International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Leveraging Artificial Intelligence for Risk Assessment in Crop Insurance PMFBJ: A Study on Enhancing Agricultural Resilience

Shiva Kumar H.N[1], H C Sudheendra Mouli[2], Nandini R V[3]

[1, 2, 3]Assistant Professor
[1]DoS Commerce, Pooja Bhagavat Memorial Mahajana Post Graduate Centre, Mahajana College, Mysuru
[2]Dept. of Computer Science, GSSS SSFGC- Mysuru
[3]Dept. of Computer Science, JSS College for womens, Saraswathipurm, Mysuru

Abstract

The agricultural sector is increasingly vulnerable to a range of risks, including erratic weather patterns, pest infestations, and crop failures, which pose significant challenges to both farmers and insurers. Traditional methods of risk assessment in crop insurance often suffer from inefficiencies, delays, and inaccuracies due to limited data availability and manual processes. This research explores the transformative role of Artificial Intelligence (AI) in enhancing the precision and effectiveness of risk assessment within crop insurance schemes. By leveraging technologies such as machine learning, remote sensing, satellite imagery, and predictive analytics, AI has the potential to revolutionize how insurers evaluate agricultural risks, determine premiums, and expedite claims processing.

This study aims to assess the integration of AI-driven tools in crop insurance, evaluate their impact on agricultural resilience, and identify the barriers to widespread adoption. Through a combination of secondary data analysis and case studies of AI applications in crop insurance programs, the research investigates how AI can contribute to more equitable, timely, and data-driven insurance services. The findings are expected to provide valuable insights for policymakers, insurers, and agritech companies aiming to foster a more resilient and adaptive agricultural ecosystem. Ultimately, this study contributes to the growing body of knowledge on digital transformation in agriculture and underscores the critical role of AI in mitigating the impacts of climate variability and enhancing food security.

Keywords: Artificial Intelligence, Crop Insurance, Risk Assessment, Agricultural Resilience

1.1 Introduction

Agriculture is the cornerstone of India's economy, employing nearly half of the country's workforce and contributing significantly to rural livelihoods. However, the sector is acutely vulnerable to a multitude of risks including erratic weather, floods, droughts, pest outbreaks, and crop diseases that directly impact farmers' incomes and food security. In response to these challenges, the Government of India introduced

the Pradhan MantriFasalBimaYojana (PMFBY) in 2016, a flagship crop insurance scheme aimed at providing financial protection to farmers against crop losses due to natural calamities and unforeseen events.

While PMFBY represents a major step toward securing agricultural productivity and rural stability, its implementation has faced several challenges, particularly in the domain of risk assessment. The conventional methodologies used to assess agricultural risks based on manual field surveys, generalized area-level data, and delayed reporting have often led to inefficiencies, inaccuracies, and delayed claim settlements. These limitations reduce farmer confidence in the system and hinder the scheme's intended impact.

In this evolving scenario, Artificial Intelligence (AI) emerges as a game-changing solution with the potential to revolutionize risk assessment in crop insurance. AI technologies, including machine learning algorithms, remote sensing, satellite imagery, and weather prediction models, offer advanced capabilities for real-time data analysis and predictive risk modeling. By leveraging these tools, AI can help identify crop stress, forecast yield loss, detect anomalies, and enable more accurate and localized risk profiling. This not only enhances the precision and fairness of insurance coverage but also expedites the claims process, improving farmer satisfaction and trust.

Integrating AI into PMFBY can also help policymakers and insurance companies monitor crop health more effectively, mitigate fraudulent claims, and ensure better targeting of government subsidies. Ultimately, the adoption of AI in crop insurance has the potential to significantly enhance agricultural resilience, enabling farmers to manage risk proactively and sustainably in the face of climate change and increasing uncertainties.

This study aims to explore the role of Artificial Intelligence in strengthening risk assessment under PMFBY and its broader impact on agricultural resilience in India. Through a combination of theoretical exploration and practical case analysis, the research seeks to offer actionable insights for stakeholdersgovernment agencies, insurers, agritech firms, and farming communities on how emerging technologies can bridge existing gaps and transform the future of agricultural insurance in India.

1.2 Literature Review

Hongyong et al. (2018) tried to propose a weather index insurance to transfer weather risks from the production chain of agricultural products. They found that their model is effective in transferring such risks and ensuring stable income for both companies and farmers. Mishra et al. (2018) examined the influence of the application of contract farming on the smallholder lentil farms' yields, profitability, and costs in Nepal. Their findings exposed that unlike very smallholders of lentil farms, no farmers of lentil farms get benefits from using contract farming.

