CropConnect: An Intelligent Agriculture Marketplace for Price Prediction and Smart Contract Farming

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***Abstract*—The farming sector is crucial in driving economic development and guaranteeing food availability, especially in emerging nations where many individuals rely on agriculture for their income. Nevertheless, farmers often encounter obstacles such as fluctuating prices, lack of market clarity, restricted access to trustworthy buyers, and excessive reliance on middlemen, which ultimately diminishes their profits. To tackle these challenges, this document introduces CropConnect, a smart online agricultural platform aimed at enabling direct communication between farmers and purchasers through informed decision-making based on data.**

The suggested system incorporates sophisticated machine learning methods, such as Extreme Gradient Boosting (XGBoost) and Long Short-Term Memory (LSTM), to achieve precise crop price forecasts and risk assessments grounded in both historical and current agricultural information. Moreover, a mixed recommendation framework that integrates content-based and collaborative filtering approaches is established to efficiently connect farmers with appropriate buyers. The platform is created using contemporary web technologies, ensuring it is scalable, capable of real-time interactions, and features an intuitive user interface.

Tests reveal that the proposed system delivers enhanced prediction accuracy and improves transaction effectiveness when compared to conventional approaches. By minimizing reliance on middlemen and offering dependable predictive insights, CropConnect aids in fostering transparency, lowering financial uncertainties, and encouraging sustainable and scalable practices in contract farming.

***Index Terms*—Contract farming, XGBoost, LSTM, machine learning, agriculture, price prediction, and recommendation systems**

I. INTRODUCTION

The agricultural sector significantly contributes to the economies of nations in development by generating jobs and securing food supplies. However, this important industry encounters many difficulties such as fluctuating prices, ineffective supply chains, and insufficient access to direct markets. Typically, farmers depend on middlemen to market their products, which leads to lower earnings and a lack of transparency.

The emergence of digital technologies and machine learning has created new possibilities for revolutionizing agricultural practices. Smart platforms can evaluate extensive datasets, forecast market shifts, and promote effective exchanges among various parties involved. Machine learning algorithms can detect trends in past agricultural information and deliver insights that enhance decision-making processes.

The suggested platform, CropConnect, functions as an online agricultural marketplace that employs machine learning strategies to improve contract farming. This system allows farmers and purchasers to communicate directly, anticipates crop prices, assesses transaction risks, and offers smart suggestions. By merging predictive analysis with an easy-to-navigate interface, the platform aims to boost market effectiveness and lessen uncertainties in agricultural commerce.

II. OBJECTIVES

The primary goal of the suggested CropConnect system is to create a smart online agricultural platform that enhances openness, effectiveness, and the quality of decision-making in contract farming.

The detailed aims of the system are outlined as follows:

- To create and implement an online platform that allows farmers and buyers to communicate directly, eliminating the need for middlemen.
- To deploy machine learning algorithms for precise forecasting of crop prices based on past agricultural data.
- To establish a contract risk assessment tool that examines the trustworthiness of transactions conducted between farmers and buyers.
- To create a recommendation engine that identifies appropriate buyers and farmers according to crop variety, preferences, and previous engagements.
- To bolster decision-making within agricultural markets by supplying insights derived from data and current information.
- To elevate transparency and effectiveness in agricultural supply chains through digital innovation.

III. LITERATURE REVIEW

Numerous research initiatives have been undertaken to enhance agricultural frameworks through the use of information technology and machine learning methodologies. The initial agricultural information systems mainly aimed at delivering fundamental services, including updates on weather conditions and information regarding market prices. While these systems boosted farmers' knowledge, they fell short in offering predictive functionalities and intelligent support for decision-making.

The application of machine learning methods in agriculture for forecasting and analysis has become widespread. Sankhe et al. [1] introduced a crop forecasting system leveraging machine learning algorithms, which showcased better accuracy in predicting agricultural yields. In a similar vein, Navale et al. [5] created a model for predicting crop prices using machine learning techniques, emphasizing the critical role of historical data in discerning market patterns.

Advancements in deep learning have significantly improved prediction abilities. Models like Long Short-Term Memory (LSTM) are particularly effective in time-series analysis, enabling the capture of temporal relationships within agricultural datasets. These models yield predictions that are more precise than those generated by conventional statistical and machine learning techniques [7].

The emergence of digital agricultural marketplaces aims to minimize reliance on intermediaries. Padole et al. [2] suggested a digital platform that directly links farmers with consumers, enhancing access and profit margins. Nevertheless, these systems predominantly concentrate on connectivity and are deficient in intelligent features such as recommendation systems and predictive analytics.

Research into contract farming systems has been conducted to bolster market stability and mitigate risks. Babu et al. [3] proposed a framework that guarantees trustworthy agreements between farmers and buyers. Though this method fosters trust, it does not incorporate predictive models or automated decision-making processes.

