CROP PREDICTION SYSTEM USING MACHINE LEARNING AND ANALYSIS OF SOIL NUTRIENTS USING SATELLITE IMAGING AND IOT

Guide:

Dr.G.Geetha

Associate Professor

Department of Information Science and Technology

Students:

Dhineshbalan N (2020115028)

Sasi Kumar K (2020115076)

Overview

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  - Novelty
  - Need , End Users & Social Relevance
- Objective
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Introduction

- Agriculture plays a pivotal role in global food security, facing mounting challenges amidst population growth and environmental pressures.
- Our project aims to provide personalized crop predictions tailored to specific farming conditions and promote using innovative technologies for agriculture.

Problem Statement

- Traditional methods of crop prediction rely on manual observations without considering soil nutrients, which are often inefficient and prone to inaccuracies.
- To develop accurate crop prediction and analysis of soil nutrients in order to optimize management practices in agriculture.

Novelty

- Provides Crop prediction with higher accuracy based on soil nutrients(N,P,K), Temperature, Humidity, pH and Rainfall.
- Using Landsat and sentinel satellite images and its band values to detect soil nutrients.
- Combining the concepts of IOT , ML and Satellite Imaging.

Need , End Users& Social Relevance

- With the growing global population, there's an increasing demand for food production, making it essential to maximize crop yields while minimizing resource usage.
- The primary end-users would be farmers, agricultural consultants and policymakers involved in agriculture.
- This solution empower farmers to make informed decisions contributes to increasing food availability , it promotes the adoption of technology in agriculture.

Objective

- To Provide Accurate
  - Predict crops based on soil nutrients
  - Analysis of soil nutrients
- To
  - Reduce time and travel
  - Implement technology in Agriculture

Literature Survey

Sl.No	Author Journal Year	Title	Proposed method / Algorithm Used	Limitation
1	Dr. John Smith, Dr. Emily Johnson Journal of Soil Science and Agriculture September 2022	Soil Texture Estimation Using Radar and Optical Data from Sentinel-1 and Sentinel-2	1.Collecting ground-truth measurements and satellite data. 2.Testing of various indices and SWIR bands for estimating clay contents. 3. Using SVM and RF algorithms for clay content estimation. 4.Evaluation of the classification results using three-fold cross-validation.	1. Lack of testing the soil sample in different approach. 2. Lack of testing the soil samples in different climatic conditions. 3. RF algorithm was found to be more accurate than SVM for clay content estimation.

Literature Survey

Sl.No	Author Journal Year	Title	Proposed method / Algorithm Used	Limitation
2	Murali Krishna Senapaty, Abhishek Ray, Neelamadhab Padhy MDPI, Basel, Switzerland 2023	IoT-Enabled Soil Nutrient Analysis and Crop Recommendation Model for Precision Agriculture	1.Real-time data collection using IoT sensors for soil nutrients, GPS location, moisture, temperature, and water level. 2.Analysis of collected data using Random Forest algorithm. 3.Generation of crop recommendations based on the analyzed data.	1.Initial setup costs for implementing IoT technology. 2.Dependence on technology, which may lead to issues if systems fail. 3. Need for technical expertise to interpret and act on the generated recommendations.

Literature Survey

Sl.No	Author Journal Year	Title	Proposed method / Algorithm Used	Limitation
3	Chaitanya B. Pande 2021 Journal of the Saudi Society of Agricultural Sciences	Prediction of Soil Chemical Properties Using Neural Network Wavelet Model	1. Develop prediction models for soil chemicals such as carbon, pH and EC using neural network wavelet model (polynomial and ANN) . 2. Accurate mapping of soil chemical parameters for agriculture, forestry, ecological planning, and crop yield production.	1.Requires expertise in using neural network models and wavelet transform methods. 2. Relies on the availability and quality of satellite images and soil samples for validation. 3. May have limitations in predicting certain soil chemical properties accurately.