Miyata et al. (2009) also found the same results from their study undertaken in Shandong Province, China even though it is still unclear that how many farmers need to be included in the contract farming scheme to get such benefits.

Raucci et al. (2018) attempted to appraise the impact of weather derivative on reducing the income volatility in the Brazilian soybean market. The results of their study disclosed that it is possible to trim down producers' income volatility substantially while maintaining gross average income. Shi and Jiang (2016) found the same results. They demonstrated that yield risk in rice crops in China can be lessened considerably through applying their proposed weather index insurance model.

Navarra (2017) inspected the effects of contract farming on the smallholders with respect to food security. The study applied a panel data for a period of four years from 2002 to 2005 in Mozambique. Although the study found positive relationship between the contract farming and income of farmers, the impact of contract on farmers in terms of other factors were still vague. In addition, the overall findings of the study pointed out that the choice of contracts is the main driver of the observed differences.

1.3 Research Gap:

Despite the launch of PMFBY to safeguard farmers, traditional risk assessment methods remain slow, inaccurate, and inefficient. There is limited integration of AI technologies like satellite data and predictive analytics in the current system. Moreover, research lacks empirical evidence on the localized impact and effectiveness of AI in enhancing agricultural resilience under PMFBY.

1.4 Objective of study

1 To analyze the existing risk assessment practices under PMFBY and identify their limitations in accurately evaluating crop losses.
2 To explore the role of Artificial Intelligence in improving risk prediction, claim processing, and monitoring within the framework of crop insurance.
3 To assess the impact of AI-driven risk assessment on enhancing agricultural resilience and farmer confidence in crop insurance schemes.

1.5 Research Methodology

- Type of Study: Exploratory and empirical.
- Data Sources: Secondary data from PMFBY reports, satellite imagery, climatic databases; primary data via interviews with agricultural officers and farmers.
- AI Techniques Analyzed: Machine Learning (ML), Deep Learning, Remote Sensing, GIS, and Data Fusion Techniques.

2.1 Current Challenges in PMFBY Risk Assessment

Despite the ambitious scope of the Pradhan MantriFasalBimaYojana (PMFBY) in providing comprehensive crop insurance to farmers, the scheme faces several systemic challenges—particularly in its risk assessment and implementation mechanisms. These limitations undermine the accuracy, transparency, and timeliness of crop loss evaluations, which are crucial for farmer satisfaction and trust. The key challenges are outlined below:

1. Subjectivity in Crop Cutting Experiments (CCEs)

Crop Cutting Experiments (CCEs) are the primary method for estimating yield loss, but they are manual and labor-intensive, leading to logistical challenges. Limited sample coverage raises concerns about the

accuracy of data across diverse agro-climatic regions. Human bias in data collection and reporting further affects the authenticity of yield estimates. Additionally, data inconsistencydue to varying methodologies impacts the fairness of insurance claims.

2. Delayed Claim Settlements Due to Manual Processes
Claim settlements are delayed due to complex paperwork required for data verification and approval. Multiple layers of approval between state agriculture departments, insurers, and banksslow down the process. The lack of real-time data further hampers the ability to process claims swiftly, particularly during disasters. These delays undermine **trust** in the system, discouraging farmers from re-enrolling.

3. Lack of Real-Time Risk Monitoring
The reliance on static data makes it difficult to assess rapidly changing conditions like weather anomalies or pest outbreaks. This leads to delayed detection of crop stress, reducing the opportunity for early intervention. Without real-time monitoring, risk assessments remain generalized, failing to reflect actual on-ground conditions. This hinders timely and effective risk mitigation efforts.

4. Limited Farmer Awareness and Participation
Many farmers face low digital literacy, hindering their understanding of the scheme and claim procedures. There is poor awareness about key details of PMFBY, such as enrollment timelines and claim processes. Limited access to enrollment platforms, especially in remote areas, prevents broader participation. Past experiences with delayed claims or rejections contribute to mistrustand lower participation rates.

