Web Based Recommendation System for Farmers

Kiran Shinde[#1], Jerrin Andrei[#2], Amey Oke[#3]

[#]*Computer Department, KJ Somaiya College of Engineering, Vidyavihar- Mumbai University*
KJ Somaiya College of Engineering, Vidyavihar, Mumbai, India

[1]kiran.shinde@somaiya.edu
[2]jerrin.k@somaiya.com
[3]amey.oke@somaiya.edu

Abstract— India being an agricultural country is still using traditional ways of recommendations for agriculture. Currently recommendations for farmers are based on mere one to one interaction between farmers and experts and different experts have different recommendations. Recommendation can be provided to farmers using past agricultural activities with help of data mining concepts and the market trend can be merged with it to provide optimized results from recommender. The paper proposes the use of data mining to provide recommendations to farmers for crops, crop rotation and identification of appropriate fertilizer. The System can be used by farmers on web as well on android based mobile devices.

Keywords— *Crop Recommendation, Crop Rotation Recommendation, Fertilizer Recommendation, Data mining, Market trend.*

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I. INTRODUCTION

Agriculture is a prime occupation in India from ages and thus plays a vital role in an Indian economy. India is an agricultural country with second highest land area of more than 1.4 million square-kilometres under cultivation. India possesses a tremendous potential to be a superpower in the field of agriculture. Agriculture promotes poverty upliftment and rural development. Agriculture is India's biggest economic sector and employed 52.1% of total work force in 2009-10. Number of farmers in India is 23.4 crores in 2001. As of 2011, India had a large and diverse agricultural sector, accounting, on average, for about 16% of GDP and 10% of export earnings. Today in India agriculture is being neglected which has led to losing hope of farmers in agriculture which has led to rise in the number of farmer suicides. There is no such universal system to assist farmers in agriculture. India's population has been rising at 1.6% per annum, which means that the growth in agricultural production must also increase at this minimum rate to ensure that there are no supply bottlenecks.

Solutions are obvious India must invest in the agriculture sector, in R&D, in irrigation, intermediary-less sales of produce and effective information centres to provide answers to farmers' queries. In India agricultural is carried out from ages and thus we have a rich collection of agricultural past data which can used for recommendation. Data mining techniques and algorithms can be used for recommending single crop and pattern of crops for crop rotation. However to obtain optimized and valid results system needs to be in continuous learning which can be done by including latest datasets in the system.

Abbreviations

WEKA	Waikato Environment for Knowledge Analysis
ID3	Iterative Dichotomiser 3
FP Tree	Frequent Pattern Tree
N	Nitrogen
P	Phosphorus
K	Potassium
S	Sulphur
API	Application Programming Interface

II. ARCHITECTURE OF RECOMMENDATION SYSTEM

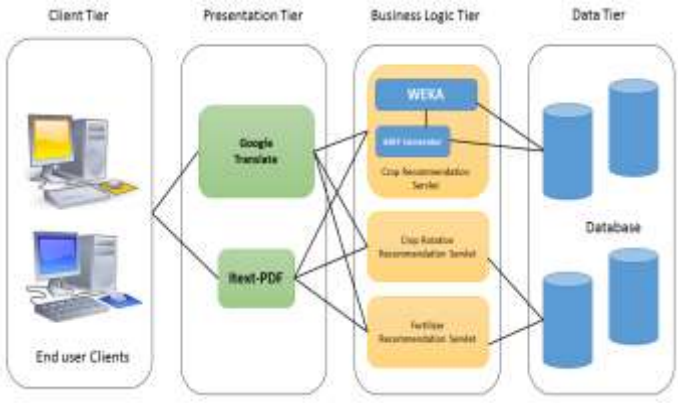

Fig. 1.0 Architecture of Fertilizer Recommendation system.

The Architecture of the system is Multitier/N-Tier which is a client–server architecture. In this architecture presentation, application processing, and data management functions are physically separated. The Data Tier consists of databases which consists of data of past agricultural activity, Market prices, Fertilizers etc. The Business Tier consists of Servlet modules which consist of all the business logic for the system which are hosted on a separate application server. The Presentation Tier consists of view oriented API's like Google Translate and Itext-Pdf for presentation to users and the Client Tier consists of users with browser clients for system access.

