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A STUDY AGRICULTURAL BONUS IN BANK OF MAHARASHTA

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ABSTRACT

The agricultural sector in India has historically been a cornerstone of its economic structure, contributing significantly to GDP and employment. Despite numerous policy interventions and banking support mechanisms, rural farmers continue to face challenges related to credit availability, delayed financial assistance, and inadequate incentives. The concept of an Agricultural Bonus, specifically within the Bank of Maharashtra, serves as a timely intervention designed to motivate timely loan repayments, support investment in agricultural inputs, and enhance crop yields. This study aims to delve deep into the practical structure, outreach, challenges, and impact of such bonus schemes. However, manual identification of eligible beneficiaries often leads to inefficiencies, delays, and unequal benefit distribution. To address this, the study explores machine learning (ML) integration into the scheme, where historical data patterns are leveraged to build intelligent prediction models. Algorithms such as Decision Trees, Random Forests, SVM, and XGBoost are used to model the behavior of farmers and assess bonus eligibility. By combining economic policy analysis with software technology, the study brings a fresh interdisciplinary approach. It not only provides insights into the current agricultural bonus scheme in Bank of Maharashtra but also proposes a predictive ML-based decision support system that can revolutionize financial inclusion in rural areas. This innovation will ensure better targeting, timely disbursement, and increased agricultural productivity.

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I.INTRODUCTION

India's agrarian economy remains one of the most complex and dynamic sectors, influenced by unpredictable weather, market volatility, outdated practices, and fragmented landholdings. In this context, the role of financial institutions like the Bank of Maharashtra becomes instrumental in providing the financial lifeline necessary for agrarian sustenance. One innovative initiative, the agricultural bonus scheme, seeks to provide performance-linked financial rewards to farmers who demonstrate credit discipline and productivity improvements. By incentivizing timely repayments and promoting investment in high-quality inputs, these bonuses are expected to create a cycle of prosperity and increased trust between the farmer and the bank.

Yet, even with noble intentions, the practical implementation of such bonus schemes encounters numerous operational, logistical, and socio-economic barriers. First, farmers in remote areas often lack awareness about the scheme's existence or its eligibility criteria. Second, banks struggle with timely identification and disbursement due to manual data processing and bureaucratic delay. Third, no reliable prediction mechanism exists to prioritize recipients or forecast budget requirements. These limitations not only dilute the scheme's effectiveness but also erode farmer confidence in institutional support.

In an era where data is a strategic asset, this study explores how machine learning and artificial intelligence can enhance the design and

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execution of agricultural bonus schemes. By analyzing past loan behavior, demographic factors, land ownership patterns, yield data, and socio-economic indicators, predictive models can be built to proactively identify eligible farmers and prevent leakage or inefficiencies. The introduction of software-based extensions to conventional banking operations holds the potential to redefine how rural incentives are administered, monitored, and optimized. Thus, this research becomes a significant contribution to data-driven agricultural policy reform, merging the worlds of banking, rural development, and cutting-edge software engineering.

Definition:

In the context of this study, Agricultural Bonus refers to a financial or material incentive given by banking institutions—particularly the Bank of Maharashtra—to farmers who meet certain performance-based conditions. These may include timely repayment of loans, adoption of environmentally sustainable farming practices, improved crop yield, or participation in government-aligned initiatives such as Pradhan Mantri Fasal Bima Yojana (PMFBY) or Kisan Credit Card (KCC) schemes. Unlike subsidies, which are often provided upfront, bonuses are reactive rewards—offered after performance is evaluated over a certain time period. A bonus disbursement system is typically governed by rules and evaluation matrices embedded within the bank's operational policy framework. In traditional settings, these evaluations are conducted manually by credit officers and branch managers using subjective judgment. However, this approach is not scalable in the digital age.

This is where Machine Learning (ML) enters the picture. ML refers to the field of computer science where algorithms are trained using historical data to learn patterns, make predictions, and automate decisions. In our context

Precision Agriculture: Application of data science in farming to increase yield and efficiency.

Financial Inclusion: Ensuring individuals and businesses have access to useful and affordable financial products and services.

Smart Agriculture: A digital framework that incorporates AI, IoT, and big data analytics into farming.

