SUGGESTING SUITABLE CROPS BASED ON NUTRIENTS USING DEEP LEARNING

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Abstract

In the modern world, the population keeps on increasing the amount of birth rate is increasing but the death rate is decreasing, due to this, there are highly dependent on food items which results in poverty. The solution for this is to increase the cultivation of crops. The process of cultivating the crop has many difficulties that had been faced by the farmers like what type of crop is suitable for cultivation for the current soil condition. What are the pest and diseases that have a chance to affect the crop? How much water is needed for the crop to grow? For this, we make a solution for the problem to make farmers easier to cultivate the crop. We are going to suggest a crop using deep learning techniques based on nutrient content in the soil like nitrogen, phosphorus, potassium, temperature, and humidity. This can be done by using an Artificial Neural Network (ANN) in deep learning. We are going to predict the pest and diseases that have a chance to affect the suggested crop. We also predict the amount of water that is needed for the crop that we suggested earlier. All these things are done by using deep learning techniques. Also, we suggest the pesticides that can be used if the predicted pest affects the crop. This will help the farmers to increase their crop yield

Keywords: Crop suggestion; Artificial Neural Network; Deep learning technique; prediction; water requirement.

1. Introduction

In 2023, there are 8.0 billion people on Earth. Day by day, the population keeps growing. This will prompt the question of whether or not everyone on the planet has access to enough food to sustain their existence. There is not enough food in several countries, including South Sudan, Malawi, and Mozambique, for people to have regular lives. Food insecurity exists in a lot of nations. The United States Department of Agriculture (USDA) first used the term "food insecurity" in the 1990s to characterize the lack of access to enough, safe, and nutritious food to meet people's dietary needs for an active and healthy life. Food insecurity is a symptom of poverty, which also leads to hunger, malnutrition, poor income, illiteracy, homelessness, substandard housing, social injustice, etc., [1]. The main reason for poverty is the number of food products that we produce is not sufficient for the population, so increasing the production of food products that may reduce the poverty. Indian politicians in the 1980s shifted their focus away from food self-sufficiency and towards generating additional money in rural areas to address the problem of poverty, which was mostly a rural concern. The acceleration of agricultural growth, with a special focus on bolstering the position of small farmers and extending the productivity revolution to non-irrigated areas, was a significant element of the plan for decreasing poverty. To assist underprivileged populations who might not have benefited sufficiently from the growth of agriculture as a whole, targeted anti-poverty measures were added to this effort. India used this approach very well in the 1980s [2].

Agriculture is the hardest job to do. Choosing the right crop, protecting it from pests and diseases, how much water is needed for the crop, irrigation systems, and other aspects are all important in agriculture. To obtain a high crop yield, all of these conditions must be met. The most crucial decision is choosing a crop that is appropriate for the land; otherwise, there is no use in cultivating it. Corn, for instance, requires more nitrogen. On low-nitrogen soil, it cannot grow. Using an Artificial Neural Network (ANN), we will propose the best crop based on the nutrients in the soil to resolve this problem. The quantity of water required for the specific crop is the next crucial factor.

After selecting the suitable crop the next thing is to predict the pest and disease that are having a high amount of chance affecting the particular crop that we suggested. Pests and diseases need to be taken care of that seriously otherwise they cause major damage to the crop. Coffee rust, caused by Hemileiavastatrix, has had significant impacts on coffee-growing countries worldwide. Outbreaks in the past have led to the abandonment of coffee farming, and recent epidemics have affected numerous countries in South and South-East Asia and Central and South America. The impact of coffee rust cannot be underestimated, as it can devastate coffee plantations and cause economic hardship for farmers and entire communities [3]. It is important to know what pest affects the crop, so we predict the pest and disease for the crop that we suggested using ANN. Also, we are going to suggest the pesticides that can be used if the particular pest affects the crop.

