

Optimizing Fertilizer Recommendations for Banana Plant Using Feature Extraction Method and Machine Learning Classification



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ABSTRACT

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The Fertilizer Recommendation System for Banana Plant using Feature Extraction proposes a system for recommending the optimal fertilizer type and quantity for banana plants based on various features extracted from the soil and plant samples. The proposed system utilizes various machine learning techniques, such as feature extraction and classification, that analyze the data collected from the soil and plant samples. The study also involves data mining techniques to identify relevant features that affect the growth and health of the banana plant. The system provides an easy-to-use interface that enables farmers to input the collected data and receive customized fertilizer recommendations that are specific to their banana crop. The proposed system is expected to improve the yield and quality of banana crops while reducing the cost of fertilizers and minimizing environmental impact.

1. INTRODUCTION

Banana is most widely grown and consumed fruit in India, and banana cultivation has a long history in the country. India is one of the largest producers of bananas in world, accounting for over 29% of the global production. Banana cultivation is mostly carried out in states like Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, and Karnataka. Bananas are known for their high nutritional value, rich taste, and versatility. They are consumed both as a fruit and as a vegetable in India. Bananas are also used in the production of various processed products such as banana chips, banana powder, and banana puree. If you are planning to start a banana plantation in India, it is essential to choose the right variety of banana plants that are well-suited to the local climate and soil conditions. You can seek guidance from agricultural experts and horticulturists in your area for selecting the right variety and obtaining the necessary inputs such as fertilizers, pesticides, and irrigation systems.

Fertilizer Recommendation has been developed as a tool for precision agriculture that provides the right amount and type of fertilizer to plants. This is especially important for the banana plant, which is a highly nutrient-demanding crop. In recent years, machine learning techniques have been utilized to develop more efficient and accurate fertilizer recommendation systems. One such approach is the use of feature extraction, which involves extracting relevant information from input data to make informed decisions. In this context, feature extraction can be used to analyze soil samples, plant tissue, and weather conditions to determine the appropriate fertilizer recommendations for banana plants. This system can optimize crop yields and minimize environmental impact by reducing fertilizer overuse.

2. FIELD STUDY

The soil must be fertile, well-drained, and abundant in organic matter for banana plants. Banana plants like a pH range of between 5.5 and 7.0. Root rot can be caused by too much moisture in the soil; thus it should be able to hold moisture without becoming saturated. A healthy soil for banana plants should contain a blend of sand, silt, and clay as well as a significant amount of organic material, like compost or well-rotted manure. Additionally, it must be nutrient-dense and have sufficient amounts of potassium, phosphorus, and nitrogen. Adding peat moss or pine needles to the soil can help reduce the pH because banana plants love slightly acidic soil. Mulching the soil surrounding the plant with organic material, such as straw or leaves, can also be beneficial [1].

2.1 Soils

There are different types of soils in which banana plants grow Alluvial soil, Black soil, red soil, Laterite soil, Desert soil, Mountain soil, Saline soil and Alkaline soil, Peaty soil. Banana plants thrive in alluvial soil because it has excellent drainage and water-holding capacity. The soil can hold onto moisture for long periods, which is essential for the growth and development of banana plants.

i) Alluvial soil is rich in organic matter, which provides the necessary nutrients for the plants. In fact, alluvial soil is ideal for growing bananas since it offers a number of favorable circumstances for their development.

ii) Black soil is formed from volcanic ash and lava, and is rich in minerals such as calcium, magnesium, and iron. The high clay content of black soil helps it retain moisture, which

is important for banana plants as they require consistent moisture levels to grow and produce fruit.

iii) Red soil is generally low in organic matter and nutrients, which can make it difficult to support healthy banana plant growth. Additionally, red soil has poor water-holding capacity and drainage, which can lead to waterlogged conditions that can be harmful to banana plants.

iv) Laterite soil, also known as lateritic soil, is a type of soil that is commonly found in tropical regions, including some parts of India, Africa, and South America. While laterite soil can be used for banana plant cultivation, it requires some preparation and amendments to be suitable for healthy plant growth.

v) Desert soil, also known as arid soil, is generally not suitable for banana plant cultivation due to its poor fertility, lack of organic matter, and low water-holding capacity. Banana plants require moist and fertile soil to grow and produce fruit, which is not typically found in desert regions. Banana plants require moist and nutrient-rich soil to grow and produce fruit.

vi) Mountain soil is typically lower in fertility due to the lower levels of organic matter and nutrients, which can limit the growth of banana plants. Additionally, mountain soils can be rocky and have poor water-holding capacity, which can lead to water stress in the plants [2].