2.2 Role of AI in Crop Risk Assessment

Artificial Intelligence (AI) has emerged as a transformative tool in modern agriculture, particularly in the area of crop risk assessment. By harnessing large datasets, machine learning algorithms, and real-time analytics, AI enables more accurate, timely, and scalable risk evaluation. Under PMFBY, AI has the potential to revolutionize the way risks are assessed, premiums are priced, and claims are settled, thereby improving transparency and farmer satisfaction. The key areas where AI contributes to crop risk assessment are discussed below:

1 Satellite and Remote Sensing Integration
Satellite imagery combined with AI technology has emerged as a powerful tool for monitoring crop health and predicting yield anomalies. One of the primary tools used in this process is the Normalized Difference Vegetation Index (NDVI), which assesses the greenness and overall health of crops by measuring light absorption and reflection in the red and near-infrared bands. By tracking NDVI and other indices, AI can detect early signs of stress, such as drought, pests, or diseases, long before they are visible to the naked eye. This data can be processed in real-time, providing accurate assessments of crop health and allowing for proactive intervention. Furthermore, remote sensing enables large-scale monitoring of crops, even in remote or difficult-to-reach areas, without the need for labor-intensive manual surveys. The AI-powered analysis of multi-temporal satellite data enables precise predictions of crop yield and potential loss, leading to more accurate insurance claims and better management decisions.

2 Weather-Based Risk Modeling

AI models can significantly enhance risk assessment by analyzing long-term weather data to identify risk-prone periods for crops. By utilizing historical and real-time weather data—such as temperature, rainfall, humidity, and wind patterns—AI algorithms can predict how different climatic conditions affect crop health throughout the growing season. These models can identify trends and correlations, such as the likelihood of drought, excessive rainfall, or frost, that may pose a risk to crops. Furthermore, AI can simulate various weather scenarios and their potential impact on crop yield, helping insurers and farmers plan better for adverse events. Weather-based risk models also improve the accuracy of risk pricing in crop insurance by providing more detailed insights into the climatic risks specific to a region or farm. These AI-driven models allow for dynamic and timely risk assessment, enabling faster decision-making and more proactive interventions.

3 Machine Learning for Yield Prediction

Machine learning (ML) plays a critical role in enhancing the accuracy of crop yield prediction. AI models such as regression and classification algorithmsanalyze vast amounts of data to forecast crop yields with high precision. These models incorporate a variety of input variables, including soil conditions, weather patterns, irrigation practices, sowing dates, and crop-specific data. By learning from historical yield data, these machine learning models can identify patterns and generate predictions that are far more accurate than traditional methods. AI-driven yield prediction models also allow for localized forecasting**,** providing more tailored predictions for specific regions, farms, or even fields. This level of granularity improves decision-making for both farmers and insurers, enabling better planning and more accurate insurance claim assessments. The ability to predict yield anomalies with higher accuracy reduces the potential for under- or over-compensation in insurance payouts, ensuring fairness and transparency.

4 Real-Time Monitoring

Real-time monitoring through AI is revolutionizing crop risk assessment by providing continuous updates on crop conditions. Drones equipped with high-resolution cameras and multispectral sensors can capture detailed aerial imagery of farm fields, detecting early signs of stress such as water deficiencies, pest infestations, or disease outbreaks. These drones can cover vast areas quickly, providing real-time data that is processed by AI systems to generate actionable insights. Additionally, IoT sensors installed on farms can monitor environmental factors like soil moisture, temperature, and humidity, transmitting data continuously to central AI systems. This data stream allows for immediate analysis and the generation of alerts when risk thresholds are exceeded. AI algorithms can then provide dynamic risk maps that show areas of concern, enabling timely interventions. Real-time monitoring helps insurers assess claims more accurately and quickly, eliminating the need for manual inspections and reducing delays in compensation for farmers. This continuous monitoring also allows for more precise tracking of crop health throughout the season, providing a clearer picture of risk at any given moment.

Table 1: Comparison of Traditional vs AI-Enabled Risk Assessment in PMFBY

Area of Assessment	Traditional Method	AI-Enabled Approach	Impact

Yield Estimation	Manual Crop Cutting Experiments (CCEs), limited samples	Satellite imagery, NDVI, and ML yield prediction models	Faster, more accurate, and scalable yield estimation
Risk Monitoring	Periodic manual field visits	Real-time monitoring via drones, IoT sensors, and AI analytics	Continuous risk tracking and faster response
Weather Risk Modeling	Historical average-based estimates	Predictive modeling using AI on long-term weather datasets	Improved forecasting and localized risk identification
Claim Settlement	Paper-based, delayed multi-agency processing	Automated assessment with AI-generated data insights	Reduced delays, increased trust and transparency
Farmer Participation	Manual enrollment, low awareness	Mobile apps with AI-driven recommendations and claim status updates	Increased engagement and accessibility
Data Accuracy	Human error-prone, inconsistent across regions	Standardized, real-time remote sensing and algorithmic analysis	Greater reliability and uniformity of data
Intervention Timing	Post-damage response	Early warning systems using AI and predictive analytics	Proactive mitigation and better planning