An examination of current systems reveals that the majority of the solutions emphasize individual components such as prediction, marketplaces, or contract management. There is a noticeable absence of integrated platforms that merge machine learning-based forecasting, risk evaluation, and intelligent recommendation features. The CropConnect system is proposed to fill this gap in research by offering a comprehensive solution that consolidates all these capabilities into one platform.

IV. PROPOSED SYSTEM

A. System Overview

The suggested platform, CropConnect, is a smart web-based agricultural service aimed at enabling direct communication between farmers and purchasers. The system utilizes machine learning methods to deliver predictions on crop prices, analyze contract risks, and offer intelligent matchmaking capabilities. By merging predictive analytics with a digital marketplace, this platform promotes transparency, lessens reliance on middlemen, and fosters effective agricultural dealings.

B. System Architecture

The architecture of the CropConnect system is constructed with multiple layers, comprising four primary sections:

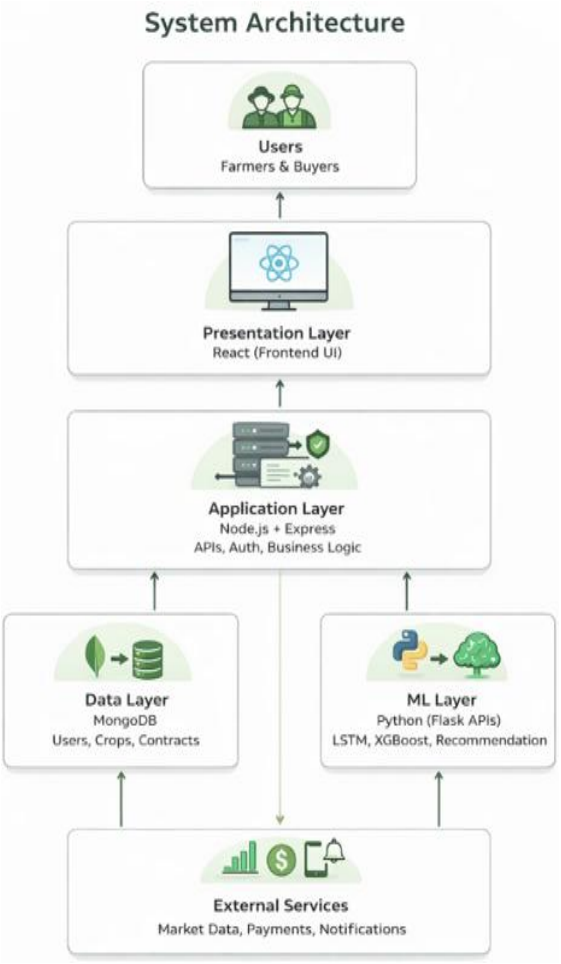

Fig.1: System Architecture

1. Presentation Layer:

This section is the user interface of the system, built with React. It provides an interface for farmers and purchasers to engage with the platform through functionalities such as sign-up, logging in, listing crops, and accessing predictions. The interface has been designed for ease of use and responsiveness.

2. Application Layer:

The application segment is created using Node. js and Express. It is responsible for business logic, handling user requests, managing processes, and interfacing with the database and machine learning components via REST APIs.

3. Data Layer:

The data section utilizes MongoDB to retain all system information, which includes user profiles, details about crops, past pricing data, and transaction logs. It ensures effective data management and retrieval.

4. Machine Learning Layer:

This segment includes models crafted with Python. XGBoost is employed for forecasting crop prices, while LSTM is applied for analysing time-series data and predicting trends. The models are deployed as APIs and offer instantaneous predictions.

C. System Workflow

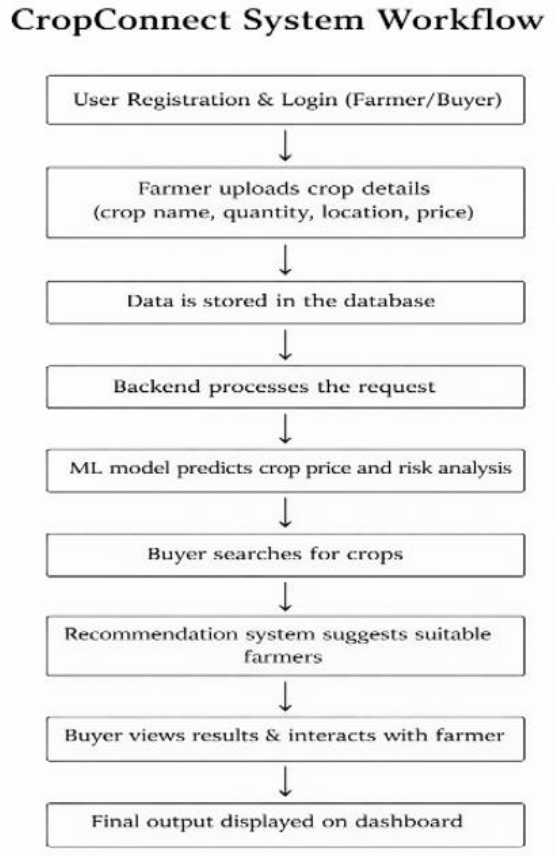

Fig.2 System Workflow

The system's workflow consists of the following steps: Users create accounts and access the platform. Farmers input crop information such as type, amount, and location. The system processes this data and forwards it to the machine learning models. These models yield predicted prices for crops and risk assessments. Purchasers look for crops and receive suggestions based on the system's analysis.

