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SUGGESTING CROPS TO FARMERS BASED ON AN OPTIMAL RECOMMENDATION SYSTEM (ORS)

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Abstract
Farming is the process of cultivating soil and producing crops. This has been the basic survival mode for the farmers. Farming and agriculture are critical to a country's economy. Till date many farmers cultivate the soil and plan for producing crops has been done using the traditional farming techniques. These techniques were not precise and resulted in reduced productivity and also consumed a lot of time. The aim of this work is to help farmers choose the appropriate crop, cultivate them efficiently. By planting the appropriate crop and planting them at the correct time may help the farmers in achieving high productivity at low cost. Thus, the recommendation system ORS proposed in this paper recommends the farmers with an appropriate crop based on various parameters like the demand for that particular crop and the time it is sown. A sample dataset Crop Recommendation dataset was initially used for building the ORS model.

INTRODUCTION

Agriculture, or farming as it is commonly known, is the practice of growing crops and raising cattle. It contributes greatly to a country's economy. Many raw materials and food products are produced by agriculture. Raw materials such as cotton, jute is used by industries for manufacturing various products that is used in day-to-day life. Agriculture not only helps for food production but also produces resources needed for creating commercial products. Agriculture used traditional techniques for cultivation of crops. Conventional or traditional farming is mostly practiced all over the world. It involves techniques suggested by experienced farmers. These techniques are not precise hence results in hard labour and time consumption.

Indian farmers have knowledge and approach for cultivating and growing crops based on land nature that has evolved around thousands of years of observation and experience, and that is the main cause to explain why farmers produce food without such infrastructure for over billions of people in every year. India is an agriculture-based country where significant agricultural progress has been made via the use of machines. By 2051, we have to sustain over 10 billion individuals, which would require 70% expansion in the worldwide production of food products [1]. For decades, rising farm debts have been a problem in the state. However, there has been a bulk of farmer suicides in India due to rising living costs, policy changes,

water shortage, and higher land rental lease costs (particularly in Punjab) [2]. Worse still, the current climate crisis has resulted in a rise in crop fires and a decrease in annual precipitation.

Modern data-based agriculture positively impacts, providing a sustainable and profitable livelihood while decreasing damage to the environment to properly analyse modern agriculture's role in sustainable decision-making [3]. As Indian population is increasing day by day so there is more requirement of crop yield. To increase the crop yield and profit for the farmers more accurate and profitable crop should be cultivated. This is achieved by considering financial dimension as a return on investment (ROI) which helps for the farmers to take more accurate and an intelligent decision for the crop selection based on the profit and loss as per the market price.

Most of the methods proposed suggest a crop to the farmers based on the soil, market price. The method proposed in this paper suggests a crop based on the demand, the region where the crop is to be planted etc.

The main contribution of the proposed ORS method is summarized as below

- Recommendation system to recommend a crop to the farmer
- The crop is selected based on the demand for that crop in that region
- A dynamic and live calculation of the demand list is carried out
- Synchronization is used to update the demand list based on which the next recommendation is processed
- A deal breaker is used when more than one farmer requests for a particular crop
- All the data are handled in a secure manner using encryption
- A disaster backup plan is used while recommendation, so as to have a backup amount of crop when a natural calamity affects a particular region's crop

RELATED WORK

It is conceivable that the need for food must have increased by 70 percent, and the culture of moving people from rural to urban areas is also a topic of discussion. As the population increases, one can imagine if the land used for agriculture will experience a very drastic decline

in the years to come. The most important reasons for reduced food production are improper planning, inappropriate harvesting, unpredictable weather conditions, irrigation techniques, and other matters such as livestock not being maintained [4]. By using the current technologies, the productivity of farming can be increased. One area also discussed is Artificial Intelligence (AI), where an algorithm learns independently and contributes to developing new insights [5].

Smart Farming was introduced because this technique promises efficiency in which farmers take advantage of IoT to be applied to all farming methods and implementation methods [6]. Smart Farming [7] – [10] is widely used in agriculture because it is very helpful. In intelligent surveys, each planted area had various criteria and could be measured from both quantity and

quality. Some critical Criteria for Smart Farming, such as nutrients [11], soil [12], pests [13], irrigation [14] etc., determine the ability and suitability of certain types of crops.