Research Problem:

In India's vast and diverse agricultural landscape, the success of financial support mechanisms such as agricultural bonuses relies heavily on timely disbursement, accurate beneficiary targeting, and policy transparency. However, despite the good intentions behind such schemes, a significant disparity exists between the designed objectives and ground-level implementation. One of the primary research problems observed is the lack of systematic, data-driven frameworks for identifying eligible farmers and measuring the actual impact of bonuses on agricultural performance and financial stability. The bonus disbursement process in banks such as the Bank of Maharashtra is often guided by manual processes, subjective judgments, and bureaucratic evaluations, leading to inefficiencies, delays, and even wrongful exclusions. This undermines the very goal of incentivizing responsible credit behavior and enhancing agricultural output. Moreover, there is no predictive mechanism that proactively identifies which farmers are most likely to benefit from bonuses or who might default in the absence of such incentives. This presents a critical gap in rural financial planning, especially when the same sector is being revolutionized by digital technologies like mobile banking, AI-enabled loan approvals, and e-KYC systems. In the current model, there is little to no integration of historical repayment behavior, yield metrics, or seasonal credit risks in determining who receives agricultural bonuses. This not only reduces efficiency but also affects trust among farmers who are either

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unaware or feel excluded. The research problem, therefore, is twofold: first, evaluating whether the current agricultural bonus scheme under Bank of Maharashtra meets its strategic objectives, and second, designing a machine learning–driven model that automates bonus eligibility forecasting, enhances policy implementation, and ensures inclusive, targeted rural development.

RESEARCH METHODOLOGY

To address the multifaceted objectives of this study, a hybrid research methodology was employed, combining both qualitative and quantitative research techniques, supplemented by predictive data modeling using machine learning. The primary objective was to evaluate the practical effectiveness of the agricultural bonus scheme in the Bank of Maharashtra and extend this understanding into a digital solution framework. The methodology involved field surveys, structured interviews, and data mining of historical loan and bonus records. A stratified random sampling approach was used to select 500 farmers from multiple districts in Maharashtra, ensuring diversity in farm size, geographic location, crop types, and financial background. Semi-structured interviews with bank officials, agricultural officers, and rural development experts provided insights into operational challenges and perceptions regarding the bonus scheme.

Quantitative data collected from the Bank of Maharashtra included: disbursed loan amounts, repayment schedules, bonus disbursements, farmer credit scores, crop yields, and transaction history. These data were processed using Python libraries such as Pandas, NumPy, and Scikit-learn for cleansing, encoding, and feature scaling. Machine learning models including Logistic Regression, Decision Trees, Random Forests, and XGBoost were applied to train a bonus eligibility prediction system. The models were validated using metrics such as accuracy, F1-score, precision-recall curve, and ROC-AUC to determine their effectiveness in automating the decision-making process. Furthermore, descriptive statistical tools were used to identify patterns and relationships between credit performance and bonus reception. Ethical compliance was ensured by anonymizing participant data and securing necessary approvals from local banking authorities. This methodology not only enabled a thorough policy analysis but also laid the foundation for a technology-driven prototype that could transform rural banking operations through intelligent automation.

II.LITERATURE REVIEW

The relationship between agricultural financing and rural development has been the subject of extensive scholarly and policy research over the past decades. According to Singh and Sharma (2020), access to affordable and timely institutional credit is a major determinant of rural prosperity, yet the effectiveness of incentive structures like bonuses remains poorly documented. Studies by NABARD (2021) and the Reserve Bank of India (2020) stress that while financial inclusion has improved due to schemes like the Kisan Credit Card and direct benefit transfers, bonus-linked repayment incentives are inconsistently implemented across different banks and regions. Mehta et al. (2019) emphasized that agricultural bonuses play a critical psychological role in motivating farmers to maintain loan discipline, but also pointed out that without transparency and automation, these schemes risk becoming tokenistic.

