International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 05 | May -2017 www.irjet.net p-ISSN: 2395-0072

Use of Machine Learning Techniques to Help in Predicting Fertilizer Usage in Agriculture Production

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Abstract – *India is an Agricultural country and the major occupation of Indians is farming. Agriculture has contributed a lot in the growth of Indian economy. But the decline in the productivity is being seen from a decade. There are several reasons behind this like fragmented land holdings, illiteracy of Indian farmers, lack of decision making capacity in choosing good seeds, manure and lack of irrigational facilities etc. Many of these problems are being resolved through various acts passed by government, still some of them are unresolved. In this paper we have discussed about improper fertilizer usage in agriculture and how it can be resolved through supervised Machine learning algorithms like regression, Support vector machines, Multi-layer perceptron etc.*

Key Words: **Fertilizer, Supervised Machine learning algorithms, Regression, Support vector machines, Multi-layer perceptron**

1. INTRODUCTION

India is the leading producer of some of the crops like it is second leading producer of pulses. When we compare per hectare yield of India with other countries, it is 3 tonnes which is lowest in the world [1]. The reasons are lack of irrigational facilities, improper pest management, soil erosion due to natural calamities, inadequate storage facilities, lack of transportation, scarcity of capital etc. Moreover most of the Indian farmers are illiterate and poor. They cannot afford for good quality seeds and modern fertilizers, and cannot take decisions that help them to increase the crop yield.

1.1 Existing techniques

There are some techniques to solve agricultural issues like rule based systems [2], data mining techniques [3] etc. The rule based systems help farmers to take decisions in choosing good quality seeds, proper quantity of pesticides to be used etc. They work well if and only if all the situations under which decisions can be made are known a head. Maintenance and extension of a rule base can be difficult for a relatively large rule base (beyond 100 rules). It also involves high operational costs.

1.2 Proposed technique

Machine learning has Intelligence built in it. It learns from it's previous experience and improves itself to predict the results more accurately. They help to increase the productivity in three dimensions:

- Quality and judicious use of inputs such as water, seeds, fertilizers and pesticides.
- Judicious and safe exploitation of modern technology including genetically modified seeds.
- Shift into high value commodities.

In this paper, we have taken the agricultural profile of various crops grown in India. Machine learning algorithms are used in predicting fertilizer consumed in kg/hectare for a given hectare of land. Weka tool is used to compare the performance of algorithms.

2. MACHINE LEARNING TECHNIQUES

The Machine learning algorithms like regression algorithms, Multi-layer perceptron are used to predict the crop yield based on fertilizer consumption. This helps the farmers to decide the quantity of fertilizer to be used in the cultivation [2]. In our experiment, the agro data for various crops from 1965 to 2007 is collected [6] and various machine learning algorithms is applied on the data using WEKA tool with 10 fold cross validation. Each one of them is discussed below:

Simple Linear Regression

This regression model involves one predictor variable. It is used to model the linear relationship between one dependent variable known as predictant with one independent variables known as predictor. This fertilizer consumption prediction model for rice crop, we have fertilizer consumption as predictant and predictor is productivity kg/ha.

Multiple Linear Regression

This regression model involves more than one predictor variables. It is used to model the linear relationship between one dependent variable known as predictant with many independent variables known as predictors. Here fertilizer consumption is dependent variable. Independent variables are cropping area, yield and productivity.

Multilayer perceptron (MLP)

A MLP is a feed forward artificial neural network model that maps set of input data like year, cropping area, productivity, and yield into set of appropriate output i.e. fertilizer consumed in kg per hectare. MLP uses supervised learning technique called backward propagation for training the network. It consists of three or more layers they are one input layer, one output layer and one or more hidden layers.

Support Vector Machine

It is a supervised machine learning algorithm used for both classification and regression challenges. The algorithm is selected by setting the RegOptimizer in WEKA. It also predicts the fertilizer consumed based on cropping area and productivity per hectare.

The Weka results for the various crops dataset is as shown below

Table -1: Cross validation results

Comparing different Machine learning Algorithms			
	Multiple Regression	Multi-layer Perceptron	SMOreg
Time taken to build(in seconds)	0.17	0.14	0.04
RMSE	12.1461	7.6281	12.8027
Correlation Coefficient	0.9796	0.9922	0.9776

In our experiment, we have used the terms namely Root Mean Squared Error (RMSE) and Correlation coefficient which are defined as below:

RMSE: The root-mean-square error (RMSE) is a frequently used measure of the differences between values (sample and population values) predicted by a model or an estimator and the values actually observed.

Correlation coefficient: A correlation coefficient is a statistical measure of the degree to which changes to the value of one variable predict change to the value of another.

MAE: The Mean Absolute Error is a quantity used to measure how close forecasts or predictions are to the eventual outcomes. It is an average of the absolute errors.

From Table 1 it is observed that the correlation coefficient is near to 1, which means there is a strong dependency of fertilizer consumption on productivity and cropping area. For Support Vector and Multiple Regression the RMSE is 12.8 and 12.14 respectively. These values are more than Multi-layer perceptron. The Weka results for Multi-layer perceptron has given MAE (Mean Absolute Error) of 6.2, which means the predicted values are closer to actual values. Figure 1 shows that Root Mean Squared Error (RMSE) is the least in case of Multi-layer perceptron. Hence, they give more accurate predictions compared with regression and support vector algorithms.

3. CONCLUSIONS

This paper attempts to predict the consumption of fertilizers to increase the crop yield through various machine learning algorithms. Various techniques like SMOreg, Multilayer perceptron etc. and statistical model MLR algorithm is applied on the existing data and analyzed the results. It is observed that Multi-layer perceptron is more accurate in predicting the results. In our future work, we are including soil parameters, temperature, and rainfall and see how machine learning algorithm behaves.

ACKNOWLEDGEMENT

This work reflects an application of Machine learning algorithms in agriculture. Special thanks to Dr.Kavitha C, Head of the Department, Global academy of Technology and our Principal Dr. Rana Prathap Redddy N for their support. The authors can acknowledge any person/authorities in this section. This is not mandatory.

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