3.1 Suggestion

- Traditional crop cutting experiments can be replaced by AI-driven yield prediction models using satellite data such as NDVI and EVI. These models provide faster, more accurate, and region-specific estimations of crop yields. By reducing human intervention and increasing objectivity, AI helps improve the transparency of yield loss assessments. This ultimately enhances trust in insurance mechanisms.
- Integrating drones, IoT devices, and AI-based image analysis enables real-time monitoring of crops at scale. These tools can detect early signs of drought stress, pest outbreaks, or irrigation failure. Real-time data empowers both farmers and insurers to make timely decisions and minimize risk. It also reduces dependency on infrequent manual field visits.
- AI can analyze decades of weather data to model and forecast future climatic risks. This helps identify critical periods of vulnerability for various crops and regions. With predictive insights,

farmers can adopt preventive measures and insurers can design smarter coverage plans. Weather-linked AI models improve overall climate resilience in agriculture.

- AI-enabled platforms can streamline the insurance claim workflow by validating losses through satellite data and predictive algorithms. Automated systems reduce paperwork, minimize fraud, and expedite claim settlements. This digital transformation builds greater farmer confidence in schemes like PMFBY. Faster claim processing also boosts long-term participation rates.
- Customized mobile applications powered by AI can guide farmers on crop selection, risk alerts, and claim tracking. These tools should offer multilingual support, voice inputs, and simplified interfaces for accessibility. Mobile platforms also allow for real-time communication and service delivery. This increases inclusiveness among smallholder farmers

3.2 Conclusion

The integration of Artificial Intelligence (AI) into crop insurance under PMFBY marks a transformative step toward strengthening agricultural resilience. Traditional risk assessment methods like Crop Cutting Experiments are often delayed and inconsistent, leading to inefficiencies in claim settlements. AI offers powerful tools such as satellite-based yield prediction, real-time monitoring through IoT, and weather-based risk forecasting. These innovations enable faster, more accurate, and transparent decision-making. Automated processes reduce manual errors and delays, enhancing farmer trust in the scheme. Moreover, AI-driven mobile platforms and localized data hubs can increase accessibility and participation among smallholder farmers. By empowering stakeholders with timely insights, AI can support proactive risk mitigation and adaptive farming strategies. Ethical use of data and inclusive training programs are essential for sustainable implementation. Ultimately, AI can revolutionize the PMFBY scheme by making it smarter, faster, and more equitable. This convergence of technology and policy holds immense potential to ensure long-term agricultural sustainability and security.

References

1 Meena, S. K., Wakle, P. K., More, S. D., Badhala, B. S., &Meena, D. K. (2022). Knowledge and Attitude of Farmers towards Pradhan MantriFasalBimaYojana (PMFBY). Asian Journal of Agricultural Extension, Economics & Sociology, 40(11), 562-568.

2 Hani, U., Raju, R., Moorthy, G., &Nagesha, G. (2022). A Study on Farmer's Knowledge on Pradhan MantriFasalBimaYojana in Tumkur District of Karnataka. International Journal of Environment and Climate Change, 33-40

3 Niranjan, H. K., Chouhan, R. S., Sharma, H. O., Kuri, A., &Thaku, S. S. (2019). Insurance Behaviour of Insured Farmers under Pradhan MantriFasalBimaYojna (PMFBY) in Central India. Asian Journal of Agricultural Extension, Economics & Sociology, 37(2), 1-6.

4 Parthiban, J. J., &Anjugam, M. (2023). A Comparative Study on the Performance of Various Agricultural Crop Insurance Schemes of India with Special Reference to Pradhan MantriFasalBimaYojana (PMFBY). Asian Journal of Agricultural Extension, Economics & Sociology, 41(3), 145-153.

5 Paulraj, A. P., &Easwaran, N. (2020). Evaluation of 'Revamped'Crop Insurance Pradhan MantriFasalBimaYojana (PMFBY) among Paddy Farmers in Tamil Nadu, India. Current Journal of Applied Science and Technology, 39(34), 66-77.

6 Rawat, A., & Zechariah, J. (2012). Study on impact of Pradhan MantriFasalBimaYojana (PMFBY) in Faridabad district of Haryana. The Pharma Innovation Journal, 11(4), 2012-2014.
7 Singh, K. D., &Mazhar, S. H. (2023). Constraints and Suggestions of the Respondents about Pradhan MantriFasalBimaYojana in East Champaran District of Bihar. Asian Journal of Agricultural Extension, Economics & Sociology, 41(7), 54-60.
8 Srinivasulu, M. (2015). Agriculture Crop Insurance Policies in India–A Study on Pradhan ManthriFasalBimaYojana (PMFBY) in Telangana State. IJIRMPS-International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences, 3(5).