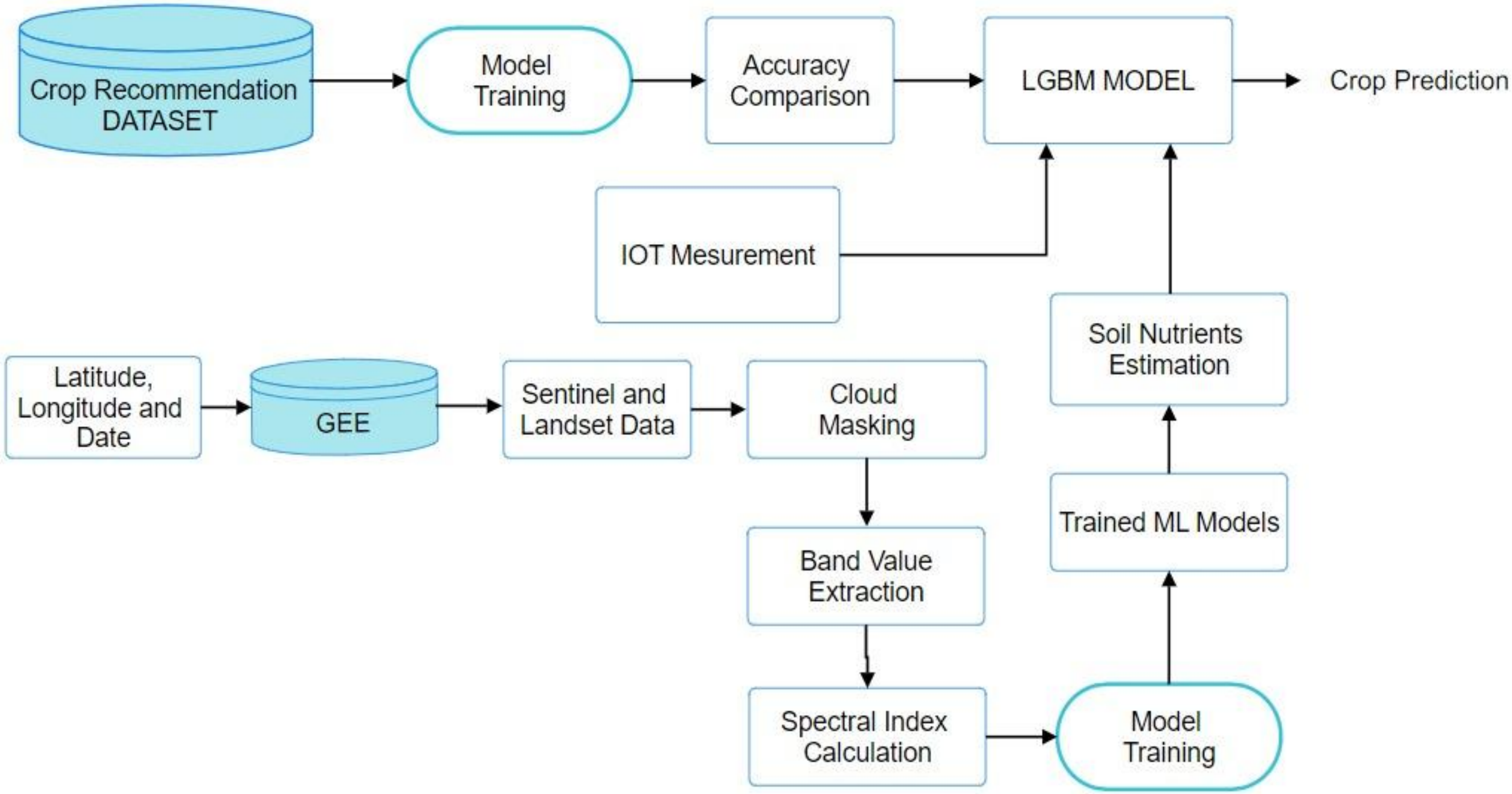
Literature Survey

Sl.No	Author Journal Year	Title	Proposed method / Algorithm Used	Limitation
4	Sonal Agarwal and Sandhya Tarar Journal of Physics 2021	A hybrid approach for crop yield prediction using machine learning and deep learning algorithms	1. Factors like N, P, K, crop rotation, atmospheric and surface temperature are taken as inputs. 2. ML model is trained using SVM. 3. Deep Learning techniques like LSTM and RNN is used to predict the best suitable crop for best yield.	1.Initial setup costs 2.Requires expertise in using neural network models

Proposed Solution

Existing Solution	Our Solution
• Provides crop prediction using iot device to test the soil nutrients • Less accuracy of crop prediction	• Satellite image based testing • We can Analyze the soil nutrients without manually collecting data • Improved accuracy by using Light GBM

Architecture Diagram



Crop Recommendation Data Set

- The data used to train the model was collected from Harvard Dataverse. The name of the dataset is crop recommendation dataset.

- The dataset consists of 2200 samples of 22 different crops whose predictions are made using 7 features: nitrogen, phosphorus, potassium, and pH content of the soil, temperature, humidity and rainfall.

- The dataset is perfectly balanced, with each crop having 100 samples.

Data Set and Data Fields

	P	K	temperatu	humidity	ph	rainfall	label
90	42	43	20.87974	82.00274	6.502985	202.9355	rice
85	58	41	21.77046	80.31964	7.038096	226.6555	rice
60	55	44	23.00446	82.32076	7.840207	263.9642	rice
74	35	40	26.4911	80.15836	6.980401	242.864	rice
78	42	42	20.13017	81.60487	7.628473	262.7173	rice
69	37	42	23.05805	83.37012	7.073454	251.055	rice
69	55	38	22.70884	82.63941	5.700806	271.3249	rice
94	53	40	20.27774	82.89409	5.718627	241.9742	rice
89	54	38	24.51588	83.53522	6.685346	230.4462	rice
68	58	38	23.22397	83.03323	6.336254	221.2092	rice
91	53	40	26.52724	81.41754	5.386168	264.6149	rice
90	46	42	23.97898	81.45062	7.502834	250.0832	rice
78	58	44	26.8008	80.88685	5.108682	284.4365	rice
93	56	36	24.01498	82.05687	6.984354	185.2773	rice
94	50	37	25.66585	80.66385	6.94802	209.587	rice
60	48	39	24.28209	80.30026	7.042299	231.0863	rice
85	38	41	21.58712	82.78837	6.249051	276.6552	rice
91	35	39	23.79392	80.41818	6.97086	206.2612	rice
77	38	36	21.86525	80.1923	5.953933	224.555	rice
88	35	40	23.57944	83.5876	5.853932	291.2987	rice
89	45	36	21.32504	80.47476	6.442475	185.4975	rice