A. Crop Recommendation

For the dataset which we have considered, we have taken the data from 1998 to 2009 as a training set and tried applying the following algorithms on this training set by taking the data of 2010 as a test set and then seen the output. This predicted output is compared with the actual output which is already available and the efficiency can be computed thereafter

1. *Random Forest Algorithm:*

The efficiency of this Naive Bayes' algorithm on the dataset we have is about 50% and that of ID3 is about 70 % which is not acceptable as crop recommendation has to be accurate. We have also applied Random Forest Algorithm in order to predict the most suitable crop based on the user input and found this to be the most accurate of all. The efficiency of this algorithm on the dataset we have is about 90% i.e. more than that of Bayes theorem and ID3 algorithm as well. This theorem is similar in working as that of ID3 algorithm but has a greater accuracy than ID3. This is because ID3 algorithm constructs only a single tree and so even if one node/crop is not incorporated into the tree accurately, the entire prediction can go wrong, while Random Forest constructs a random number of trees and the final output is the one which is predicted by a maximum number of trees. So the possibility of prediction going wrong is reduced greatly due to the consideration of a forest of trees rather than a single tree. As Random Forest Algorithm gives a good accuracy, we have decided to go forward with it.

Fig. 1.1 Input of Crop Recommendation system.

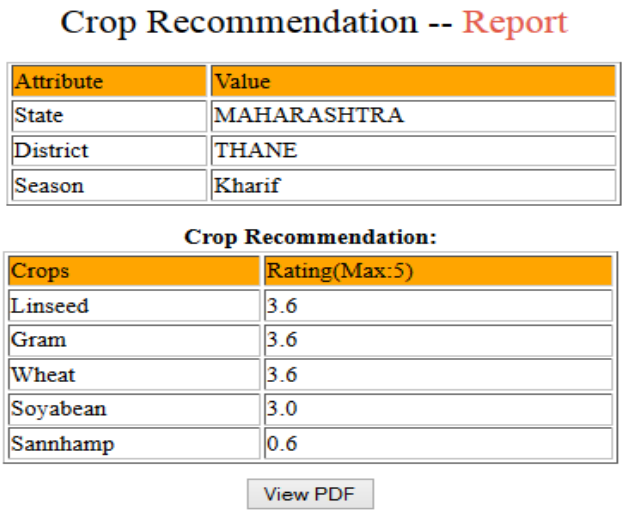

Fig. 1.2 Output of Crop Recommendation system.

2. RATING SYSTEM FOR CROP OUTPUT FROM RANDOM FOREST ALGORITHM:

The rating system will be based on the following three factors:

- Year of Cultivation of Resultant Crop
- Market Price of Resultant Crop
- Output/Area Ratio of Resultant Crop

The point distribution for each of these is as follows:

Factor	Max Points
Year of Cultivation of Resultant Crop	1
Market Price of Resultant Crop	2
Output/Area Ratio of Resultant Crop	2
Total	**5**

Thus a total of 5 points will be allotted to each crop and the crop with maximum points can be recommended to the farmer. The market trend i.e. the cost of each crop is stored in the database. While recommending more than one crop, the first factor to be taken into consideration will be the year factor followed by market factor followed by the ratio factor which are explained below.

2.1 Rating Scheme for Year of Cultivation of Resultant Crop:

Taking year of agricultural activity into consideration is an important aspect as there is always a change of trend in the agricultural activity carried in a region. Old data may become inefficient in next few years. Year will be rated out of one depending on which year is the latest. For e.g.:

Year	Rating
2008	0.4
2009	0.7
2010	1

2.2 Rating Scheme for Market Price of Resultant Crop:

Assuming that all the maximum cost of a crop is 1000, we can have the following rating. This rating will be out of 2 i.e. least cost will have higher rating and vice-versa. For e.g.

Cost Range(Rs/kg)	Rating
800-1000	0.8
400-800	1.4
<400	2

2.3 Rating Scheme for Ratio of Resultant Crop:

The ratio will be calculated as:

$$Ratio = \frac{Production\ (Tonnes)}{Area\ (Hectares)}$$

Thus the crop with highest ratio will be given priority first followed by the second crop with next highest ratio and so on. The ratio will be rated out of 2 as follows:

Ratio	Rating
0.3-0.7	1.6
0.1-0.3	0.8
0.0-0.1	0.2

So the crop will be rated out of 5 and can be displayed to the farmer in decreasing order.

