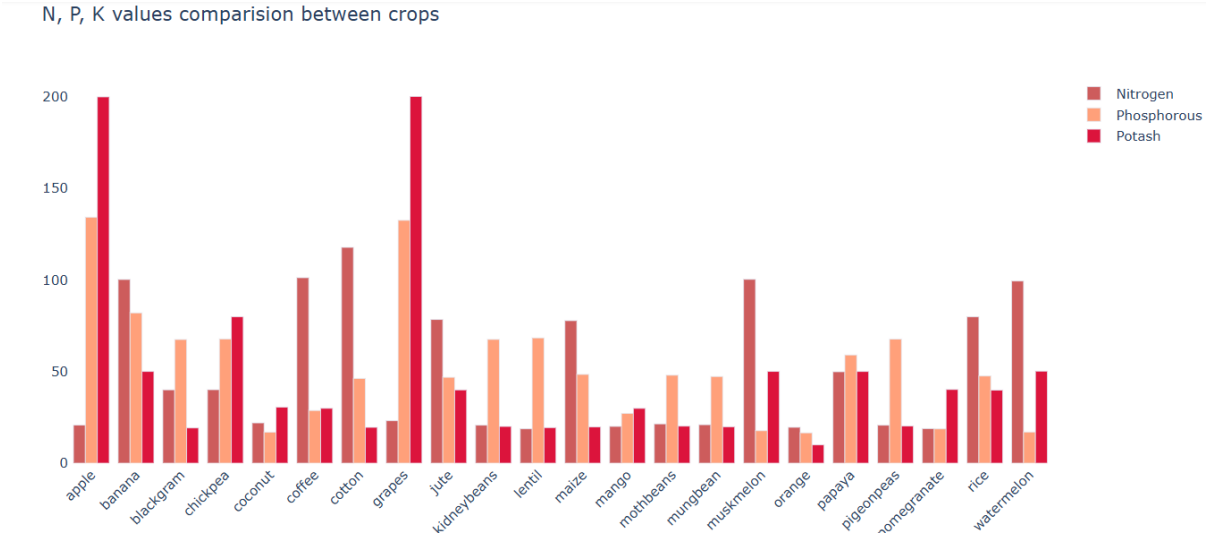
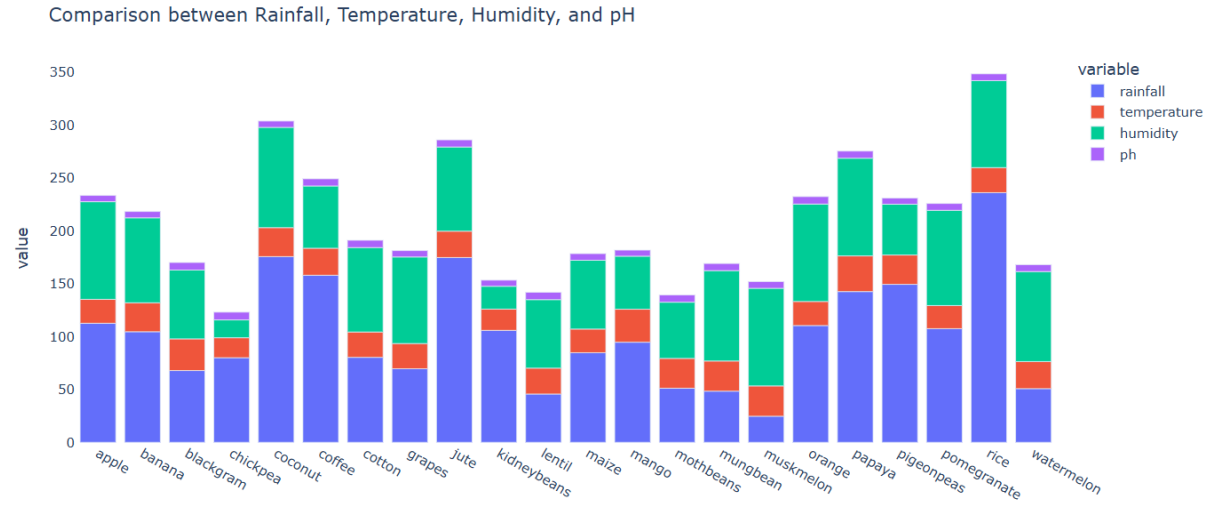
CROP RECOMMENDATION