- N - ratio of Nitrogen content in soil - mg/kg
- P - ratio of Phosphorus content in soil - mg/kg
- K - ratio of Potassium content in soil - mg/kg
- temperature - temperature in degree Celsius
- humidity - relative humidity in %
- pH - pH value of the soil
- rainfall - rainfall in mm

Machine Learning Algorithms

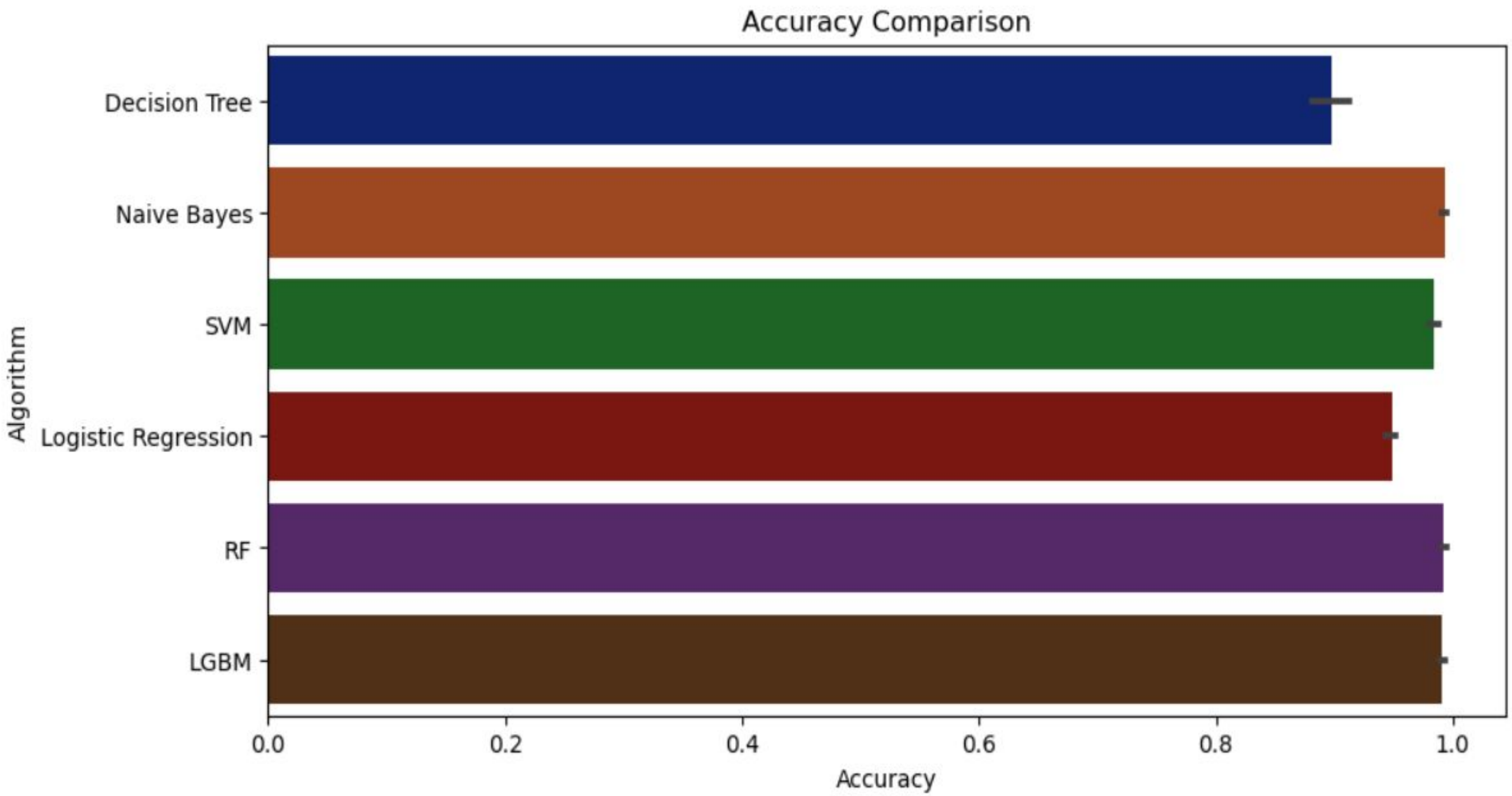
- Light Gradient Boosting Machine (Light GBM) Classification
- Random Forest Classification
- Support Vector Machine (SVM) Classification
- Decision Tree Classification
- Naïve Bayes Classification