2. Literature review

The theoretical aspects of food insecurity are discussed in this article, along with its definition, causes, impacts, and potential remedies on a global and national scale. A simple definition of food security is having access to enough food on a local, national, and international basis [1]. The literature on the significance of plant diseases occasionally highlights their potential contribution to previous food shortages and even famines. In addition to such serious crises, Plant diseases should be considered key crop performance reducers having effects on the sustainability of systems from an ecological, agronomical, social, and economic perspective [3]. In this paper [4] they did crop prediction using ml we are going to use dl. The performance of deep learning and machine learning is explained here [5]. The concept of artificial neural networks and their application is explained here [6]. Biotic stress, like abiotic stress, is a major factor in the global loss of crop production. One of the main causes of lower agricultural output is the harm done by insect pests [7]. The prevalence of pests, particularly weeds, diseases, and animal pests, puts the productivity of crops farmed for human consumption at risk. Crop protection techniques can prevent or lessen the large crop losses caused by these dangerous organisms [8]. Pesticides are substances that are used to eliminate or wear down the number of undesired pests in agricultural or experimental fields. Certain pesticides have a specific mechanism of action to get rid of pests and are organism-specific [9]. If not treated promptly, plant diseases can have disastrous effects on agriculture. Plant diseases are spread by a range of pests, weeds, and pathogens. Farmers encounter a plethora of obstacles, including a reliable water supply, erratically falling rain, storage space, and several plant diseases [10]. In [11] the loss of crops due to diseases in food production is explained. The calculation of evapotranspiration and the requirement for water is explained [12]. How we implement ANN in text classification is shown [13]. Different techniques for crop prediction are presented [14]. The work mentioned here is predicting the crop based on soil fertility using sensors. In this model one of the disadvantages is we should place sensors for every cultivating field. The model we are going to propose will rectify this fault [15].

3. Proposed System

The system we suggested will forecast the ideal crop based on soil nutrients like nitrogen, phosphate, and potassium as well as temperature, soil ph and humidity. We will predict the pest, disease risk for that crop, pesticide use for the pest, and crop water requirements.

A. Data Collection

The most crucial part of this process is data collecting, during which we will gather datasets from a variety of sources, like APMC's website, government websites, etc. The dataset's quality will have the biggest impact on how the system performs [4]. The following are the parameters that we use in crop prediction:

- nitrogen
- phosphate
- potassium
- temperature
- humidity
- soil ph

Parameters for pest and disease prediction:

The crop that we get as result acts as a parameter for pest and disease prediction

Parameters for water requirement:

- Crop
- temperature
- region

Parameters for pesticides:

The pest that we get as result acts as a parameter for pesticide

B. Data Pre-processing

Data preparation comes next when data collecting is finished. The error correction will take place at this point. Before the datasets are trained, any errors that may have been introduced during collection from various sources should be fixed. Before training the data, every dataset should be pre-processed. This will boost the system's efficiency and produce accurate results. The dataset will be divided into a training set and a test set after data cleaning.

C. Deep Learning Technique

A subset of machine learning called "deep learning" makes use of neural networks with several layers. Neural networks can learn from adjusting and adapting to input data because they are designed like the human brain. Large data sets can be used to train deep learning algorithms to identify patterns and generate highly accurate predictions or classifications. Deep learning can automatically extract features from data, eliminating the need for manual feature extraction, which is one of its key benefits. The accuracy of deep learning is better than machine learning [5]. There are different types of algorithms in deep learning like a convolute neural network, recurrent neural network, Artificial Neural Network, etc. As the datasets are in text form, we can use both ANN and RNN. We are going to use a single algorithm in the entire system which is an Artificial Neural Network (ANN).

D. Artificial Neural Network (ANN)

An Artificial Neural Network is a type of machine learning algorithm which can be used to solve both regression and classification problems. It was designed using the human brain as a model. Similar to the human brain, ANNs have neurons and a neural network where training data is stored. Input, output, and hidden layers make up an ANN. Neurons are only present in the hidden and output layers [6]. An ANN is made up of layers' worth of interconnected nodes (neurons). Each connection between a neuron and one or more neurons in the layer has a weight that defines how strong the connection is. To reduce the error between the expected output and the actual output, ANNs are trained on data, and during training, the weights of the connections between the neurons are modified until the expected output is achieved. ANN uses backpropagation and forward propagation to adjust the weight. We can also use ANN for text classification [13].

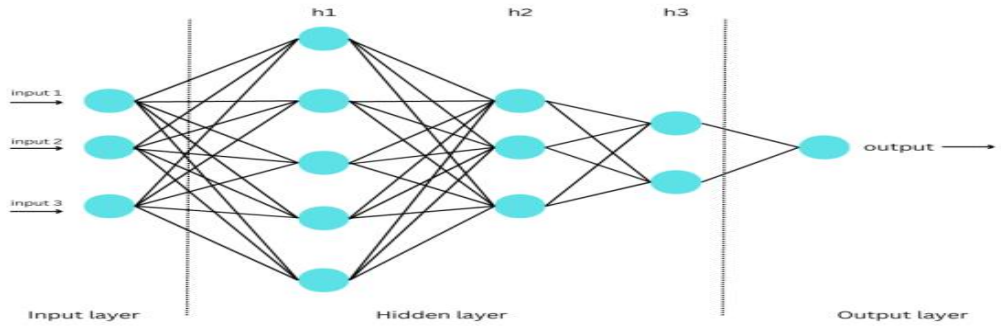

Figure 1: Artificial Neural Network

4. Crop Prediction

The process of crop prediction is started by loading the crop datasets. Once the data pre-processing is completed, the model will train the datasets using ANN. For predicting the crop, we are using various factors like soil ph, nitrogen, phosphorus, potassium, temperature, and humidity. We are not using rainfall as a parameter the rectification will be shown in the upcoming process. The input parameters can be loaded by manually or using sensors. The input parameters will be arranged as a list. There are many techniques to predict the suitable crop for the soil [14]. Here by using the Artificial Neural Network we will predict the suitable crop based on given datasets.