In the field of financial technology, research has increasingly advocated for the integration of AI and machine learning into banking operations. Das and Raut (2022) showed that ML algorithms like Random Forest and Gradient Boosting Trees outperform traditional models in predicting credit risk in rural borrowers. Similarly, Verma and Sahu (2021) demonstrated how classification models can be used to automate eligibility decisions for agricultural loan subsidies. Chatterjee (2022) explored how digital platforms can deliver personalized financial services to farmers using real-time

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weather, yield, and credit data. However, there remains a noticeable gap in literature when it comes to applying machine learning specifically to the distribution of agricultural bonuses, especially in the Indian public sector banking ecosystem. This research contributes to that underexplored niche by demonstrating how bonus eligibility can be predicted, optimized, and scaled using software solutions, thus offering a unique convergence of agricultural finance, rural policy, and data science.

III.DATA ANALYSIS AND INTERPRETATION

The study analyzed data collected from 500 farmers and 12 branch offices of the Bank of Maharashtra across different agro-climatic zones. The key variables analyzed included: type of crop, loan repayment history, bonus received, landholding size, annual yield, and demographic details.

Findings from Descriptive Statistics:

- 65% of farmers were aware of the bonus scheme.
- 40% of eligible farmers received the bonus, indicating gaps in outreach or eligibility.
- Farmers receiving bonuses reported an average 17% increase in yield due to better investment from reinvested bonus amounts.
- Loan repayment timeliness improved by 23% among bonus recipients.

ML-Based Analysis:

- Using Random Forest and Logistic Regression models:
- The most influential features in bonus prediction were: timely loan repayment, landholding size, and previous year's yield.
- The Random Forest model achieved an accuracy of 87% in predicting bonus eligibility.
- Feature importance visualization showed that repayment history had the highest weight in model prediction.

Interpretation:

The bonus scheme has had a measurable impact, but its effectiveness could be significantly improved using data-driven targeting. ML models can help identify high-potential beneficiaries, minimize human bias, and enhance the bank's decision-making process.

IV.FINDINGS

- ❖ The agricultural bonus scheme has positive outcomes for financial inclusion and crop productivity.
- ❖ Lack of awareness and insufficient eligibility communication hinder broader adoption.
- ❖ Loan repayment behavior improved significantly among bonus recipients.
- ❖ Machine learning models offer high potential to automate and optimize beneficiary selection.
- ❖ Data-driven approaches can reduce errors, fraud, and inefficiencies in scheme implementation.
- ❖ Farmers with medium to large landholdings are more likely to receive bonuses, revealing a potential equity issue.
- ❖ Regional discrepancies exist in the scheme's success, indicating the need for localized strategies.
- ❖ ML integration in agricultural finance is still nascent but shows promising early results.

V.CONCLUSION

Agriculture in India remains a high-risk yet vital sector, particularly susceptible to external factors such as climate change, market volatility, water scarcity, and changing government policies. In response to these risks, banking institutions like the Bank of Maharashtra have developed reward-based schemes such as agricultural bonuses, which serve as positive reinforcements for farmer behavior—primarily focused on timely loan repayment and sustainable farming practices. However, these bonuses, although impactful in theory, are often implemented without the

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support of modern data systems, leading to multiple issues such as delayed disbursement, poor awareness, inconsistent beneficiary selection, and absence of outcome tracking.

One of the pressing research problems is the lack of digitization and data intelligence in the design and operation of such financial incentives. Currently, banks rely on static criteria and human discretion for bonus allocation, which may result in bias, inefficiency, and underperformance of the scheme. There is no automated system to analyze farmer repayment behavior, landholding data, yield history, or prior interactions with credit facilities to determine eligibility. Furthermore, the absence of real-time dashboards or predictive insights impairs strategic planning and fund allocation at the branch or state level.

Moreover, with the introduction of data-rich environments in agriculture (e.g., IoT-based soil sensors, crop monitoring satellites, KYC-linked bank databases), there is an urgent need to synchronize financial systems with smart data tools. This disconnect leads to a scenario where thousands of eligible farmers remain unrewarded while others may benefit without substantial merit. Thus, the research problem is not just administrative inefficiency but a missed opportunity for digitally transforming rural banking using machine learning. The study therefore seeks to investigate: how effective the bonus system currently is, what its loopholes are, and how an AI/ML-driven bonus management platform can be designed to address these challenges.

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