Crop growth is primarily influenced by the soil's macronutrient and trace mineral content of the soil. Soil being the broad representation of several environmental factors including rainfall, humidity, sunlight, temperature and soil ph. [15]

Soil is an essential component of agriculture. Rooting, moisture and nutrient storage, mineral reserve, anchoring, and a variety of other variables that affect plant growth are all determined by soil depth [16] The initial step for Soil preparation is testing the soil. It involves identifying the soil's current nutrient levels and the suitable amount of nutrients to be feed to a certain soil based on its fertility and crop demands. The values from the soil test report are being used to categorize a number of key soil parameters, notably Phosphorus, Potassium, Nitrogen, Organic Carbon, Boron, as and soil ph [17]. Irrigation is a type of agriculture that plays an important role in water and soil conservation. Complicated data could be used to maintain irrigation performance and consistency when assessing systems with respect to water, soil, climate, and crop facts [18].

PROPOSED SYSTEM

The goal of proposed ORS system is to help farmers to cultivate crop for better yield through recommendation system. The architecture of the proposed model is given in figure 1.

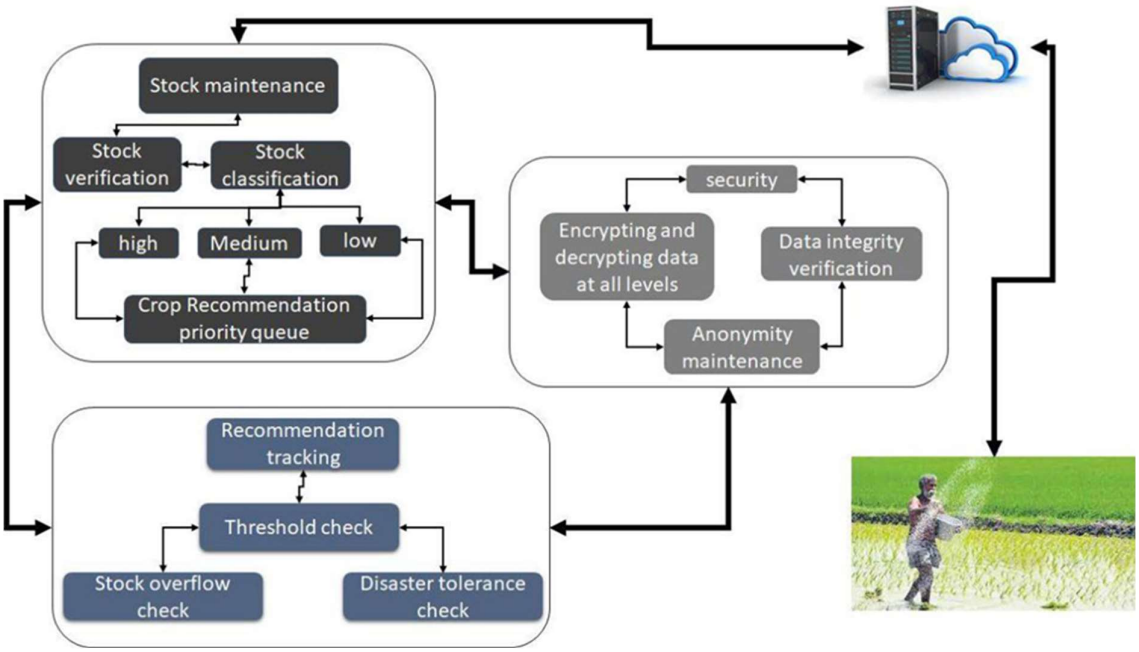

Figure 1. Architecture of the proposed ORS system

The main components of the proposed system are as below:

1. Stock maintenance
2. Recommendation tracking
3. Providing data security

Stock maintenance

When the farmer requests the recommendation to suggest a crop, the system analyses the region where the farmer is located and the time of the year is also analysed. The time for the crop to yield is also calculated. A survey is carried out for the demand that a crop has and a stock list is maintained. The maintenance of the stock is managed following a series of steps.

(a) Stock verification – This step involves in verifying the stock in periodic times an when a recommendation is being given. This step keeps track of all the stocks including the stocks that are in demand.

(b) Stock classification – The stocks are classified based on their demand. The basic classifications are high, medium and low. These levels indicate their priority based on the demands.

(c) Crop recommendation priority queue – This list has a set of crops based on the demand or need of the hour. When a farmer request for a crop to be recommended, a crop is taken from this queue and suggested to the farmer.