A. Crop Recommendation

Based on the soil ph, nitrogen, phosphorus, potassium, temperature, and humidity the suitable crop will be predicted using an Artificial Neural Network. The suitable crop will be displayed. The crop that we get as an output will be used as input in the upcoming process to predict the pest, disease, and water requirements.

Nitrogen	Phosphorus	Potassium	Temperature	Humidity	Soil ph	Crop
85	58	41	21.77046	80.31964	7.0380	rice
104	80	54	27.09062	81.33507	5.8791	banana
60	54	19	18.74827	62.49878	6.41782	maize
12	6	8	30.84835	92.86774	6.3886	orange

Figure 2: Output For Crop Prediction

The following flow chart explains the process of the system

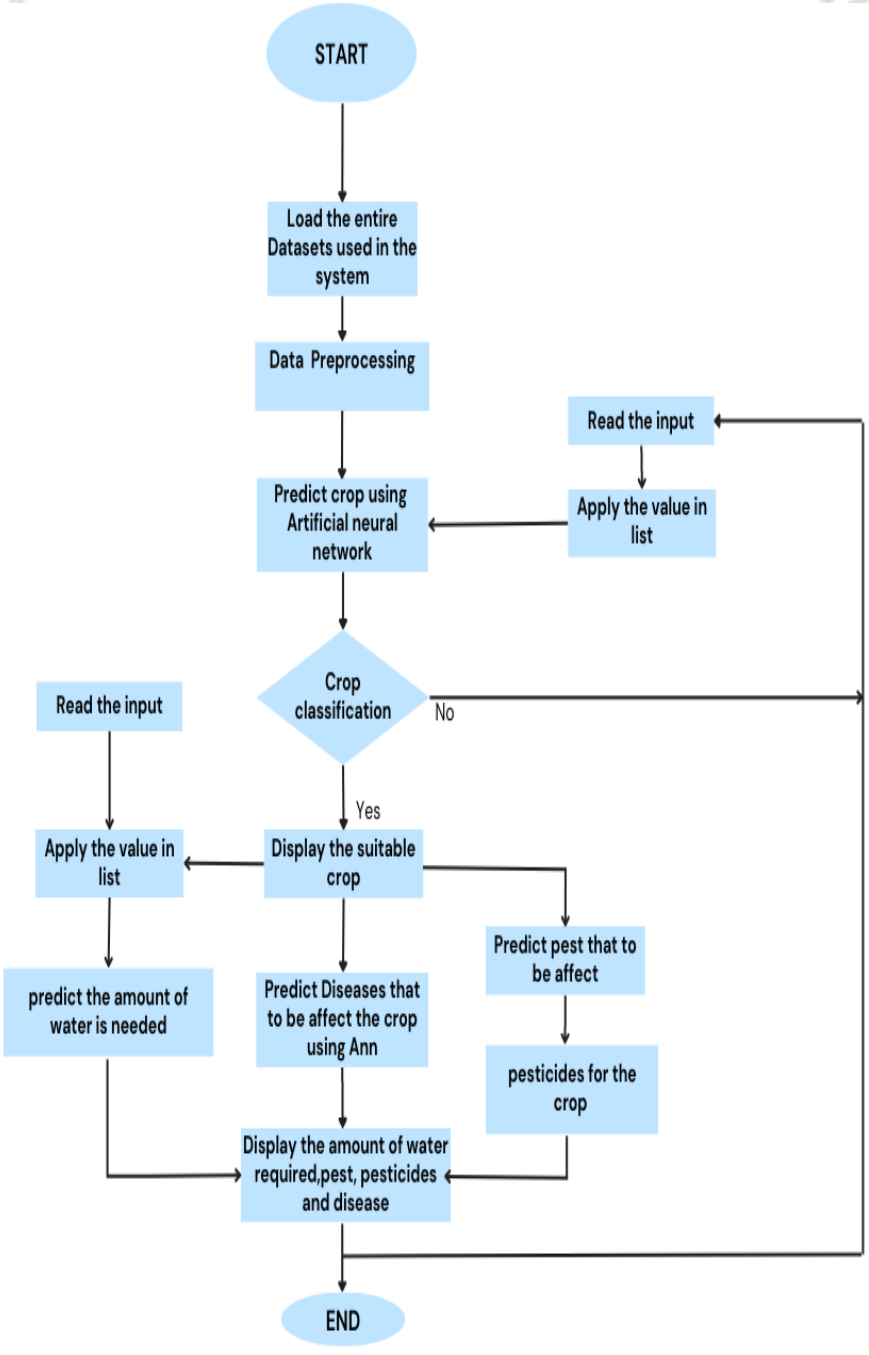

Figure 3: Proposed System Flow chart

5. Pest

A. Impact of pest in agriculture

Due to the ravages of pests, India loses farm products worth 5000 crores every year (weed diseases, insects, rodents, and during storage). The typical productivity loss is between 18 and 25 percent [7]. In 1929, fungus pathogens and animal pests each reduced cereal yield by 10%, according to German officials. Pathogens and animal pests reduced potato output by 25 and 5%, respectively, while pathogens and animal pests reduced sugar beet production by 5 and 10%, respectively (Morstatt 1929) [8]. So, it is important to know about the pest that has a major chance to affect the crop that we going to cultivate.

B. Pest Prediction

As we mentioned earlier the crop that we get as an output will be the input parameter for the pest prediction process. The datasets of pests are loaded in the Artificial Neural Network after the data pre-processing is completed for the loaded datasets. The datasets will be stored in neurons and get trained using ANN. By using the datasets, the Artificial Neural Network will predict the pest that affects the crop that we suggested in crop prediction and display the pest.

C. Pesticides

Pesticide plays a major role in agriculture to increase crop yield. Pesticides are chemicals used to control or eliminate pests such as insects, weeds, rodents, and fungi that can cause damage to crops, livestock, and human health. The use of pesticides has increased significantly over the years, as they are considered a crucial tool in modern agriculture to increase yields and protect crops from damage. Different types of pesticides can be used for different problems [9]. It is important to know which pesticide will use for the particular pest. For this, we use ANN to predict the pesticides. The result that we get in pest prediction will act as an input parameter and the datasets will be loaded in ANN. The ANN will predict the suitable pesticides based on the datasets that we get after the data pre-processing. The suitable pesticides for the pests that we predicted earlier will be displayed.

6. DISEASE

A. Impact Of Disease in Agriculture