2.2 Diseases in banana plant

(1) As per the Figure 1 Panama wilt is Gradually spreading upward, the lowermost leaves begin to turn yellow from the margins towards the centre. In the end, just the core leaf stays green for a while before also being afflicted. Around the pseudo stem, the leaves droop and break close to the base. Through rhizomes that are infected, the disease spreads.



Figure 1. Panama Disease

Source:

https://agritech.tnau.ac.in/crop_protection/images/banana_diseases/7.1.jpg

(2) As per the Figure 2 Mycosphaerella leaf spot is the third or fourth leaf down from the top, the first symptoms start to show. On the leaf, tiny dots with a yellow halo parallel to the veins and a grey centre appear. The illness spreads more quickly thanks to the conidia of the fungus, which are dispersed by wind, moisture, and old, dried diseased leaves.



Figure 2. Mycosphaerella leaf spot disease

Source:

<https://encryptedtbn0.gstatic.com/images?q=tbn:ANd9GcStti26QrS8dxuaNqkNskiSxWPWMAWEDh73fzs3X3JL&s>

(3) As per the Figure 3 Anthracnose is infected fruits initially develop little, round, black spots that get larger and turn brown as a result of the illness. Pink spore masses that cover the fruits appear along with premature ripening and shrivelling. Insects that visit banana blooms in particular and airborne conidia help spread the illness.



Figure 3. Anthracnose disease

Source: <https://content.peat-cloud.com/w400/anthracnose-of-banana-banana-1563270982.jpg>

(4) As per the Figure 4 Moko disease is petiole breaks, the leaves droop, and the leaves become yellow as they go upward. The bacteria persists in soil, vegetative propagative organs, wild host plants, and plant detritus, which aids in its spread.



Figure 4. Moko disease

Source: <https://content.peat-cloud.com/w400/moko-disease-banana-1563272291.jpg>

(5) As per the Figure 5 Bacterial soft rot is young suckers are the main victims of this illness, which results in rotting and a bad odour. When infected plants are removed from the ground, the corm and roots remain in the soil because the rot originates in the collar area. Crop waste contains bacteria that can live and spread infection through water splashes and injured tissues.



Figure 5. Bacterial soft rot disease

Source: <https://content.peat-cloud.com/w400/bacterial-soft-rot-of-banana-banana-1563276484.jpg>

(6) As per the Figure 6 Bunchy top is along with marginal chlorosis and leaf curling, noticeable dark green streaks can be seen on the petioles and midrib along the veins of the leaves. The banana aphid vector, *Pentalonia nigro-nervosa*, as well as diseased plant waste, plant wounds, and injuries, can all transmit the illness.

(7) As per the Figure 7 Banana bract mosaic virus (BBMV)

is Spindle-shaped pinkish to crimson streaks on the pseudostem, midrib, and peduncle are the disease's hallmark. The peduncle elongates, the hands are half-filled, and leaves cluster at the summit, simulating the palm of a wanderer. The virus, which is a member of the potyvirus family, is maintained and disseminated by flexuous filamentous virions.



Figure 6. Bunchy top disease

Source:

<https://encryptedtbn0.gstatic.com/images?q=tbn:ANd9GcQK5ztWtjfYOICvMrUKVnOztLRZ33p3hAuGrz2ceZaqg&s>



Figure 7. Banana bract mosaic virus disease

Source:

https://agritech.tnau.ac.in/crop_protection/images/banana_diseases/1_BBM_1.jpg

(8) As per the Banana streak disease (BSV) Figure 8 the yellow streaking of leaves, which eventually turns necrotic and gives older leaves a black streaked look, is a notable sign of BSV. However, mealy bugs can also help spread the virus, which is mostly propagated through contaminated planting materials.