Performance of Algorithms

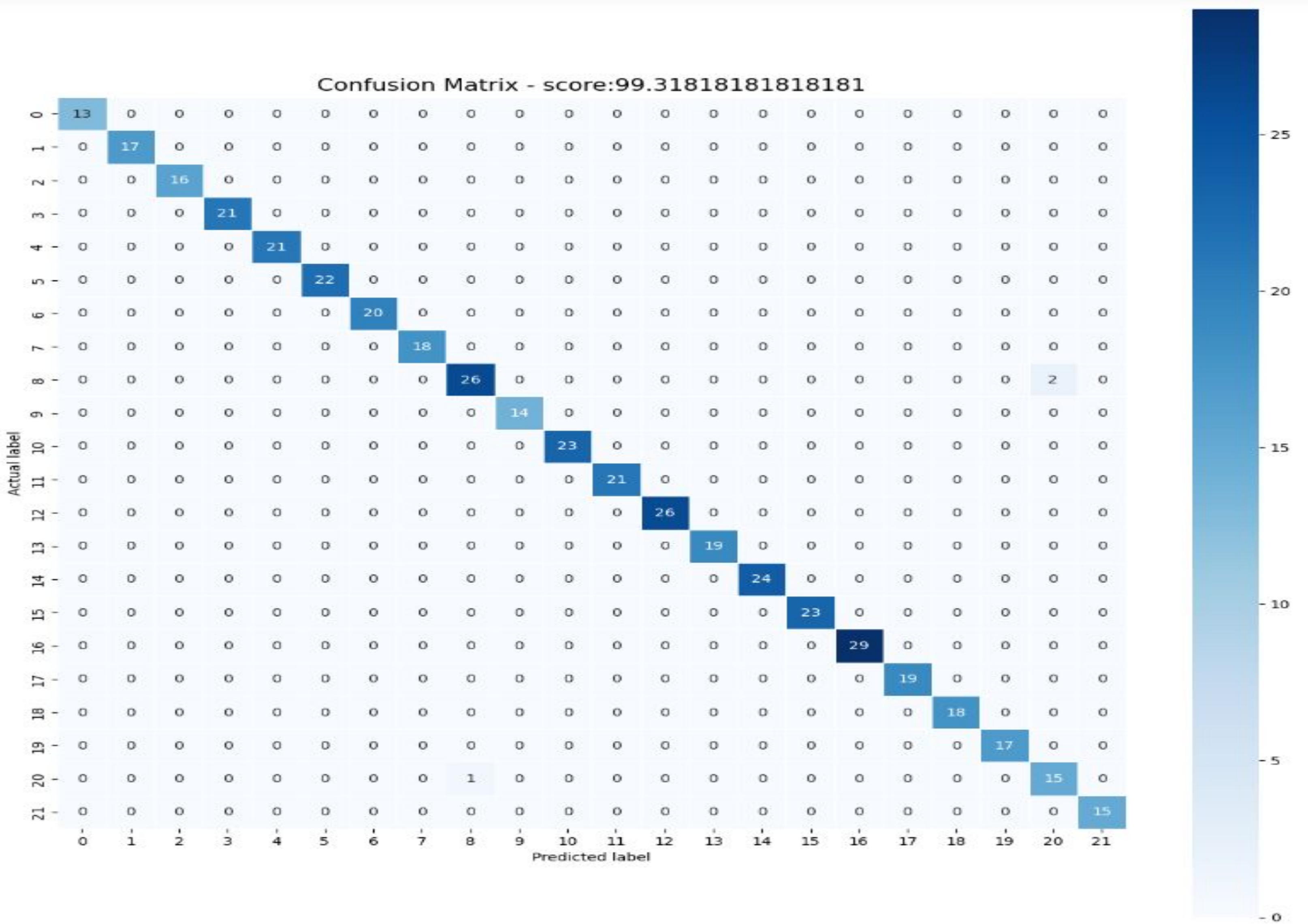
Accuracy Comparison

In [333]:
```
plt.figure(figsize=[10,5],dpi = 100)
plt.title('Accuracy Comparison')
plt.xlabel('Accuracy')
plt.ylabel('Algorithm')
sns.barplot(x = acc,y = model,palette='dark')
```