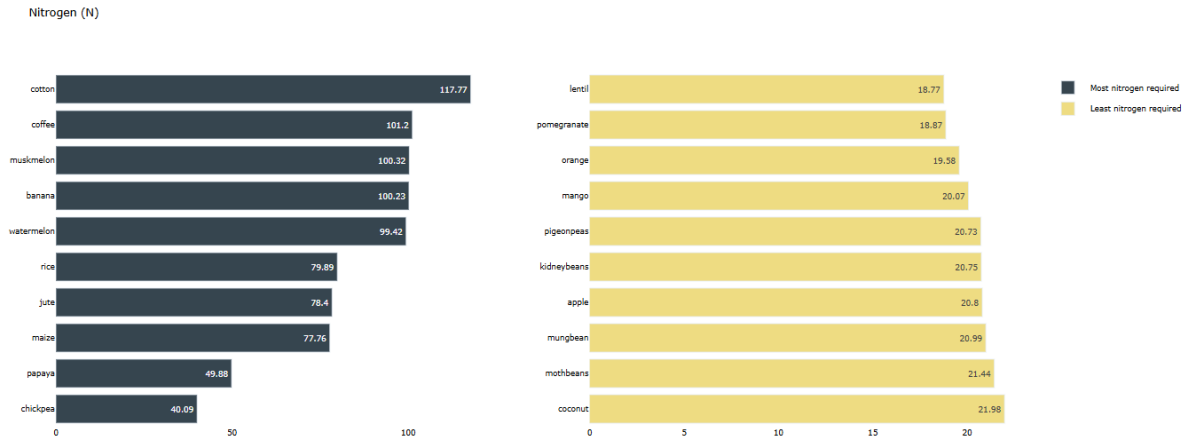
1. N. P, K COMPARISON



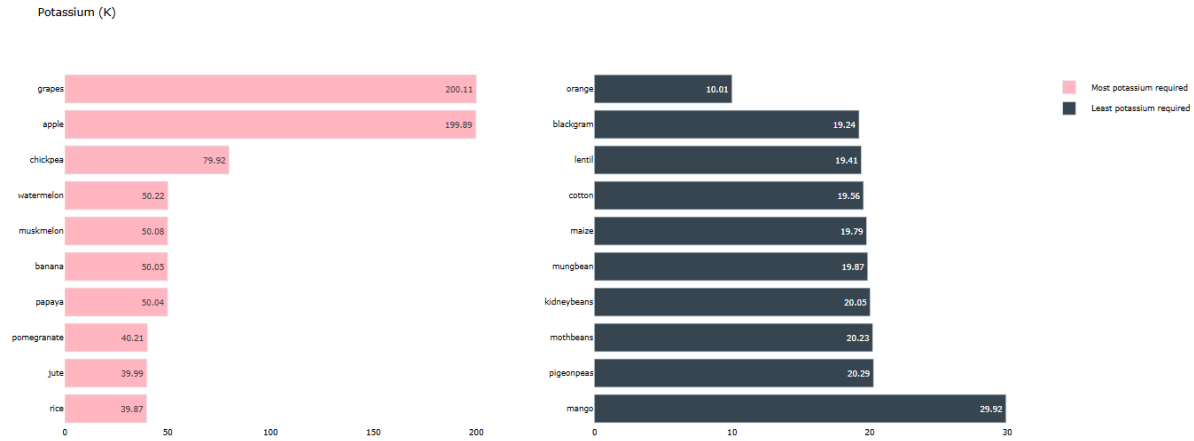
2. Rainfall, Temperature, humidity. ph COMPARISON