Figure 8. Banana streak disease

Source:

https://apps.lucidcentral.org/pppw_v10/images/entities/banana_streak_disease_215/musabsbv1.jpg

(9) As per the Infectious chlorosis (CMV) Figure 9 the disease can be seen at all phases of crop development and in all areas where bananas are grown. The leaves seem striped because of light yellow striations that run parallel to the leaf veins. The Aphis gossypii and suckers that spread the infection.

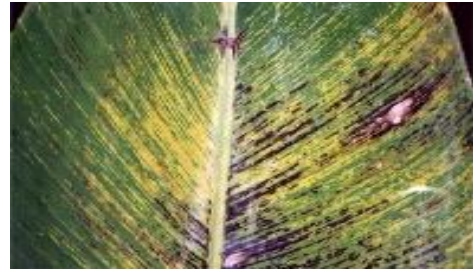


Figure 9. Infectious chlorosis disease

Source: <https://nrcb.icar.gov.in/gallery-Virology.php>

3. ALGORITHMS

There are several machine learning algorithms that can be used in fertilizer recommendation systems for banana plants. Some of the most common algorithms include:

3.1 Support vector machine

SVM is a supervised learning algorithm that can be used for both classification and regression tasks. In the context of fertilizer recommendation, SVM can be used to identify the optimal fertilizer mix for a given banana plant based on its soil conditions and growth stage.

Support Vector Machine (SVM) is a supervised learning algorithm widely used in classification, regression and outlier detection. It can also be used to diagnose plant diseases. In this algorithm, data items are represented as points in a multidimensional space where each feature corresponds to a specific relationship. SVM uses the hyperplane to classify to show the difference between different classes. The points closest to the plane are called support vectors and maximum stability is used to separate them, allowing the SVM to be trained efficiently.

Youwen and others. Identification of powdery mildew and downy mildew on cucumber leaves using SVM. They used a median filter to remove noise and used a metric and morphological algorithm for page image segmentation. The features extracted from the cucumber leaf images are then classified by SVM for disease recognition. Experimental results show that SVM outperforms neural network-based classification [3, 4].

SVM is a supervised learning algorithm that can be used for both classification and regression tasks. In the context of fertilizer recommendation, SVM can be used to identify the optimal fertilizer mix for a given banana plant based on its soil conditions and growth stage. It can also be used to diagnose plant diseases.

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Accuracy: Based on their attributes, SVM can be used for classification jobs to choose the right fertiliser for banana plants. If correctly trained and tweaked, SVM models are capable of great accuracy.

Interpretability: Decision borders and support vectors are provided by SVM models, which can help with comprehending the classification procedure. SVM model

interpretation, however, can be difficult, particularly in feature spaces with several dimensions.

Feature Importance: Although SVM does not explicitly provide feature importances, the size of the feature weights in the model can provide a clue as to how significant the features are to classification.

Scalability: SVM can be expensive to compute, particularly for large datasets. Scalability and training time can also be affected by hyperparameter adjustment and kernel selection.

3.2 K-Means

K-Means algorithm is Unsupervised machine learning is done using the K-Means technique. Each data point is assigned to the cluster with the nearest mean (centroid) after a given dataset is partitioned into a preset number of clusters.

The contour of the banana item was separated from the background using the initial k-means clustering. The surface imperfections on the banana were found using the second k-means clustering.

The G channel picture without a backdrop was selected as the clustering object because it had the biggest contrast between healthy and defective parts (the latter of which are mostly represented by black patches).

Accuracy of K-Means: K-Means is essentially a clustering technique and might not be a good choice for recommending fertiliser. However, K-Means can be used to locate clusters and then assign fresh data points about banana plants to the proper cluster/fertilizer if the data has pre-defined classifications for various fertiliser kinds.

