Development of a Predictive Model for Analyzing Crop Losses Due to Natural Disasters

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Abstract: - Natural disasters are on the rise and threaten agricultural production, leading to food security issues and poor harvests. Yield loss is difficult to define and quantify because many variables affect plant health precisely. The unreliability of databases makes it difficult to assess losses and implement solutions. This research presents a predictive model leveraging Deep Learning (DL) to enhance the accuracy and efficiency of crop loss detection during natural disasters. The term Global Residual Network (DRN) model is gaining value and has the potential to identify flood statistics in India. Adam Kreifish's Code of Optimization (ACOA) combines and transforms Kreifish's Code of Optimization (COA) and Adam's Optimization with large data sets you generate and present efficiently. This global approach makes it possible to accurately analyze the impact of natural disasters on agricultural productivity across different time periods and geographical areas. This research provides a solid foundation for reducing vulnerability in agriculture and supporting global food security initiatives by bridging the gap between deep learning techniques and complex optimization strategies. The results highlight the importance of integrating predictive analytics into disaster management strategies and pave the way for greater resilience to agricultural disruptions caused by climate change.

Keywords: Crop Loss Detection, Adam Crayfish Optimization Algorithm (ACOA), True Negative Rate (TNR), True Positive Rate (TPR)

1. Introduction:

A study of crop loss due to disasters in India covers the wide and varied impacts these events have on one of the country's most important sectors: agriculture. India, with its diverse climatic regions, is vulnerable to several disasters, including floods, droughts, cyclones, earthquakes, and pest infestations, all of which profoundly impact agricultural productivity and livelihoods. This review delves into the types of disasters affecting India, their impact on agriculture, and strategies for mitigation and adaptation [1]. Floods are among the most common natural catastrophes in the country, wreaking havoc on millions of hectares of cropland each year through waterlogging of the land, soil erosion, and sand accumulation on the productive territory. Drought, in contrast to floods, is induced by lack of rain, resulting in depletion of moisture in the soil moisture, drop in the water table, and crop failure, and it has a serious impact on rain-fed agriculture. Cyclones, particularly those with strong winds and heavy rains, destroy agricultural fields and lead to loss of soil fertility and salinization of water and soil resources. When large clouds of locusts swarm, they can obliterate crops of hundreds of thousands of hectares in a matter of days, resulting in devastating food shortages and economic hardship. Unexpected hail storms and untimely rains are destructive to fodder and standing crops, with the likelihood of changes in soil characteristics, decreased soil temperature, soil moisture, and postharvest losses. The fields being cultivated are destroyed instantly, harvested production is lost, and irrigation infrastructure is damaged. [2]. Long-term soil degradation, increased vulnerability to pests and diseases, and disruption of the agricultural calendar. Socio-economic loss of income for farmers leads to increased debt and, in extreme cases, farmer suicides. The ripple effect extends to food prices and food security at regional and national levels. Mitigation strategies need to be adopted to combat disasters and crop losses. The use of technology to predict disasters can greatly mitigate their impact by enabling early prevention and harvesting. Adopt climate-friendly agricultural practices such as diversified cropping systems, conservation tillage, and use of drought and flood-resistant crop varieties. Building robust irrigation systems, flood barriers, and improved drainage systems to control the impact of floods and droughts. Implement comprehensive crop insurance systems and provide timely financial support to affected farmers to mitigate economic shocks [3]. Educating farming communities about disaster preparedness, risk reduction techniques,

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preparedness, risk reduction techniques, and disaster recovery strategies. Strengthening policy measures and institutional frameworks that focus on integrated disaster management and resilient agricultural practices [4]. Fig. 1 suggests the crop-impacted place due to disaster catastrophes in India over the duration from 2008 to 2020. Fig. 2 shows the employment in the agriculture sector from 2017 to 2023.