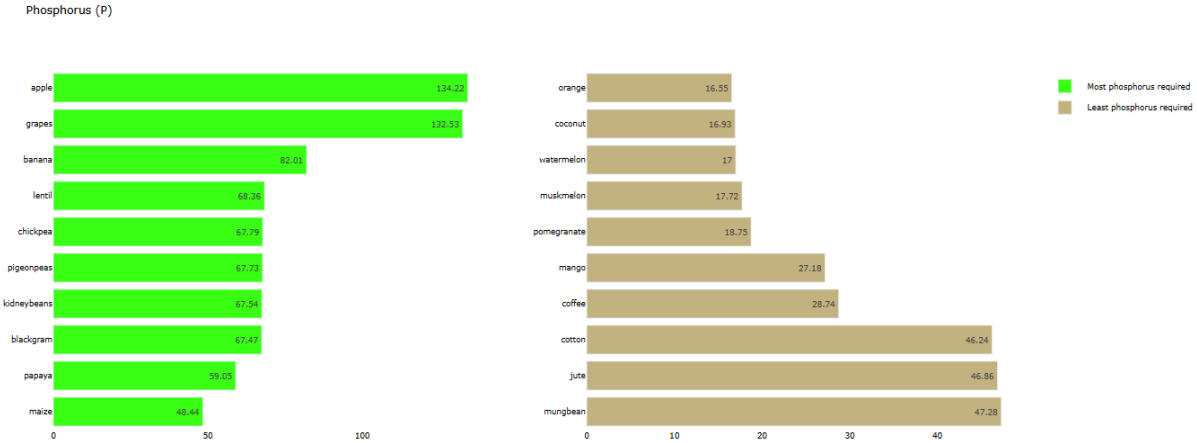
3. most and least nitrogen needed crops



4. most and least potassium needed crops



5. most and least phosphorous needed crops



6. using xg boost classifier

Classification Report:

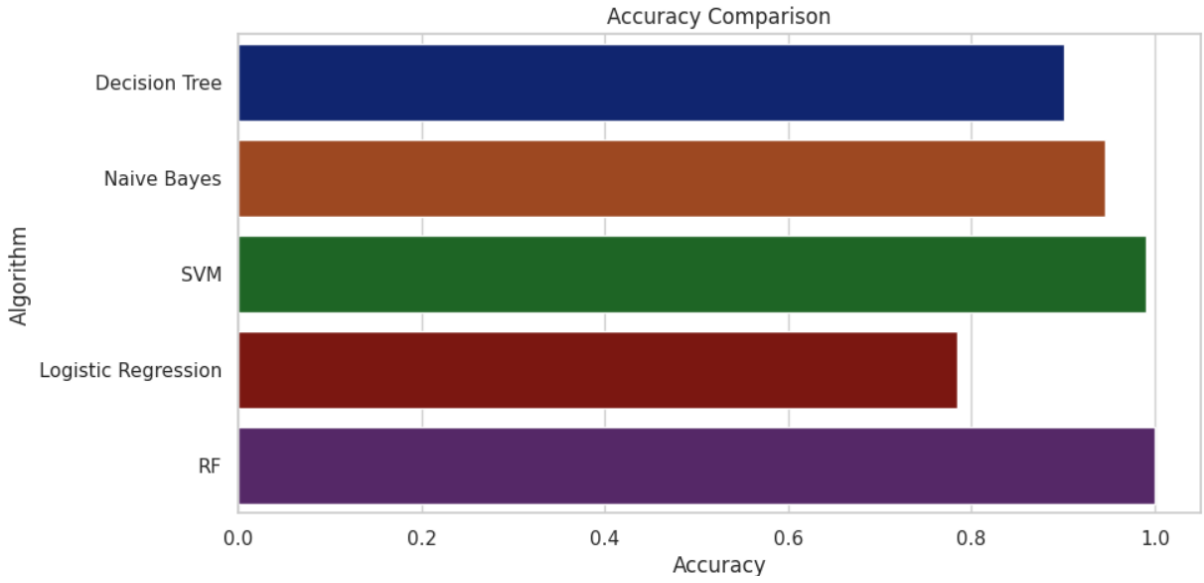
	precision	recall	f1-score	support
apple	1.00	1.00	1.00	20
banana	1.00	1.00	1.00	20
blackgram	1.00	0.97	0.98	30
chickpea	1.00	1.00	1.00	20
coconut	1.00	1.00	1.00	30
coffee	1.00	0.95	0.97	20
cotton	1.00	1.00	1.00	20
grapes	1.00	1.00	1.00	20
jute	0.97	0.97	0.97	30
kidneybeans	1.00	1.00	1.00	20
lentil	1.00	1.00	1.00	20
maize	0.97	1.00	0.98	30
mango	1.00	0.95	0.97	20
mothbeans	0.95	1.00	0.98	20
mungbean	1.00	1.00	1.00	20
muskmelon	1.00	1.00	1.00	20
orange	1.00	1.00	1.00	20
papaya	1.00	1.00	1.00	20
pigeonpeas	1.00	1.00	1.00	20
pomegranate	1.00	1.00	1.00	20
rice	0.97	1.00	0.98	30
watermelon	1.00	1.00	1.00	20
accuracy			0.99	490
macro avg	0.99	0.99	0.99	490
weighted avg	0.99	0.99	0.99	490

7. sample data

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

FERTILIZER RECOMMENDATION

1. model used and its accuracy comparison



2. soil classification

Original	
Black	0
Clayey	1
Loamy	2
Red	3
Sandy	4

3. crop classification

Original	
Barley	0
Cotton	1
Ground Nuts	2
Maize	3
Millets	4
Oil seeds	5
Paddy	6
Pulses	7
Sugarcane	8
Tobacco	9
Wheat	10
coffee	11
kidneybeans	12
orange	13
pomegranate	14
rice	15
watermelon	16