Interpretability: K-Means assigns clusters, but how to understand them relies on the features employed. Additional research and subject-matter expertise may be necessary to interpret the clusters in the context of fertiliser suggestion.

As a distance-based clustering algorithm, K-Means does not explicitly state the value of any given attribute. Domain expertise, however, can assist in determining the critical elements for fertiliser advice.

Scalability: K-Means can handle big datasets and is generally scalable. It is appropriate in situations where the variety of fertiliser kinds is known and understood.

3.3 Random forest

Random Forest is a group learning algorithm that combines the predictions of multiple decision trees. This algorithm is mainly used for classification tasks but can also be used for regression tasks. Based on many factors such as plant, soil, growth stage and history, diseases and pests, the recommendations can determine the best fertilizer for your banana plant. The choice of algorithm used in a fertilizer recommendation system will depend on many factors, such as the size of the dataset, the complexity of the problem, and the need for accuracy. However, all the algorithms listed above are well developed and have proven effective in many applications [5].

Random Forest is a group learning algorithm that combines the predictions of multiple decision trees. This algorithm is mainly used for classification tasks but can also be used for regression tasks. Based on many factors such as plant, soil, growth stage and history, diseases and pests, the recommendations can determine the best fertilizer for your banana plant. The choice of algorithm used in a fertilizer recommendation system will depend on many factors, such as

the size of the dataset, the complexity of the problem, and the need for accuracy. However, all the algorithms listed above are well developed and have proven effective in many applications.

Accuracy: Random Forest is a potent classification system that can be used to propose fertiliser. On the basis of the given data, it can produce precise predictions and handle intricate interactions between features.

Interpretability: Random Forest models can produce feature importances, which show which features are most important for recommending fertiliser. This makes it possible to interpret and comprehend the variables affecting the fertiliser suggestion.

The important features influencing the fertiliser recommendation can be found by using the feature importances that Random Forest provides. This knowledge may be helpful for comprehending the underlying causes.

Scalability: Random Forest is scalable and effective at handling enormous datasets. In comparison to decision trees, it is also capable of handling high-dimensional feature spaces and is less prone to overfitting.

Random forest and support vector machines are preferred for the desired results. Random Forest is effective for Soil Classification and achieves 86.35% accuracy compared to SVM. In the case of crop prediction, SVM outperforms Random Forest with 99.47% accuracy. The accuracy of this method using Kmean's minimum evaluation and SVM with GA algorithm is 86.54%, 93.63% and 95.71%, respectively [6].

Random Forest shows out as a powerful algorithm for fertiliser suggestion when taking into account accuracy, interpretability, feature relevance, and scalability. It can scale well to big datasets, execute classification jobs efficiently, and offer feature importances for interpretation. However, the final method selection should take into account the details of the task at hand—recommending fertilizer—as well as the features of the dataset and the available computing power. To make an educated choice, it is advised to experiment with and contrast the results of several algorithms on the particular dataset.

4. DATASET

```
import numpy as np
import pandas as pd
import cv2
import os
from random import shuffle
import os
import matplotlib.pyplot as plt
IMG_SIZE=100
BASE_PATH = './input/banana-leaf-disease/dataset/'
data = pd.read_csv("./final_dataset.csv")
data
```

4.1 Output

```
Xy0[ 20 160 6 ... 2 2 3]11[90 92 79 ... 10 45 43]12[37 42 37 ...
73 74 73]13[97 65 62 ... 4 7 21]14[ 27 46 179 ... 231 236
238]15[249 250 250 ... 2 1 0]16[ 15 96 105 ... 136 128
140]17[106 99 78 ... 34 53 62]18[ 51 33 25 ... 82 23
194]19[121 124 127 ... 157 150 138]010[193 196 209 ... 216
212 217]011[134 134 150 ... 127 131 138]012[255 255 255 ...
255 255 255]013[ 84 126 214 ... 111 77 110]014[58 55 59 ...
```