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B. Crop Rotation Recommendation

Crop rotation plays a vital role in agriculture. Due to crop rotation a farmer can yield crops for entire year and maintain the fertility of soil at same time. For recommendation of crop rotation, the crop yielded by farmer is taken as input. Applying sequential algorithm like FP Tree on the past data a pattern can be generated to find out what sequence of crop has been yielded successfully over the years.

Consider following table which represents record of crops yielded by 5 different farmers in a particular region.

Id	**Crops Yielded**
1	Wheat, Rice
2	Potato, Rice, Tomato
3	Soyabean, Tomato
4	Potato
5	Wheat, Rice

The FP Tree would work as follows,

Initially, the frequencies of all item sets i.e. crops here will be calculated and sorted in descending order.

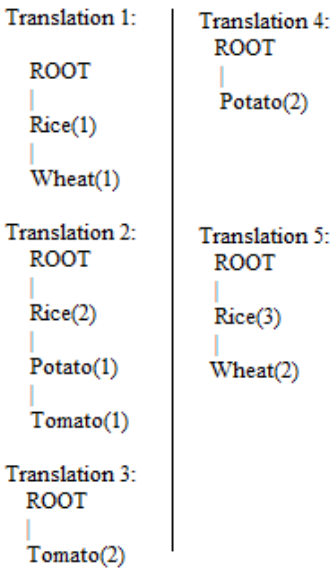
Crop	Frequency
Rice	3
Tomato	2
Potato	2
Wheat	2
Soyabean	1

A certain threshold will be set and items having frequency lesser than threshold will be neglected while constructing a tree. Let's assume that threshold here is 2 and hence apart from Soyabean whose frequency is 1, all the other crops are considered while forming a tree.

Before formation of tree, all crops are again arranged in decreasing order for all individual translations. Hence the modified table would look as below.

Farmer No.	Crops Yielded
1	Rice, Wheat
2	Rice, Potato, Tomato
3	Tomato
4	Potato
5	Rice, Wheat

For each translation from 1 to 5, a branch of FP-Tree would be constructed. All the branches will have a common starting element as ROOT.



Now an input will be taken from farmer who is using the system. The input will represent the crop which he has yielded previously. Based on that a pattern will be searched to recommend best crops for rotation.

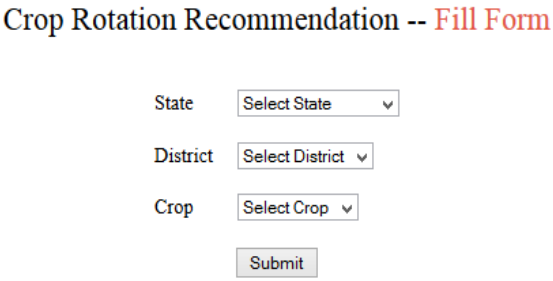


Fig. 2.0 Input of Crop Rotation Recommendation system.

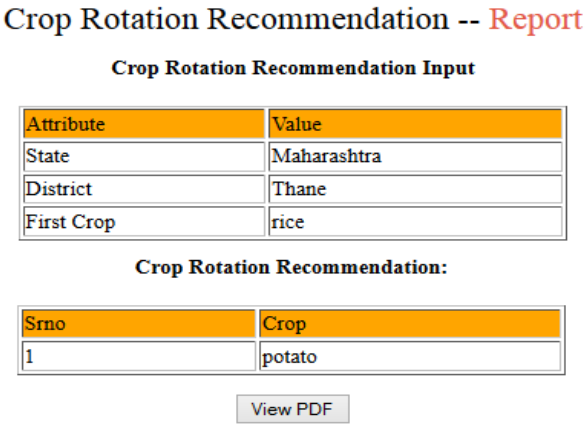


Fig. 2.1 output of Crop Rotation Recommendation system.

Thus for this particular region the best crop for crop rotation is Potato

C. Fertilizer Recommendation

An approach for giving fertilizer recommendations refers to the way conclusions are drawn based on soil tests. Soil-testing labs and crop consultants may give different recommendations based on the same test results if they use different approaches. This may be very confusing to both growers and the person who gives the recommendations.

There are four basic fertilizer recommendation approaches:

1. Build-up and Maintenance
2. Sufficiency
3. Basic-cation saturation ratios
4. Quantitative approach

Sufficiency Approach

In the sufficiency approach, fertilizers are applied only to meet the nutrient requirements of the crop. The goal of this approach is to maximize profitability in a given year, while minimizing fertilizer applications and costs. When soil test levels are low, fertilizer rates that are higher than the nutrient removal of the crop are recommended. When soil test levels are high, reaching the critical soil test level, the recommendation decreases to almost zero.

