FarmGuide- One-stop solution to farmers

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***Abstract*— Agriculture and the allied sectors largely contribute to the livelihood of more than 70% rural population in India. Indian economy is highly influenced by these sectors which contribute to 18% of our country's GDP. But the farmers, who are the backbone of this system, suffer severe losses and the suicide rate keep rising with more than 12,000 suicides per year. The main reasons for this include lack of awareness about market trends, ideal sowing dates as well as crop diseases that affect the yield.**

With the help of Cognitive implications and the predictive analysis using artificial intelligence, this situation can be improved. This paper emphasises on creating a one-stop solution that can provide assistance to the farmers at different stages; from sowing to selling their product. The paper mainly focuses on three modules namely: Sowing dates prediction, Crop Disease detection, and Market Intelligence along with Buying selling Portal. As for the farmers, they do not need any special tools other than mobile phones with an internet connection to use these features, thereby making it practical and cost-effective.

Availability of such a platform can increase the productivity in the farms and thereby can be a boon to Indian Agriculture.

Keywords*— GDP (Gross Domestic Product); ML (Machine Learning); Regression model; Deep convolutional model; F1 Score; Agriculture; Mean Log Loss; Crop diseases.

I. Introduction

Sowing date plays a major role in crop yield, due to the weather-dependent Indian agriculture. With the help of regression models, an optimal sowing date is predicted by taking farmer's location, land size, weather conditions, previous year's data into account to optimize the yield.

Crop diseases affect the yield of the crop to a large extent. Disease detection module detects the type of disease with the help of deep learning Convolutional Neural Network (CNN) architectures. Upon the identification of the disease, the system estimates remedial measures to be taken. All the user needs to upload the photo of the infected crop leaf.

Market intelligence module provides the farmer with the current market trends so as to elevate profit margins. The system directly connects the farmer with the interested buyers, and thereby eliminates the middleman.

All these modules are integrated and accessed through a chatbot which uses natural language processing. Users can also query through voice commands which are interpreted by the chatbot.

II. Relevance

Indian agriculture sector accounts for 18% of India's gross domestic product (GDP) and provides employment to 50% of the countries workforce[1]. India is the world's largest producer of pulses, rice, wheat, corn, fruits, spices, and spice products. Indian farmers not only have to struggle for the better yield against the natural disasters but also have to try to deal with the losses of the net output because of lack of knowledge of current market trends and real-time advisory platforms available.

III. In the exsting system

During the literature survey, various projects which have different agricultural modules separately developed were observed. The paper focuses on following major drawbacks :

- Farmers still rely on their past experience regarding sowing dates [2].
- Identification of infected crop just by observing the colour of the leaf is inefficient [3].

- Identification of infected crop just by observing the colour of the leaf is inefficient [3].
- No proper system or technology to assist farmers regarding fertilizers and pesticides required after detection of disease.
- The middle-man fools the farmer with the wrong market price. [2]

IV. Literature Survey

As a literature survey helps to implement techniques from various domains and form a perfect unicorn of the system solutions. Literature survey of different papers, articles, journals has put light on the severity of the existing problem, lacuna in an already implemented system and understanding of problem statement from ground level with different angles of understandings. Moreover, Table I shows the existing architectures present in the system and refined architectures which will be present in the proposed system are mentioned. Specifications of these architectures and techniques are described in Table II. Advantages and Disadvantages of the same are mentioned in Table III and Table IV.

TABLE I. Algorithm utilized in the existing and proposed system

Architectures / Techniques utilized in the existing systems	**Architectures / Techniques utilized in the proposed systems**
LeNet-5 [4]	AlexNet [6]
VGG-16 [5]	ResNet-n [7]
	Inception Model [8]

TABLE II. Number of Layers in architecture

Architecture	**Deep Layers**	**Fully Connected Layers**	**Output Softmax Layer**	**Total Layers**
LeNet-5 [4]	2	2	1	5
VGG-16 [5]	13	2	1	16
AlexNet [6]	5	3	1	9

TABLE III. Advantages and Disadvantages of architecture

Architecture	**Advantage**	**Disadvantage**
LeNet-5 [4]	Easy to implement	Fewer features extraction
VGG-16 [5]	The very deep model can learn a lot of features.	The possibility of overfitting on given dataset.
AlexNet [6]	Similar to LeNet-5 but bigger	Requires larger memory and computational resources

TABLE IV. Advantages and Disadvantages of techniques used in the proposed system

Techniques	**Specification of layers**	**Advantage**	**Disadvantage**
ResNet-n [7]	N deep layers	Takes care of vanishing and exploding gradient descent.	Difficult to implement and involves a lot of handcrafting of weights.
Inception Model [8]	Hybrid layer of various architecture and techniques	Combination of one and more techniques into a single model.	Large number of parameters to be learned in training. Hence computationally expensive

Advantages, disadvantages and comparative study are shown in Table III which has been done from a GitHub link [9] which refers to the course from deeplearning.ai.