57 31 64]015[255 255 255 ... 255 255 255]016[255 255 255 ... 255 255 255]017[255 255 255 ... 255 255 255]018[51 43 36 ... 43 33 31]019[114 110 110 ... 65 53 47]220[255 224 252 ... 93 123 159]221[187 179 184 ... 96 148 120]222[255 255 255 ... 44 31 30]223[101 130 142 ... 236 171 99]224[6 13 46 ... 0 11]225[255 254 254 ... 255 255 255]226[250 252 249 ... 45 65 62]227[164 174 164 ... 13 23 34]2

Dataset

https://drive.google.com/file/d/1gw7sLvh_SvNU6mFKZK8aQWSZCw4ihzPL/view?usp=sharing

4.2 Recommendation of best fertilizer for high yield of banana

A banana plant's rapid growth rate makes it a high-demand feeder. Young plants may require ¼ to ½ of fertilizer per month. The key nutrients for fertilization are Nitrogen (N), Potassium (K), Phosphorus (P), Calcium (Ca), Magnesium (Mg), Sulfur (S), Boron (B), Zinc (Zn). A banana tree thrives when provided with sufficient amounts of Nitrogen (N), Potassium (K), Phosphorus (P) through regular feedings, which can be achieved using either an 8-10-8 (N-P-K) chemical fertilizer or organic composted manure is mentioned in Table 1

i) Nitrogen: Insufficient root growth in plantations exhibits symptoms such as reduced bunch weight and compromised fruit quality. For vegetative growth and total plant development, nitrogen is crucial. It is an essential part of proteins, amino acids, and chlorophyll, all of which are necessary for photosynthesis and the creation of energy in plants.

ii) Phosphorus: Plants experience stunted growth and poor root development when lacking in phosphorus. For plants to transport and store energy, phosphorus is required. It is essential for the growth of the roots, flowers, and fruits. The creation of DNA and RNA, which are essential for plant growth and reproduction, also involves phosphorus [7].

iii) Potassium: Insufficient potassium results in leaf congestion, delaying in flower initialization and leading to reduced in yield and quality. Banana plants need potassium for their general well-being and vigour. It improves fruit quality, strengthens disease resistance, and contributes to the activation of several enzymes involved in a variety of metabolic processes. It also aids in controlling water intake.

iv) Boron: Insufficient boron leads to reduced leaf area, curling, and deformation, inhibiting root and flower formation. Numerous physiological processes, such as the creation of cell walls, pollen germination, and fruit development, include the element borax. It aids in the transport of carbohydrates and the control of plant hormone levels [8]

v) Magnesium: Yellow discoloration appears in the middle blade and midrib of leaves when there is a deficiency in magnesium. Magnesium is essential for photosynthesis and is a key component of chlorophyll. It is essential for the use of light energy, the activation of enzymes, and the production of proteins and carbohydrates.

vi) Sulfur: Deficiency in sulfur is characterized by yellow or white appearance of young leaves, stunted growth, and small congested bunches. The synthesis of several amino acids, proteins, and enzymes requires sulphur. It supports root growth, chlorophyll production, and overall plant growth. The metabolism of nitrogen is also aided by sulphur.

vii) Zinc: Insufficient zinc results in smaller, lanceolate-

shaped young leaves, while the fruit becomes light green, twisted, short, and thin. Zinc is necessary for the production of many enzymes and hormones in plants. It is essential for healthy development, leaf growth, and glucose metabolism. Additionally, fruit set and pollen germination are also impacted by zinc.

viii) Calcium: A deficiency in calcium causes leaf lamina deformation or absence. Calcium is necessary for the formation of cell walls, healthy root and shoot development, and the avoidance of ailments such blossom end rot in banana fruits. It helps preserve the integrity of cell membranes and facilitates the transport of other nutrients throughout the plant [9].

Table 1. Fertilizers recommended by the local dealer

Fertilizer	Sufficiency
Potassium	1%
Iron	0.5 with 1% urea
Copper	0.50%
Zinc	0.50%
Magnesium	0.50%

(Source: <https://www.haifa-group.com/banana-fertilizer/crop-guide-banana-fertilizer-recommendations>)

5. THE FERTILIZER RECOMMENDATION FOR THE BANANA PLANT

There are several fertilizer companies in Andhra Pradesh that manufacture fertilizers suitable for banana plants. Here are some of the most well-known and trusted fertilizer companies in Andhra Pradesh.