Results are presented on the user's dashboard, facilitating knowledgeable decision-making.

D. Key Features

The proposed platform offers the following functionalities:

• Precise crop price forecasts using machine learning techniques.
• Contract risk evaluation to ensure secure transactions.
• Smart recommendation system for matching farmers with buyers.
• Immediate data processing and forecasting.
• A web-based platform that is scalable and easy to use.

V. METHODOLOGY

A. Dataset Description

The system employs various datasets, which include information about crops, farmers, buyers, as well as contracts. These collections feature details like types of crops, geographical location, previous pricing, and records of transactions.

Table 1 Dataset Attributes

Attribute	Description
Crop Name	Type of crop
Price	Market price
Location	Region
Season	Crop season

B. Data Preprocessing

Data preprocessing is conducted to enhance the accuracy of the model. The procedure encompasses:
Eliminating duplicate entries
Addressing missing data through imputation methods
Transforming categorical variables into numerical formats
Standardizing and normalizing features

C. Machine Learning Models

1. XGBoost Model

The XGBoost framework is utilized for making predictions with structured datasets. It constructs a combination of decision trees aimed at reducing forecasting errors and boosting precision.

2. LSTM Model

The LSTM framework is applied for forecasting time-series data. It is designed to capture time-related dependencies found in past information, facilitating precise predictions of upcoming crop prices.

D. Recommendation System

A combined recommendation strategy is adopted:
Filtering based on content that considers crop specifications Filtering through collaboration that depends on user engagement
This approach enhances the effectiveness of pairing farmers with buyers.

E. Evaluation Metrics

The system incorporates assessment metrics including:
Mean Absolute Error (MAE) Root Mean Squared Error (RMSE) Overall accuracy and F1 score

VI. EXECUTION

A. Tools Used

The system is built with the following:
User Interface: React. Js
Server Side: Node. js utilizing Express
Artificial Intelligence: Python
Data Storage: MongoDB

B. Process Flow

The process consists of:
User sign-up and login
Farmers submitting crop information
Processing of data and forecasting
Creation of recommendations
Presentation of outcomes to users

C. Connection

The system links the user interface, server side, and artificial intelligence components through REST APIs. This setup facilitates immediate interaction and effective data handling.

VII. RESULTS AND DISCUSSION

The findings from the experiment reveal that the suggested CropConnect system is successful in

accurately forecasting crop prices and enhancing transaction efficiency. The evaluation of the machine learning models was done using conventional regression assessment tools like Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE).

The outcomes suggest that both models function well, with the LSTM model exhibiting marginally superior performance because of its capability to understand temporal relationships in time-series information. Conversely, the XGBoost model operates effectively on organized tabular data and delivers dependable predictions.

Table 2: Model Performance

Model	MAE	RMSE	Accuracy
XGBoost	2.5	3.8	91%
LSTM	2.1	3.2	93%

From Table II, it is clear that the LSTM model results in lower error rates and greater accuracy than XGBoost, which makes it a better fit for agricultural data that is dependent on time. Nonetheless, XGBoost is still a potent alternative because of its quicker training process and overall efficiency.

Apart from accuracy in predictions, the recommendation system greatly enhances the effectiveness of connecting farmers with buyers. By examining user preferences and past interactions, the system shortens search durations and improves the overall user experience.

In addition, the platform enhances clarity by offering dependable price forecasts and assessments of contract risks. This enables users to make well-informed choices and minimizes uncertainties in agricultural dealings.

In summary, the proposed system aids in better decision-making, increased efficiency, and decreased reliance on middlemen, thus fostering a more transparent and sustainable agricultural environment.

VIII. CONLCUSION AND FUTURE SCOPE

The research introduces CropConnect, a smart farming marketplace that utilizes machine learning approaches like XGBoost and LSTM to predict crop prices accurately and conduct risk assessments. This platform improves transparency, lessens reliance on middlemen, facilitates informed choices, and allows seamless and trustworthy communication between farmers and purchasers through a scalable online interface.

Upcoming research will aim to incorporate up-to-date market and weather information, enhance model efficacy via cutting-edge deep learning methods, integrate blockchain technology for transaction security, and expand the platform to mobile applications for greater accessibility.

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