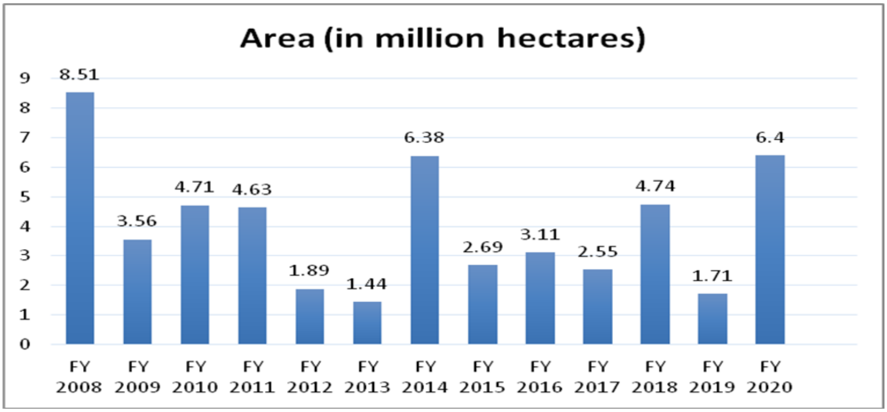

Fig. 1 Financial Year vs Area

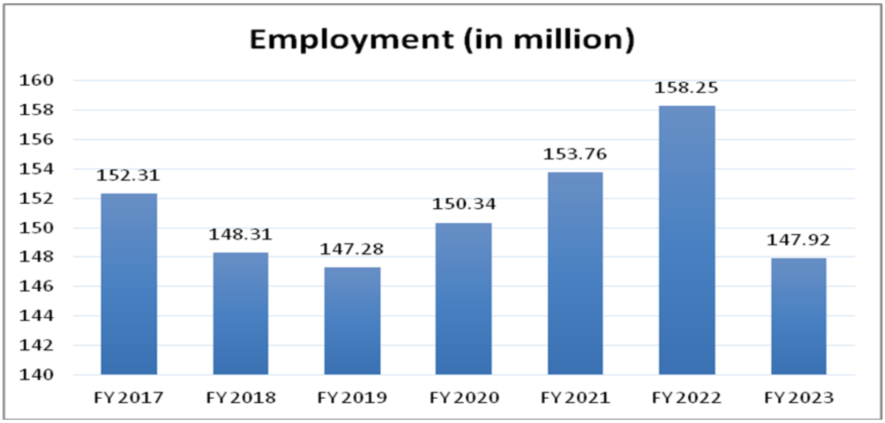

Fig. 2 Employment in the agriculture sector (in millions) from 2017 to 2023

2. Literature Review

The author gives a complete look at the estimation of crop losses resulting from floods, focusing on the Panaro River region. This examination addresses an essential need in agriculture and catastrophe control by imparting a multi-faceted method to evaluate the impact of floods on crop production, making use of diverse resources of records and modeling techniques [5]. The author provides a complete analysis of crop vulnerability to weather-associated severe events and weather exchange using vulnerability curves. This takes a look at addressing an important want in agricultural hazard management by presenting a scientific approach to quantifying the susceptibility of crops to damaging climate situations and climate variability [6]. Investigations consequences of disasters or calamities on the efficiency of rice farming in Sri Lanka. This examination addresses a vital element of agricultural sustainability and resilience by analyzing how excessive climate occasions, such as floods, droughts, and storms, affect the productivity and efficiency of rice manufacturing systems.[7]

This Research paper offers a comprehensive evaluation of the effect of disaster failures on the Indian agriculture industry over a two-decade period. Examination of the way numerous disaster failures, along with floods, droughts, cyclones, and severe climate activities, have affected exceptional segments of the Indian agriculture enterprise from 2000 to 2020 [8]. It introduces a novel technique for swiftly assessing flood-triggered crop damage with the use of far-flung sensing technology. This examination addresses a critical need in catastrophe response and agricultural control by imparting a timely and correct approach for quantifying the extent and severity of crop loss floods [9]. This examination addresses a critical need in catastrophe response and agricultural control by imparting a timely and correct approach for quantifying the extent and severity of crop losses following floods.[10]

3. Proposed Methodology:

The studies conducted specialize in assessing agricultural losses from the Panaro River flood using AGRIDE-c, APSIM, and WOFOST models. It explores version sensitivities to flood simulation strategies, which include HEC-RAS and FwDET, for flood quantity and depth. The duration of flooding was ascertained using satellite imagery and reputable reports. The observation contrasts model-based crop loss predictions with information from field surveys performed put up-flood [11]. It includes a conceptual framework, a precis of the methodologies used for simulating flood dangers, crop boom, and harm, and information on area survey methodologies. The detailed architecture of the proposed model is shown in Fig. 3.