(1). Nagarjuna Fertilizers and Chemicals Limited: Nagarjuna is a leading fertilizer company in Andhra Pradesh that offers a range of fertilizers suitable for banana plants. They offer both organic and inorganic fertilizers such as urea, DAP, MOP, and NPK.

(2). Coromandel: Coromandel is a best company for fertilizer in India and has a strong presence in Andhra Pradesh. They offer a range of fertilizers suitable for banana plants. They offer both organic and inorganic fertilizers such as urea, DAP, MOP, and NPK.

(3). Andhra Pradesh State Fertilizers and Chemicals Limited (APSFCL): APSFCL is a government-owned fertilizer company in Andhra Pradesh that offers a range of fertilizers suitable for banana plants. They offer both organic and inorganic fertilizers such as urea, DAP, MOP, and NPK [10].

(4). Zuari Fertilizers and Chemicals Limited: Zuari is a leading fertilizer company in India and has a strong presence in Andhra Pradesh. They offer a range of fertilizers suitable for banana plants. They offer both organic and inorganic fertilizers such as urea, DAP, MOP, and NPK.

5.1 Nagarjuna fertilizers and chemicals limited

Sprinkling this fertilizer over the soil around my flowering tropical, working it in, and then watering, has become a steadfast part of my springtime gardening ritual. It's a slow-release formula that lasts for a full 8 weeks. Check prices for Nagarjuna Fertilizers and Chemicals Limited here. If you live in zones 9, 10 and 11, you can make a fertilizer "tea" with these water-soluble granules. Applying it either as a soil soak or foliar spray is a great way to ensure the continued health of

your banana trees and preparedness for spring. While it's rated as safe for pets and people, there is an earthy smell that your pets may be attracted to.

5.2 Pros of nagarjuna fertilizers

Excellent approach to increase nitrogen and improve soil organic matter.

It is used as a winter spray in warm regions.

5.3 Cons of nagarjuna fertilizers

pH levels will high if we use more too high for bananas.

5.4 Coromandel International limited

Coromandel International Limited is a leading fertilizer company in India that offers a range of fertilizers suitable for banana plants. Here are some pros and cons of using Coromandel fertilizers for banana cultivation:

5.5 Pros of coromandel international

Wide range of fertilizers: Coromandel offers a wide range of fertilizers suitable for banana plants, including both organic and inorganic options. This allows farmers to choose the fertilizer that best meets the specific nutrient requirements of their crops.

High-quality products: Coromandel is known for its high-quality fertilizers, which are produced using the latest technology and undergo strict quality control checks.

5.6 Cons of coromandel international

Cost: Coromandel fertilizers may be relatively more expensive compared to other fertilizer brands. This may make them less accessible to some farmers, particularly small-scale farmers.

Availability: Coromandel fertilizers may not be readily available in all areas of India, which may make it difficult for farmers in remote areas to access their products.

5.7 Andhra pradesh state fertilizers and chemicals limited (APSFCL)

Andhra Pradesh State Fertilizers and Chemicals Limited (APSFCL) is a government-owned fertilizer company in Andhra Pradesh that offers a range of fertilizers suitable for banana plants. Here are some pros and cons of using APSFCL fertilizers for banana cultivation.

5.8 Pros of andhra pradesh state fertilizers

Affordable: APSFCL fertilizers are generally more affordable compared to other fertilizer brands, which can make them accessible to small-scale farmers.

Quality control: As a government-owned company, APSFCL is subject to strict quality control measures. This means that their fertilizers are likely to be of good quality and consistent in composition.

5.9 Cons of andhra pradesh state fertilizers

Limited product range: APSFCL offers a limited range of fertilizers compared to other fertilizer companies. This may

limit the options available to farmers who require specific nutrients or fertilizer types.