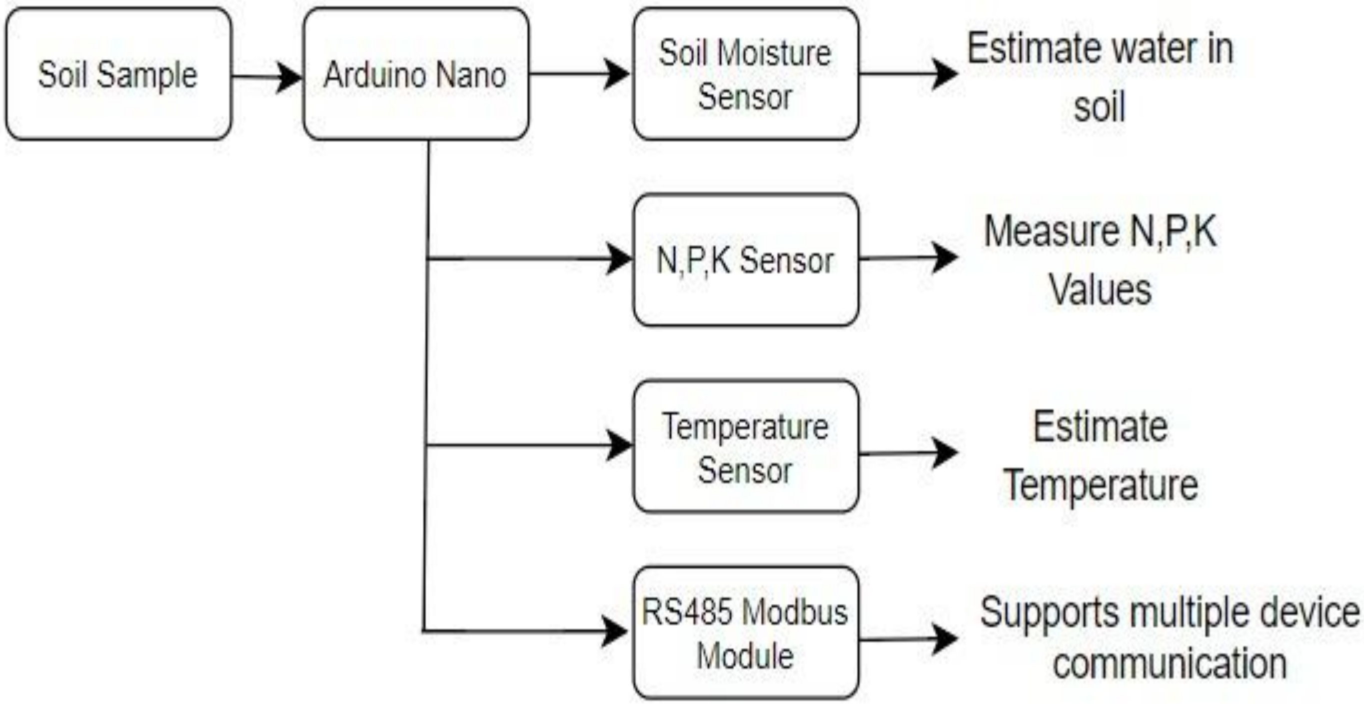
Out[333]:
```
<Axes: title={'center': 'Accuracy Comparison'}, xlabel='Accuracy', ylabel='Algorithm'>
```



Confusion Matrix



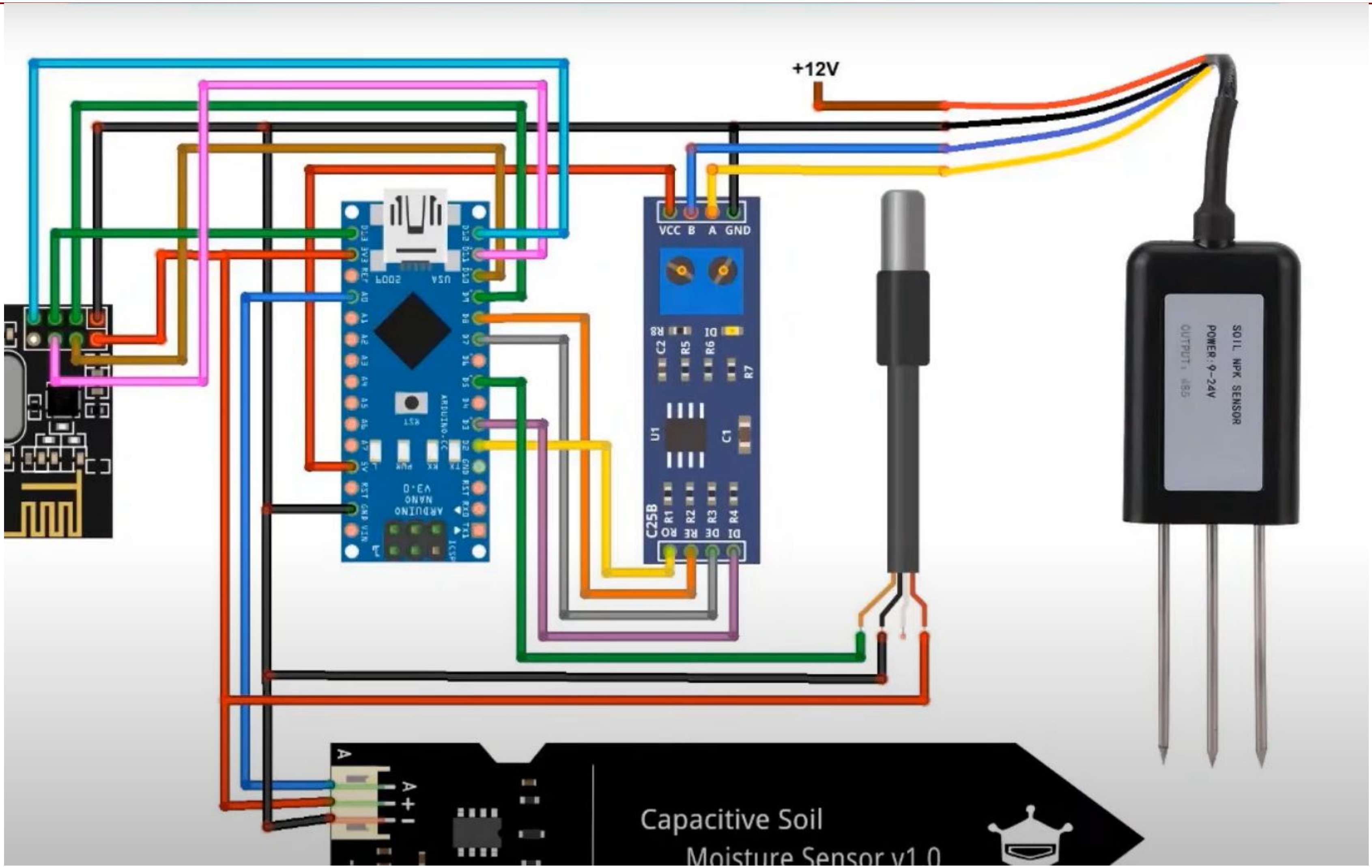
Architecture Diagram (IOT)