4. fertilizer classification

Original	
10-10-10	0
10-26-26	1
14-14-14	2
14-35-14	3
15-15-15	4
17-17-17	5
20-20	6
28-28	7
DAP	8
Potassium chloride	9
Potassium sulfate.	10
Superphosphate	11
TSP	12
Urea	13

5. sample dataset

	Temparature	Humidity	Moisture	Soil_Type	Crop_Type	Nitrogen	Potassium	Phosphorous	Fertilizer
0	20	83	26	Clayey	rice	90	49	36	Urea
1	25	84	32	Loamy	rice	66	59	36	Urea
2	33	64	50	Loamy	Wheat	41	0	0	Urea
3	34	65	54	Loamy	Wheat	38	0	0	Urea
4	38	72	51	Loamy	Wheat	39	0	0	Urea

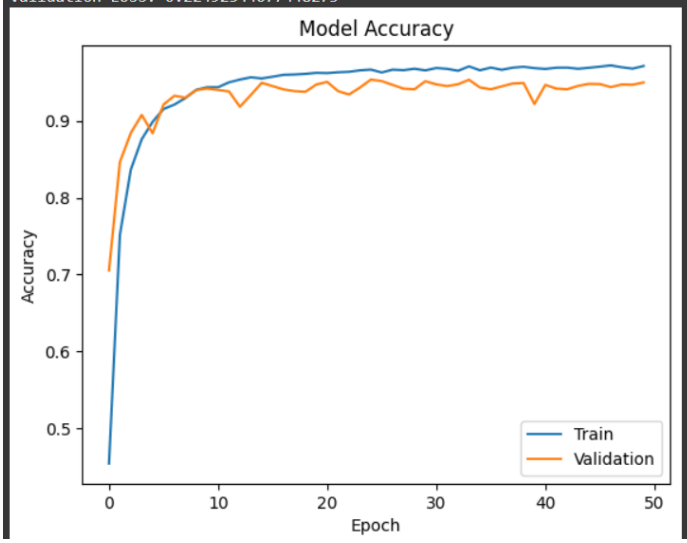
6. model classification report

```
RF's Accuracy is:  1.0 1.0
              precision    recall  f1-score   support

           0       1.00      1.00      1.00         4
           1       1.00      1.00      1.00        10
           2       1.00      1.00      1.00         1
           3       1.00      1.00      1.00        12
           4       1.00      1.00      1.00         4
           5       1.00      1.00      1.00         6
           6       1.00      1.00      1.00        13
           7       1.00      1.00      1.00        14
           8       1.00      1.00      1.00        16
           9       1.00      1.00      1.00         1
          10       1.00      1.00      1.00         2
          11       1.00      1.00      1.00         3
          12       1.00      1.00      1.00         7
          13       1.00      1.00      1.00        18

    accuracy                           1.00       111
   macro avg       1.00      1.00      1.00       111
weighted avg       1.00      1.00      1.00       111
```