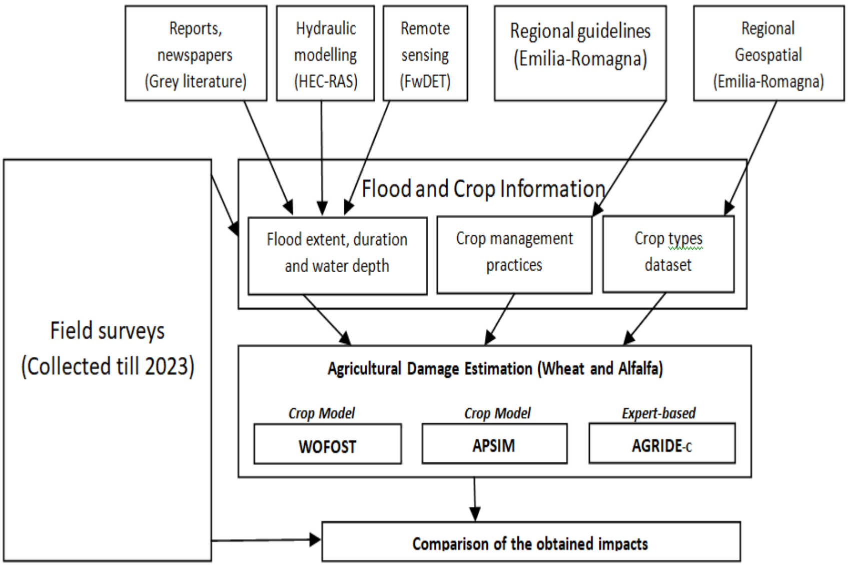

Fig. 3 Architecture of the proposed system

4. Result and Analysis:

In this research, a novel DL model is introduced for crop loss identification due to disasters, which is executed as follows. At first, the input disaster data is acquired from the India flood damage database. After, the impact of total crop loss is identified by utilizing DRN. The performance of DRN during the identification of crop loss is enhanced by tuning the DRN using ACOA, where ACOA is designed by incorporating algorithmic approaches, like Adam Optimization and COA [9] [13] [10]. Additionally, the identification of crop loss is performed with respect to value-wise damages to crop, the area affected, the value of houses damaged, the population affected, damage to public utilities, number of human lives lost, area-wise damages to crop, number of cattle lost, number of houses damaged, and total damages, i.e., houses, and public utilities, houses, crops. At last, the analysis of crop loss is performed year-wise and area-wise [15]. This illustrates the schematic view of the ACOA-DRN technique for crop loss identification due to disasters. The proposed model is shown in Fig. 4.