To form a perfect unicorn the techniques given in Table IV will help to make efficient models.

V. Proposed System

Proposed system plans to help farmers in predicting sowing date of the crop planted to yield better revenue considering all the external factors with the use of machine learning model. The proposed system also provides a module for disease identification and its preventive measure with from captured image. Preventing crops from diseases increases the yield of crop and thus overall revenue of farmers. The system also has a buying-selling portal integrated into it. This portal provides farmers with an estimated price of crop considering data from previous year prices and also allows the farmer to sell this crop through an app.

On the other hand, buyers can also register through an app and can buy crops from farmers directly. Buyers are given a list of nearby sellers of particular crop and price demanded by the farmer. Buyer can select any farmer and can call or chat to negotiate the deal directly this eliminates middlemen, hoarding of crops etc.[2]

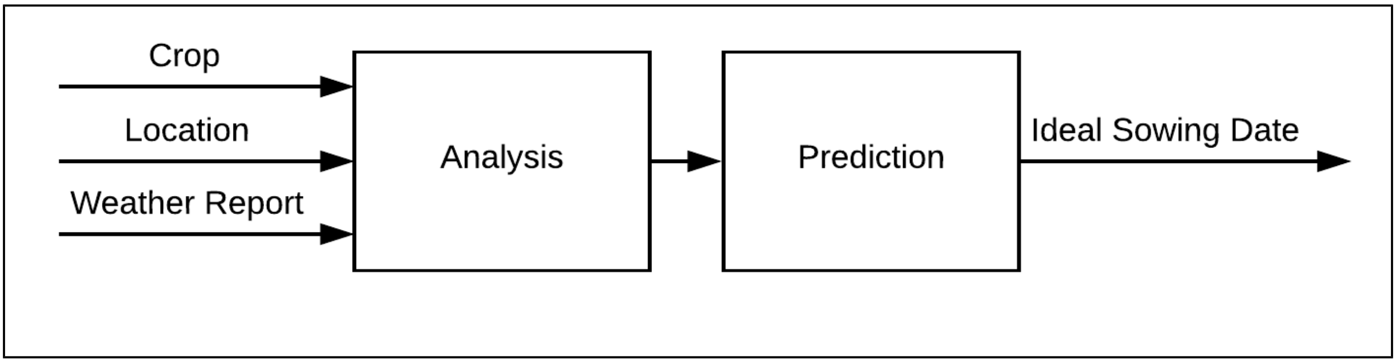

Fig. 1. Sowing Date Prediction Module.

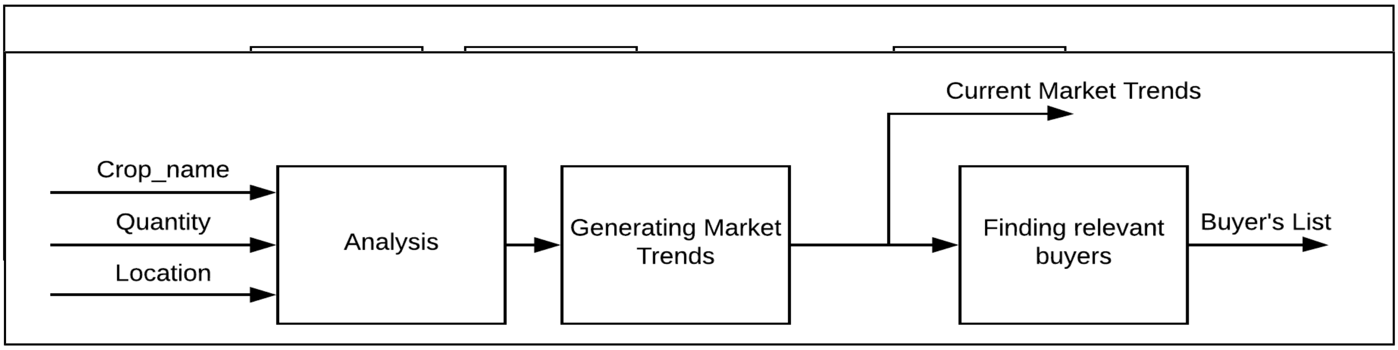

Fig. 2. Disease Detection and Supplements Estimator Module.