IOT Requirements

- N, P, K Sensor - Measure the N, P, K values
- DS18B20 - Measure the temperature
- Soil Moisture Sensor - estimate the amount of water in the soil
- RS485 Modbus Module - supports communication to and from multiple devices
- Arduino Nano Board - ATmega328P microcontroller
- Breadboard - To build Temporary circuits
- Jumper Wires - Provide connection between circuits

Circuit Diagram



OUTPUT (IoT)

Arduino Nano

sketch_may27a.ino

```
#include <Wire.h>
#include <SoftwareSerial.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include <DHT.h>

#define DHTPIN 6
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

#define RE 8
#define DE 7
#define moisture A0
#define ONE_WIRE_BUS A1
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);

const byte nitro[] = {0x01, 0x03, 0x00, 0x1E, 0x00, 0x01, 0xE4, 0x0C};
const byte phosp[] = {0x01, 0x03, 0x00, 0x1F, 0x00, 0x01, 0xB5, 0xCC};
const byte potas[] = {0x01, 0x03, 0x00, 0x20, 0x00, 0x01, 0x85, 0xC0};

byte values5[11];
byte values6[11];
```

Output Serial Monitor

Not connected. Select a board and a port to connect automatically.

New Line | 9600 baud

```
--------------------
Moisture level: 347
Average Soil N: 232.00 mg/kg
Average Soil P: 19.00 mg/kg
Average Soil K: 142.60 mg/kg
Celsius temperature: 27.94
347:27.94:232.00:19.00:142.60
Temperature: nan °C
Humidity: nan %
--------------------
```