Most laboratories and universities use this approach for their fertilizer recommendations.

Various types of nutrients essential for crops are:

Air & Water	**Soil & Fertilizer**	
	Macronutrients	**Micronutrients**
Carbon (C)	Nitrogen (N)	Zinc (Z)
Hydrogen (H)	Phosphorus (P)	Copper (C)
Oxygen (O)	Potassium (K)	Iron (Fe)
	Sulphur (S)	Manganese (M)
	Calcium (C)	Boron (B)
	Magnesium (Mg)	Chlorine (Cl)
		Molybdenum (Mo)
		Cobalt (Co)

Fig. 3.0 Essential Nutrients for crops

Nitrogen and phosphorus are the most commonly deficient nutrients in soils. Potassium and Sulphur deficiencies occur in particular areas and soil types. Calcium and magnesium are contained in lime which is plentiful in most soils and therefore deficiency problems are rare. Research has found micronutrient deficiency problems are not common.

So there are four nutrients which are to be considered essential for crops:

- Nitrogen (N)
- Phosphorus (P)
- Potassium (K)
- Sulphur (S)

Soil Analysis report for soil has to be obtained from lab to obtain N, P, K, S values for soil. Database contains N, P, K, S requirements values for crops.

Crop	N (kg/hectare)	P (kg/hectare)	K (kg/hectare)	S (kg/hectare)
Rice	27	15	0	11
Wheat	30	11	0	10
Jowar	22	10	1	7

Fig. 3.1 Crop Nutrient Requirements
(Data for representational purpose only)

Fertilizer Recommendation System consists of logic computes all the possible combination of fertilizers to meet the crop requirements and the combination with lowest cost of fertilization will be recommended.

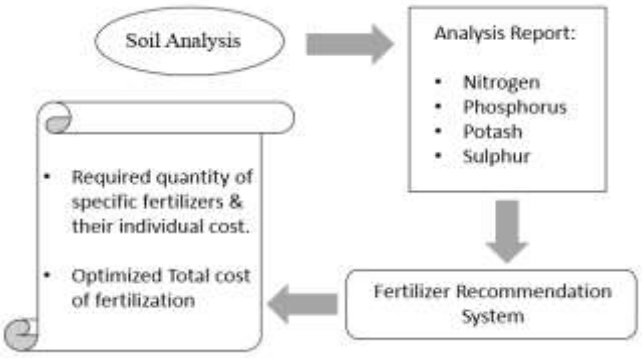


Fig. 3.2 Workflow diagram for Fertilizer Recommendation system.

Logical approach:

```
nitrogen()
{
nreq=ni;
If(ni<ni_req)
 {  ratio=nreq-ni;
   for(i=0; i<nf_count; i++)
    {
      result[i][0]=ratio/nitrogen_content[i][0];
      result[i][1]=nitrogen_price[i]*result1[i][0];
     if(i==0)
         min_cost1=result[i][1];
     if(result[i][1]<min_cost1)
      { min_cost1=result[i][1];
        index1=i; }
    }
nitrogen=nitrogen_content[index1][0]*result[index1][0]+nitrogen;
phosphate=nitrogen_content[index1][1]*result[index1][0]+phosph
ate;
potash=nitrogen_content[index1][2]*result[index1][0]+potash;
sulphur=nitrogen_content[index1][3]*result[index1][0]+sulphur;
}
```

The above logic is implemented for the nitrogen component. Similar logic should be implemented other crop nutrients.

For four nutrients all the possible permutations are:
nPr = n! / (n-r)!
4P4= 4! / (4-4)! = 24 combinations.

All these 24 combination of N, P, K, S fertilizers should be computed and the combination with lowest total cost of fertilization will be recommended.

Fig. 3.4 Sample Input of Fertilizer Recommendation system.

Fig. 3.5 Sample output of Fertilizer Recommendation system.

III. Conclusions

The paper proposes the use of data mining techniques to provide recommendations to farmers for crops, crop rotation and identification of appropriate fertilizer. The results from the recommendation system are optimized with respect to parameter consideration. In future work we will be focusing to go in more micro level of parameter consideration for recommendation which will result in increase in efficiency of the system for e.g. consideration of micronutrients in fertilizer recommendation etc. Also we have planned to turn this web application into portal where all information about agriculture will be available in one single place.

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