Recommendation tracking

This component keeps track of the recommendations that are given to the farmers. This can be done by maintaining a demand list. This demand list is maintained for all the crops in a particular area along with the quantity needed. When one crop is suggested to a farmer, the demand list is updated. So based on the updated demand list a new crop is suggested. For instance, there is a demand for 50 kgs of crop A. If farmer X is suggested to cultivate crop A, to yield 30 kgs. When the next farmer Y requests for a recommendation, the decision is done based on the remaining 20 kgs of crop B. Thus, a dynamic and live processing of demand list is performed.

The other steps involved here are as follows

(a) Threshold check – A threshold value is set for each stock. This is done to keep a hold on the number of stocks being recommended. For instance, one crop should not be recommended beyond the threshold value. There are two steps that are carried out here.

(i) Stock overflow check – Here a check is made to verify if stocks are not recommended beyond a certain value. If the same stock is recommended for many farmers, then there might be an abidance in production. This might lead to crops going waste.

(ii) Disaster tolerance check – There are unpredictable scenarios that are caused by natural calamities. Such situations are taken into consideration when a crop is suggested. For instance, if there is a demand for a particular crop D for 30 kgs. The system recommends a total of 35 kgs of the crop to be planted to the farmers. In case of a natural calamity destroying some crops, the extra 5 kgs crop being planned can be used at the time of such a disaster.

Providing security

The data needs to be protected as the data are being transmitted between many components. To protect the data the following steps are carried out

(a) Encryption and decryption – All the data are encrypted at various levels of operation. This needs to be done to defend against unauthorized changes being done to the data.

(b) Data integrity verification – The data needs to be verified for its integrity at all the levels. For instance, the stock overflow check, disaster tolerance check etc needs to be maintained intact. If there is an unauthorized change made over the data, it might cause for a major error during the recommendation.

(c) Anonymity maintenance – The crops are recommended to the farmers. This suggestion should be maintained. The performance of the proposed model would be optimal if the requests made etc are maintained in an anonymous way.

Synchronization of the demand list

The demand list is maintained for every crop and for every region pertaining to a particular state. Hence all these lists have to be synchronized so as to have the live and real time data when a particular crop or when a particular region is checked. Hence, there is a need for dynamic and live processing of the demand list.

Deal breaker

When two or more farmers requests for a particular crop, or when the demand is the same for two types of crops a deal breaker is used. A threshold value is used in the demand list to break the deal.

The pseudo code for the proposed ORS system with optimized stock maintenance is given in algorithm 1 as below

ALGORITHM 1. Algorithm for farming recommendation with optimized stock maintenance through cloud computing.

INPUT: crop stock
OUTPUT: farming recommendation with live optimization

```
BEGIN
{
READ: stocks
SET: i=0// stocks for farmers
INITIALIZE: recommendation =0 //initialize recommendation
DO
{
  WHILE (farmers >0)
   {
      Collect queries and data from farmers
      Cryptographic security for data
      Data integrity verification
      Anonymous conversion of data
      Stock verification
      Stock classification
          IF lower than threshold
              Assign low recommendation
          ENDIF
          IF within threshold
              Assign medium recommendation
          ENDIF
           IF higher than threshold
              Assign higher recommendation
           ENDIF
              Create crop recommendation priority queue
                  IF disaster occurs
                     Initiate disaster tolerance
                       Verify stocks
                        Update priority queue
                   ENDIF
    }
} Until (EOF)
}
```

ALGORITHM 1. IMPLEMENTATION

Dataset

Precision agriculture is the need of the hour. It guides the farmers to get an informed decision about the farming strategy. The Crop Recommendation dataset was used initially to build the predictive model ORS to recommend the most suitable crops to be grown in the farm based on various parameters. Using this dataset as a sample a new dataset was generated and it was used to test the proposed ORS model.

RESULT ANALYSIS

The recommendation is given based on the stock. When the stock is more for a crop, then the recommendation is given less for that crop. This is done to make sure that there is no over surplus of the crops are there. A sample graph is given in Figure 2 showing stock level Vs recommendation given. The proposed ORS model was compared with the other existing models based on the following parameters.

1. Security
2. Recommendation performance
3. Accuracy

The ORS system ensures data security by using cryptographic measures. The performance of the recommendation gives is increased when compared to the other existing model. This is due to the fact that all important features like crop demand, disaster back up are taken into consideration before suggesting a crop. The accuracy is also improved due to the same. Figure 3 gives the graph showing the comparison between the existing models and ORS model.