Fig. 3. Buying Selling Portal

The proposed system consists of 3 major modules.

A. Sowing Date Prediction Module

The farmer selects the crop. The geolocation of the farmer is captured and current weather reports in that location are provided for analysis. The prediction module then shows the ideal sowing period to the farmer which will help to enhance the crop production. Diagrammatic description of the same module is shown in Fig. 1.

B. Disease Detection and Supplements Estimator Module

The farmer will click the images of infected crop and according to the observed pattern in the image, the disease is detected. Based on the type of disease or pattern detected by the system will predict the amount of supplements it needs to provide to the plants. The system will able to predict diseases related to 12 different crop species classified in 38 classes. Modular diagram of explanation is shown in Fig. 2.

C. Buying Selling Portal

As shown in Fig. 3, Market intelligence enables the farmer to know the current trends in the market. Proposed prediction models help the farmers to estimate the upcoming market trends so that farmer can sell the product accordingly. This portal feature provides a platform for the farmer to connect to the interested buyers directly. Thereby removes the middleman.

VI. EVALUATION

As crop disease classification problem is endorsed by over 54,309 images[13] (30000 training set, 10000 validation set and remaining for the testing set) accuracy will be more than 80% for the correct positive.

The Formula for checking efficiency and accuracy combination will be as follows:-

Mean F1 score

TABLE V. RESULT CATEGORIZATION

	Predicted Result		
Actual Result		Negative	Positive
	Negative	True Negative	False Positive
	Positive	False Negative	True Positive

The F1 score is computed as follows:

$$\text{Total Predicted Positive} = \text{True Positive} + \text{False Positive} \quad (1)$$

$$\text{Total Actual Positive} = \text{True Positive} + \text{False Negative} \quad (2)$$

$$\text{Precision} = \text{True Positive} / \text{Total Predicted Positive} \quad (3)$$

$$\text{Recall} = \text{True Positive} / \text{Total Actual Positive} \quad (4)$$

$$\text{F1} = (2 * \text{Precision} * \text{Recall}) / (\text{Precision} + \text{Recall}) \quad (5)$$

Then finally the Mean of all the F1 scores across all the classes is used to come up with the combined Mean F1 score[13]. F1 score of more than 0.8 can be achieved

Mean Log Loss

$$L = -\frac{1}{N}\sum_i^N \sum_j^M y_{ij} . \text{Ln}(P_{ij}) \quad (4)$$

N refers to the total number of examples in the test set examples.
M refers to the number of classes for classification problem (38 types of diseases).
y_{ij} refers to value 1 if the i-th example in the test set represents the j-th class.
P_{ij} refers to probabilistic extent to which i-th example from the test set represents j-th class.
Ln as the natural logarithmic function[13].
Calculated Mean Log Loss can be less than 0.2.

For sowing date prediction model accuracy can be more than 60% as it is primarily dependent on weather prediction of other restful API which is uncertain due to many factors. [16]

VII. Conclusion

Looking at the plight of farmers in India and advancements in the field of Artificial Intelligence, proposed system provides assistance to farmers at various stages right from predicting sowing date, detecting infected plants and providing with its remedy and also helping out farmers to sell their products at apt prices. It not only helps farmers but also increases overall food production in the country.

Proper prediction of sowing date and early disease detection increases yield per hectare. Machine learning models have proved better results in accomplishing these modules.

VIII. Limitation

- Sowing date predictor relies on weather forecast through other restful services so accuracy of sowing date predictor is more extent dependent to accuracy of these services.
- A single CNN detects diseases for all types of crops combined thus adding a new disease or a new crop to existing knowledge base becomes computationally expensive.
- As market intelligence fails to take into account the current number of farmers growing particular crop thus model fails to record imbalance in demand and supply in economical chain leading to rise in percentage of error in market intelligence results.
- All modules are running on custom cloud based architecture requires internet connection to access these services thus making it difficult for offline usage.

IX. Future Scope

- Disease detection module can be made available offline in order to work system in majority rural areas.
- In automated agricultural system disease detection and prevention measures which needs to be taken can be performed autonomously in order to minimize farmer's intervention.
- Data accounted from disease detection model can be used to gives insights to pesticides and fertilizers companies.
- Buying Selling portal can be extended to level where end to end chain can created between customers and farmers directly even though no end has its own transport facilities.

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