Disease in agriculture crops can have a significant impact on crop yields, quality, and profitability. The symptoms of plant diseases in crops can vary widely depending on the pathogen involved. Some common symptoms include wilting, yellowing, stunting, leaf spots, cankers, and blights. Diseases can also affect different parts of the plant, such as the leaves, stems, roots, or fruit [10]. France's primary field crop is wheat, which was grown on nearly 4.8 million hectares in 2006. Despite growing worries about the negative externalities associated with traditional methods of intensifying agriculture (including, for example, intensive use of pesticides, fertilizers, growth regulators, and classical tillage) (Aubertot et al. 2006), France is one of the countries that uses the most pesticides globally. The approaches used to collect and use crop loss information for wheat in France are described in the part that follows [11].

B. Disease Prediction

In disease, the prediction process will start after the crop prediction is completed. The output in the crop prediction will act as an input parameter as same in pest prediction. The datasets will be loaded in ANN. By using the suggested crop in an earlier stage, the disease that may have a chance to affect the particular crop will be predicted by using ANN and the disease will be displayed.

7. Water Requirement

Crop water requirements (CWR) are the volumes of water needed over a given period to make up for evapotranspiration losses from a cropped area. The typical unit of measurement for crop water needs is mm per day, month, or season. There are many ways to calculate the water requirement for the crop like Reference Evapotranspiration (ET0) [12]. For example, a banana tree in a desert region with dry soil will require around 3-4 inches of water per week or roughly 12-16 inches per month.

A. Prediction For Water Requirement

We won't be able to predict the rainfall in this system because it is impossible to do so perfectly and precisely. Instead, we will forecast how much water the crop will need to grow. Temperature, the crop we anticipate will grow, and the region makes up the input parameters used here. We will manually load the region input parameter and use the temperature data from the crop prediction stated previously. The ANN loads and trains on this data. The amount of water needed for the crop that we suggested and that will receive as a result will be predicted by ANN using these trained datasets. The outcome will be given in inches per month.

8. Conclusion

This system will help the farmers in many ways. By leveraging data sets related to crops, pests, pesticides, and weather, we can predict suitable crops, pests that can affect them, appropriate pesticides to be used, and the diseases that might affect the crops. Additionally, predicting the amount of water needed for the crops to grow will help farmers make informed irrigation decisions, leading to more efficient use of water resources. All these things are done through ANN which is one of the most efficient classification methods. By using this system, the farmers can able to increase their cultivation and get good crop yield.

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