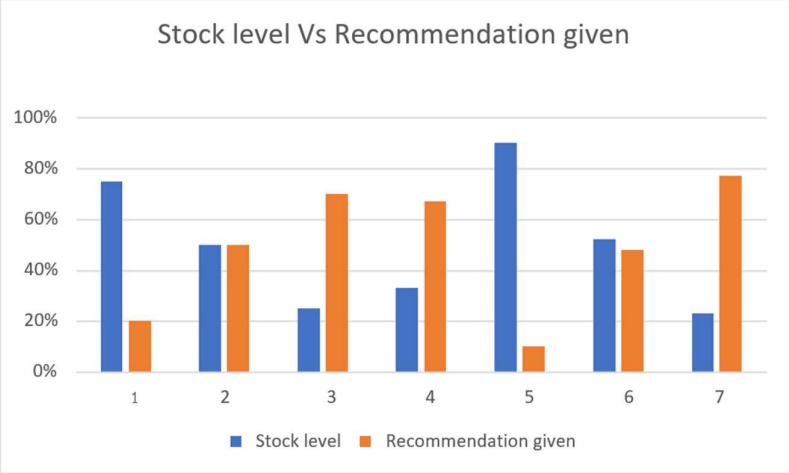

Figure 2. Graph showing stock level Vs recommendation given

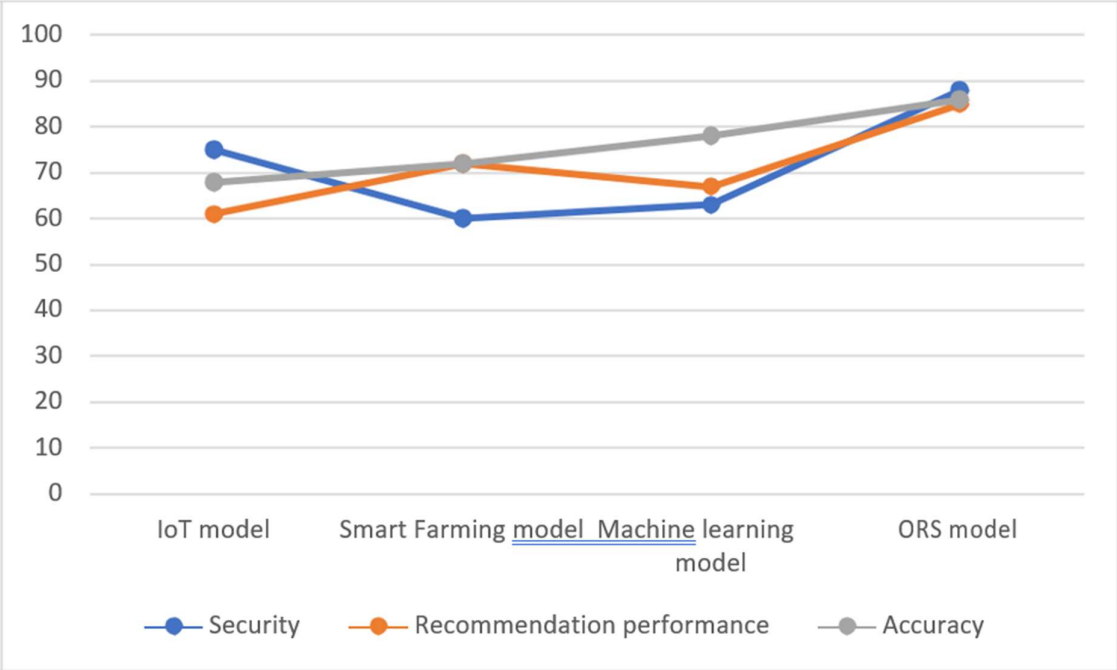

Figure 3. Graph showing the comparison between the existing models and ORS model

CONCLUSION

Thus, the proposed ORS model helps the farmers in choosing the appropriate crop, cultivate them efficiently. The recommendation is being done based on many factors. The demand of the stock in consideration, the region to which the farmers belong etc. are some of the features taken into consideration when suggesting a stock. The aim has been to provide the farmer with a crop suggestion so that he does not incur any loss. In a similar way the wastage of the crop is minimized as a check is made for stock overflow.

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