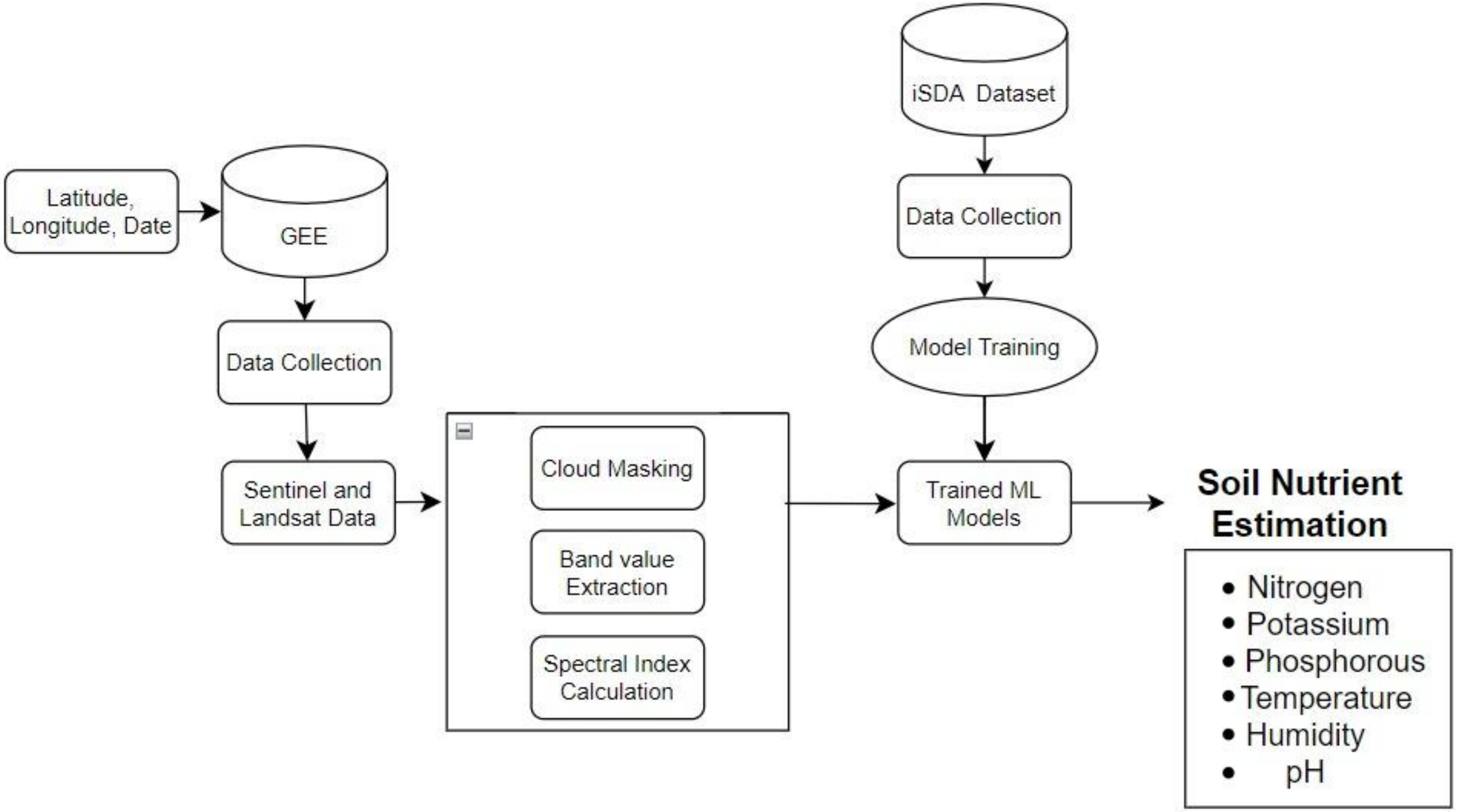
SATELLITE IMAGERY

- Using Google Earth Engine to get Landsat images

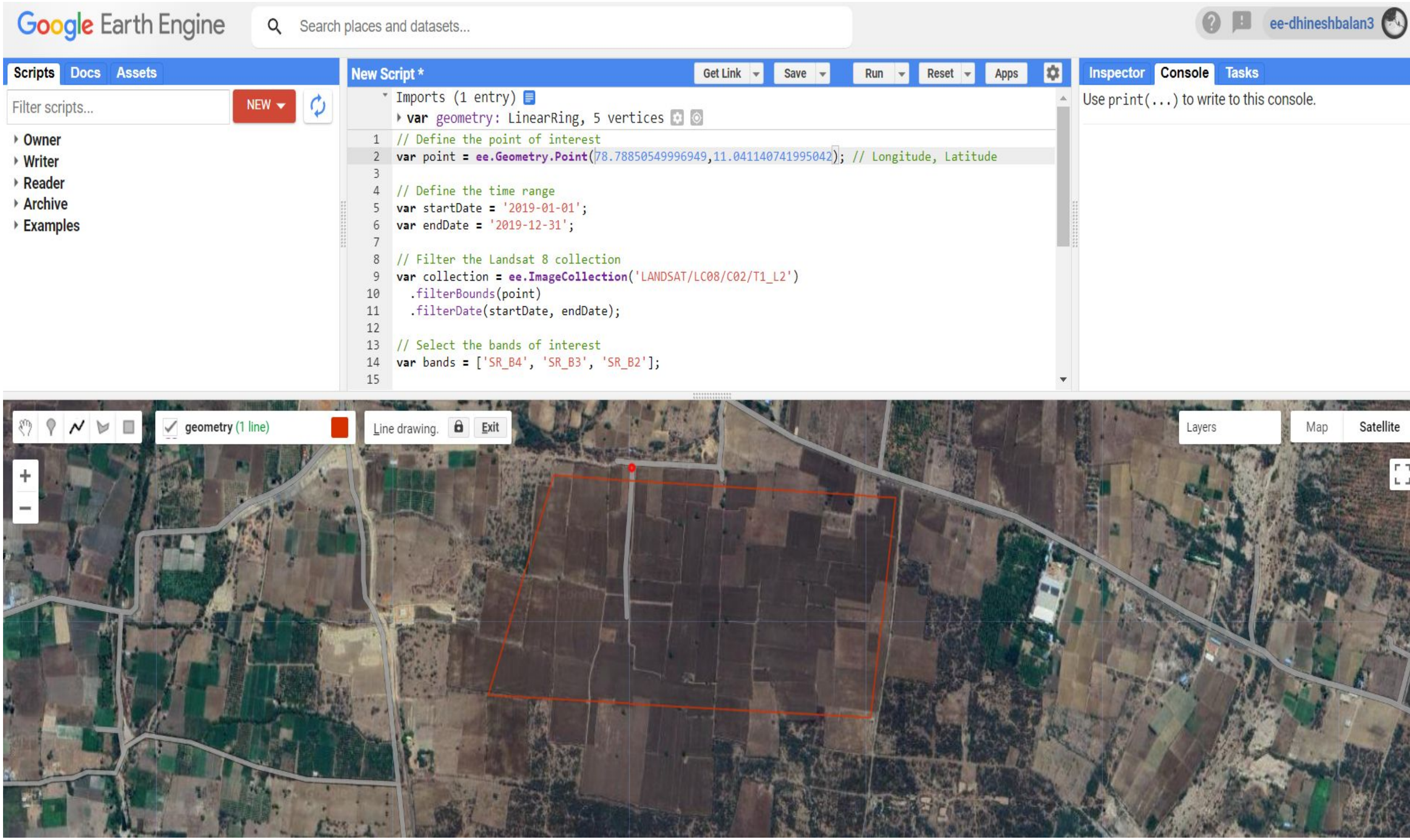
- Then Using Band values of those images we can predict the Soil Qualities.

