luo, X., & Zhang, J. (2020). Machine learning and AI in credit risk assessment: A review. IEEE Transactions on Neural Networks and Learning Systems, 31(7), 2409-2423.

[9] Government of India. (2020). Economic Survey 2019-20: Vol I. Ministry of Finance, Government of India.

[10] Reserve Bank of India. (2020). Handbook of Statistics on the Indian Economy 2019-20. Reserve Bank of India.

[11] National Bank for Agriculture and Rural Development. (2022). Annual report (Various issues). Mumbai, India.

[12] Agarwal, P., & Sinha, S. (2020). The role of commercial banks in agricultural credit in India. Journal of Rural Development and Management, 15(2), 112-127.

[13] Bhardwaj, R., & Singh, T. (2019). Artificial Intelligence in banking: Applications, challenges, and opportunities. International Journal of Financial Studies, 7(3), 45-61.

[14] Narayanan, S., & Joshi, R. (2018). Agricultural finance in India: Challenges and prospects. Indian Journal of Agricultural Economics, 73(4), 425-438.

[15] Sharma, V., & Patel, A. (2021). AI-driven credit risk assessment in Indian agriculture. Asia-Pacific Financial Review, 12(1), 39-54.