Limited technical support: APSFCL may not offer the same level of technical support as private fertilizer companies. This may make it difficult for farmers to get the advice and guidance they need to maximize their crop yield and quality.

Inorganic fertilizers: APSFCL offers primarily inorganic fertilizers, which may not be suitable for farmers who prefer to use organic fertilizers for their crops.

5.10 Zuari and chemicals fertilizers

Zuari and Chemicals Fertilizers is a leading fertilizer company in India that offers a range of fertilizers suitable for banana plants. Here are some pros and cons of using Zuari fertilizers for banana cultivation.

5.11 Pros of zuari fertilizer

Wide range of fertilizers: Zuari offers a wide range of fertilizers suitable for banana plants, including both organic and inorganic options. This allows farmers to choose the fertilizer that best meets the specific nutrient requirements of their crops.

High-quality products: Zuari is known for its high-quality fertilizers, which are produced using the latest technology and undergo strict quality control checks [11].

5.12 Cons of zuari fertilizer

Cost: Zuari fertilizers may be relatively more expensive compared to other fertilizer brands. This may make them less accessible to some farmers, particularly small-scale farmers.

Chemical fertilizers: Zuari offers both organic and inorganic fertilizers, but some farmers may prefer to use only organic fertilizers due to concerns about the potential negative effects of chemical fertilizers on soil health and the environment [12].

In conclusion, choosing the right fertilizer is crucial for the successful cultivation of banana plants. There are several fertilizer brands available in India, each with its own pros and cons. Some of the top fertilizer companies for banana plants include Coromandel International Limited, Andhra Pradesh State Fertilizers and Chemicals Limited, and Zuari and Chemicals Fertilizers. When selecting a fertilizer, farmers should consider the specific nutrient requirements of their crops, the availability and affordability of different brands, and the level of technical support and guidance offered by the fertilizer company. By carefully weighing these factors, farmers can choose the best fertilizer for their banana plants, resulting in improved yield and quality. Additionally, it is always recommended to consult with a local agriculture expert or extension agent for specific fertilizer recommendations based on the local conditions in the area.

The best fertilizer is because Farmer Coromandel International Limited Because farmers are getting more profit and more yield as per the testing results and reports [13].

Table 2 explains about the Sufficiency of Fertilizer for banana plant; and its corresponding weight in Kgs.

5.13 Report from farmers

Fertilizers

Di-ammonium phosphate (DAP)

Urea

Potash
Super (Phosphorus, Sulphur, Calcium) from Table 3.

Table 2. Sufficiency of fertilizer for banana plant

S.NO	Product Name	Kgs
1	Single Super Phosphate	50kgs
2	D-A-P	50kgs
3	D-A-P	50kgs
4	20-20-0-13	50kgs
5	20-20-0-13	50kgs
6	N.P.K 28-28-0	50kgs
7	N.P.K 14-35-14	50kgs
8	N.P.K 10-26-26	50kgs
9	N.P.K 19-19-19	50kgs
10	N.P.K 17-17-17	50kgs
11	N.P.K 15-15-15	50kgs
12	Urea	45kgs
13	Urea	45kgs
14	Ammonium Sulphate	50kgs
15	M-O-P	50kgs
16	22-0-11	50kgs

Table 3. Report for fertilizer for acre given by farmers

Fertilizer	Super	DAP	Urea	Potash
Time				
Initial	50kg	25kg		
Small Plants		25kg	50kg	
1-Month			75kg	50kg
2Months			75kg	50kg
3Months			75kg	50kg
4Months			75kg	50kg
6-7Months			75kg	50kg

6. METHODOLOGY

Fertilizer recommendation is an important task in agriculture, and there are several feature extraction methods that can be used to inform this task. Here are some common feature extraction methods for fertilizer recommendation:

6.1 Soil testing

Soil testing is a fundamental step in fertilizer recommendation. By analysing the nutrient content, pH, and other characteristics of the soil, experts can determine which fertilizers are best suited for a particular crop or region.