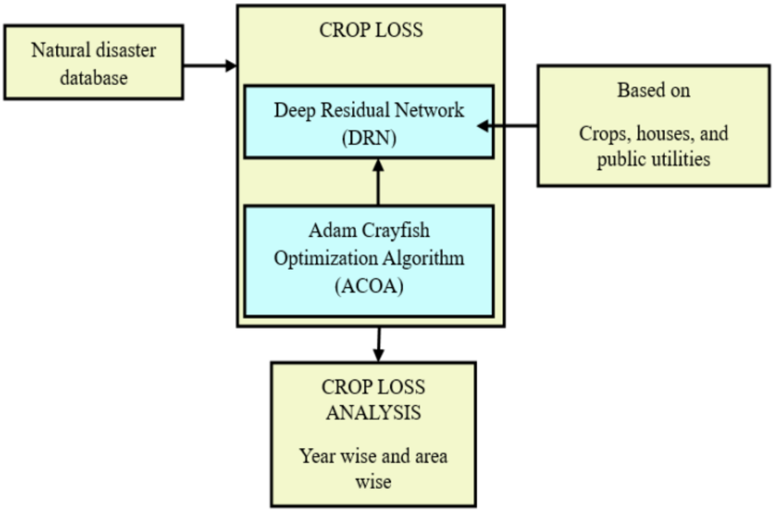

Fig. 4. Proposed model of system

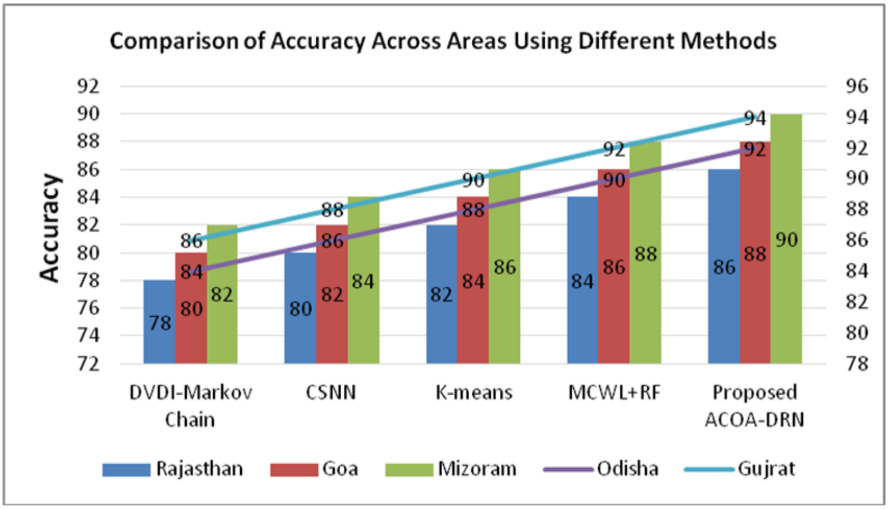

Fig. 5 Comparative evaluation of ACOA-DRN based on Area with Accuracy

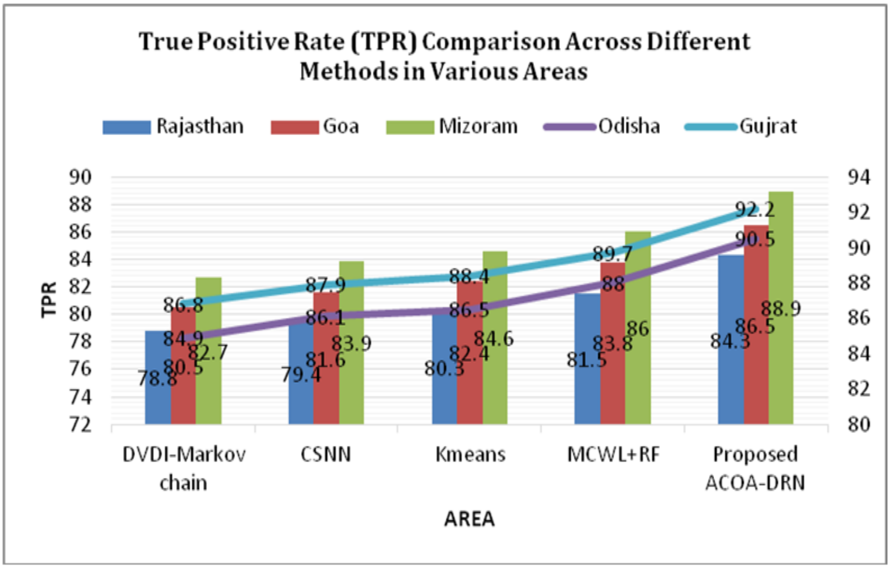

Fig. 6 Comparative evaluation of ACOA-DRN based on Area with TPR

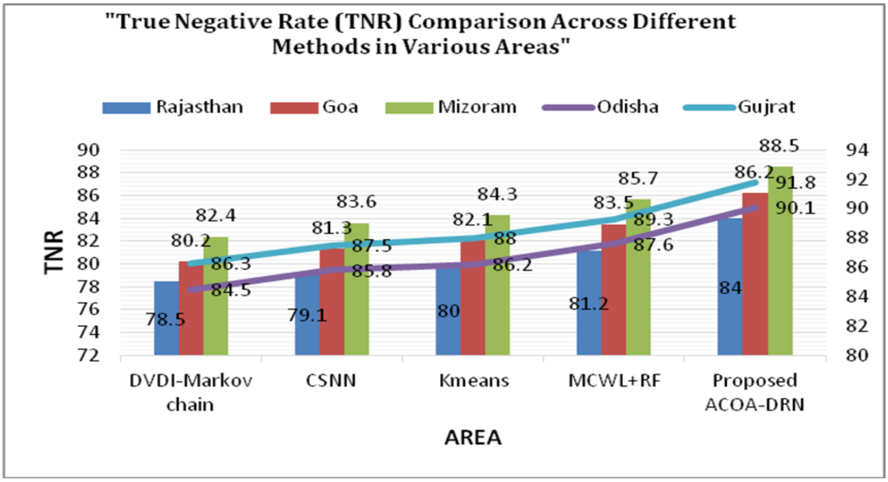

Fig. 7. Comparative evaluation of ACOA-DRN based on Area with TNR

The analysis of the ACOA-DRN model's performance in crop loss identification on an area-sensible basis offers a granular perspective on its efficacy, especially within the Gujrat location, as special in Fig. 5, Fig. 6 and Fig. 7. This in-depth assessment, categorized into accuracy, True Positive Rate (TPR), and True Negative Rate (TNR), now not simplest underscores the model's superiority over different methodologies however additionally showcases its adaptability to specific geographical contexts [3],[8].

5. Conclusion:

The assessment of the ACOA-DRN (Adam Optimization and Crayfish Optimization Algorithm - Deep Residual Network) provides a compelling testament to its scalability in crop loss identification, in particular inside the complexities introduced by way of disaster screw-ups. The accuracy of ACOA-DRN, which is 91.83.4%, overshadows different techniques. It offers reliable predictions that embellish strategies in agricultural management. The TPR, at 92.098%, underscores model sensitivity in identifying true times of crop loss for formulating disaster control and mitigation techniques. TNR version stands at 91.699%, showing its effectiveness in differentiating non-crop loss eventualities. It is essential for optimizing resource utilization. The area for a sample is Gujrat. ACOA-DRN version's accuracy rate of 92.389% confirms its adaptability to geographical settings, proving its robustness across agricultural landscapes. This accuracy, coupled with a TPR of 92.983%, emphasizes the model's capability to figure out crop loss. In times to come, agriculture will be more knowledgeable; disaster responses will be effective. The resilience of agricultural systems to the effects of disasters and calamities is enhanced. The performance of the ACOA-DRN version in figuring out crop loss because of disasters sets a basis for future work.

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