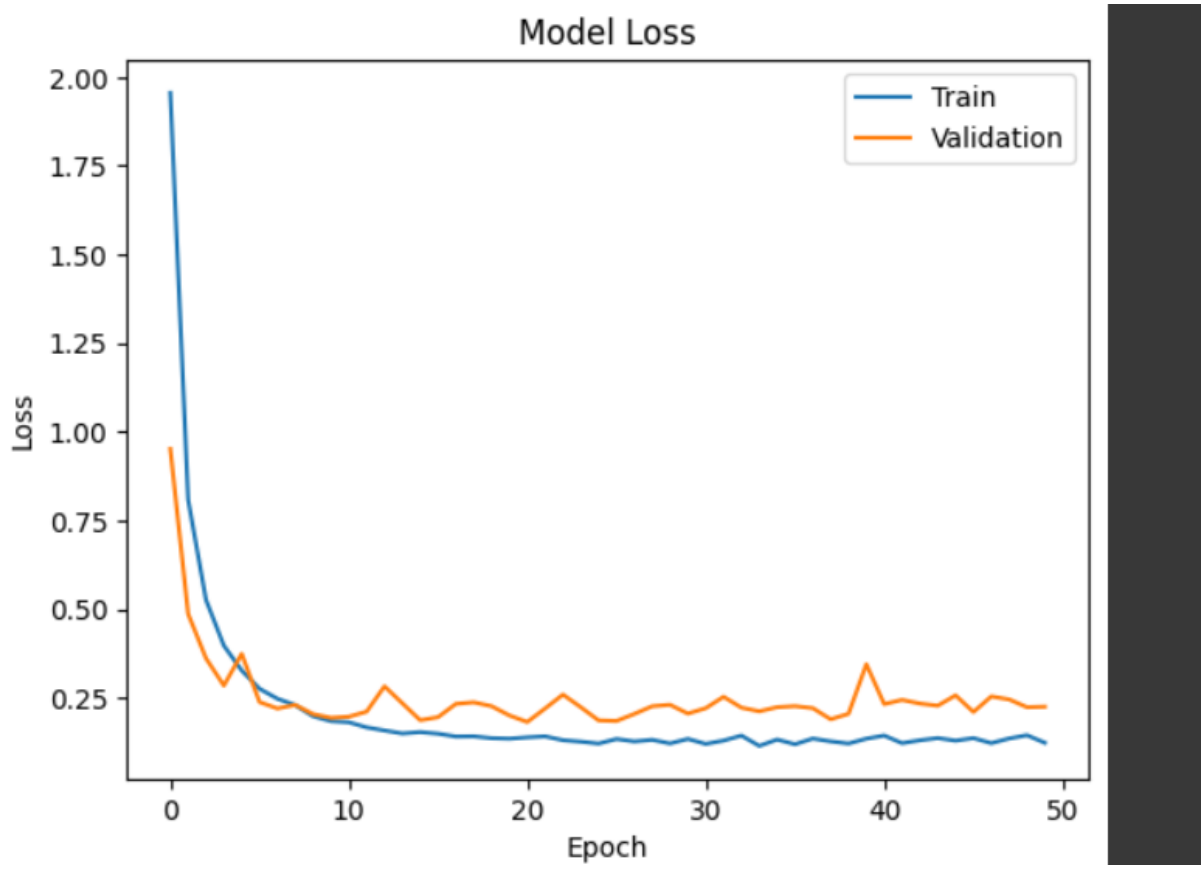
PLANT DISEASE DETECTION

1. the model accuracy, epoch trained vs accuracy score in training and validation

```
Epoch 50/50
1358/1358 ━━━━━━━━━━━━━━━━━━━━ 138s 74ms/step - accuracy: 0.9749 - loss: 0.1055 - val_accuracy: 0.9500 - val_loss: 0.2249
339/339 ━━━━━━━━━━━━━━━━━━━━ 17s 51ms/step - accuracy: 0.9524 - loss: 0.2260
Validation Accuracy: 95.0036883354187
Validation Loss: 0.22492344677448273
```



2. the epoch and the train vs validation score based on loss



🌱 A. Crop Recommendation Module

We trained multiple classifiers using real and synthetic data to predict the most suitable crop for a given set of soil and climate features.

Model	Accuracy
Logistic Regression (raw)	0.91
Naive Bayes	0.995
Bagging Classifier	0.9886
LightGBM	0.9890
Decision Tree Classifier	0.9848
Random Forest	0.9917
Logistic Regression (with tuned data)	0.9435
AdaBoost	0.095 ❌ *(underfitting)*
Gradient Boost	0.981
XGBoost (with synthetic data)	**0.99** ✅

✅ **Final Model: XGBoost** was chosen due to its **high accuracy (99%)**, robustness with synthetic data, and ability to handle complex feature relationships.

🌾 B. Fertilizer Recommendation Module

We used supervised classification to match the soil and crop data with the most effective fertilizer.

Model	Train Accuracy	Test Accuracy
Decision Tree	0.93	0.90
Naive Bayes	0.91	0.94
SVM	0.99	0.99
Logistic Regression	0.90	0.78
Random Forest	**1.0**	**1.0** ✅

✅ **Final Model: Random Forest**, due to **perfect accuracy** on both training and testing sets. It also demonstrated great generalization and interpretability for agricultural experts.

🌾 C. Plant Disease Detection Module

We trained a deep learning model using a convolutional neural network (CNN) to classify plant leaf images.

- Initial Training (50 Epochs):
  - **Validation Accuracy**: 0.95
  - **Validation Loss**: 0.22
  - **Training Time**: ~3 hours
- After Extended Training:
  - **Final Accuracy: 0.98** ✅
  - **Final Loss: 0.15** ✅

✅ **Final Model**: The **CNN** model trained over **extended epochs** gave **highly accurate predictions** for real-time plant disease detection.