6.2 Pros of Soil testing

Soil testing helps to identify nutrient deficiencies, pH imbalances, and other soil-related problems, allowing farmers to apply the right type and number of fertilizers, soil amendments, and other inputs to maximize crop yields.

Soil testing can help farmers save money by avoiding over-application of fertilizers and other inputs, which not only wastes resources but can also harm the environment.

Soil testing can prevent excessive use of fertilizers and other chemicals that can harm the environment, including water sources, by reducing the number of pollutants entering the ecosystem.

6.3 Cons of soil testing

Soil testing can be expensive, especially if multiple samples are needed to represent different areas of a farm. The cost can be a barrier for small-scale farmers who may not have the financial resources to invest in soil testing.

Soil testing as it were gives data approximately the physical, chemical, and organic properties of the soil at a specific point in time. Soil conditions can alter quickly and visit soil testing may be vital to screen changes.

Soil testing can take time, from collecting samples to receiving the results. This can be a challenge for farmers who need to make decisions quickly to optimize crop production.

6.4 Spectral analysis

Spectral analysis involves using sensors or other devices to measure the reflectance of light from plants. This can be used to determine the nutrient content and overall health of the plants, which can inform fertilizer recommendations.

6.5 Pros for spectral analysis

Unearthly investigation may be a non-destructive strategy that permits for the fast estimation of plant supplement levels without harming the plant or disturbing development

Spectral analysis provides high precision measurements, allowing for accurate determination of nutrient deficiencies or excesses in plants.

Spectral analysis is a relatively cost-effective method compared to traditional laboratory analysis, as it requires only a spectrometer and some specialized software.

6.6 Cons for spectral analysis

Spectral analysis requires calibration against laboratory data, which can be time-consuming and expensive to develop.

Spectral analysis results can be influenced by environmental factors such as soil moisture and temperature, which can affect the accuracy of the measurement.

Spectral analysis is limited to measuring certain plant nutrients and may not provide information on all nutrients necessary for plant growth.

Remote sensing: Remote sensing involves using satellites or other devices to gather data about crops from a distance. This can include information on the plant health, temperature, and other factors that can be used to inform fertilizer recommendations [14].

6.7 Pros of remote sensing

Provides data for larger area.

Provide data of very remote & inaccessible regions.

6.8 Cons of remote sensing

Needs cross verification with ground (field) survey data.

The interpretation of imagery reqs a certain skill level.

Crop modelling: Crop modelling involves using computer simulations to predict how different crops will grow under various conditions, including different types of fertilizers. These models can be used to optimize fertilizer recommendations based on factors such as soil type, climate, and crop variety.

6.9 Pros of crop modelling

Crop models' trim models can be utilized to foresee how crops will develop and create beneath distinctive natural conditions. This may help agriculturists make educated choices around planting, water system, fertilization, and other components that influence trim surrender.

Crop models are a cost-effective way to evaluate different management practices, as they can simulate crop growth and development without the need for large-scale field experiments.

6.10 Cons of crop modelling

Crop models can be complex and require a high level of technical expertise to develop and use. This can be a barrier for farmers who may not have the necessary skills or resources to use these models [15].

There are uncertainties associated with crop models due to variations in weather, soil, and other factors that can affect crop growth. These uncertainties can limit the accuracy of model predictions.

7. CONCLUSION

In conclusion, the development of a fertilizer recommendation system for banana plants using feature extraction methods is a promising approach to increase the efficiency and productivity of banana cultivation. By using various techniques for feature extraction and selection, the system can accurately predict the optimal fertilizer requirements for the banana plants based on various environmental factors and soil conditions. This can significantly reduce the use of excess fertilizer and prevent environmental damage, while also improving the yield and quality of the crops. With further research and development, this system has the potential to revolutionize the banana cultivation industry and contribute to sustainable agriculture practices. these we have recommended the best fertilizer and we have did the comparative analysis for fertilizer and also for the feature extraction method. Main purpose of these research is recommending the best fertilizer and getting good yield and profit for the farmers. The algorithm that is recommended for soil classification is Random Forest and SVM algorithm is used for both good yield of crop and for the predicting the disease.

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