- Then we can Compute the values with the model trained by our dataset for crop prediction.

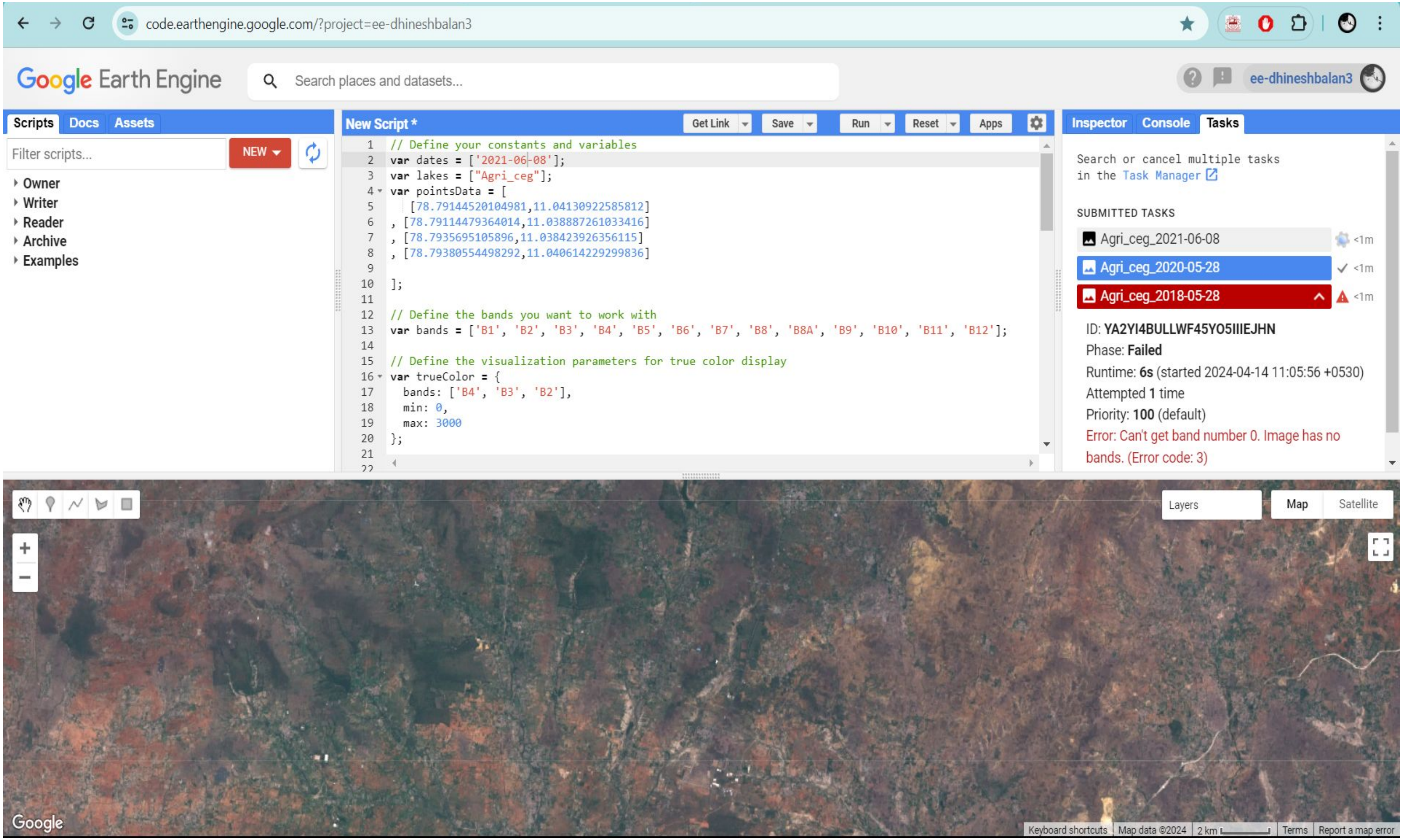
Satellite Imaging Architecture



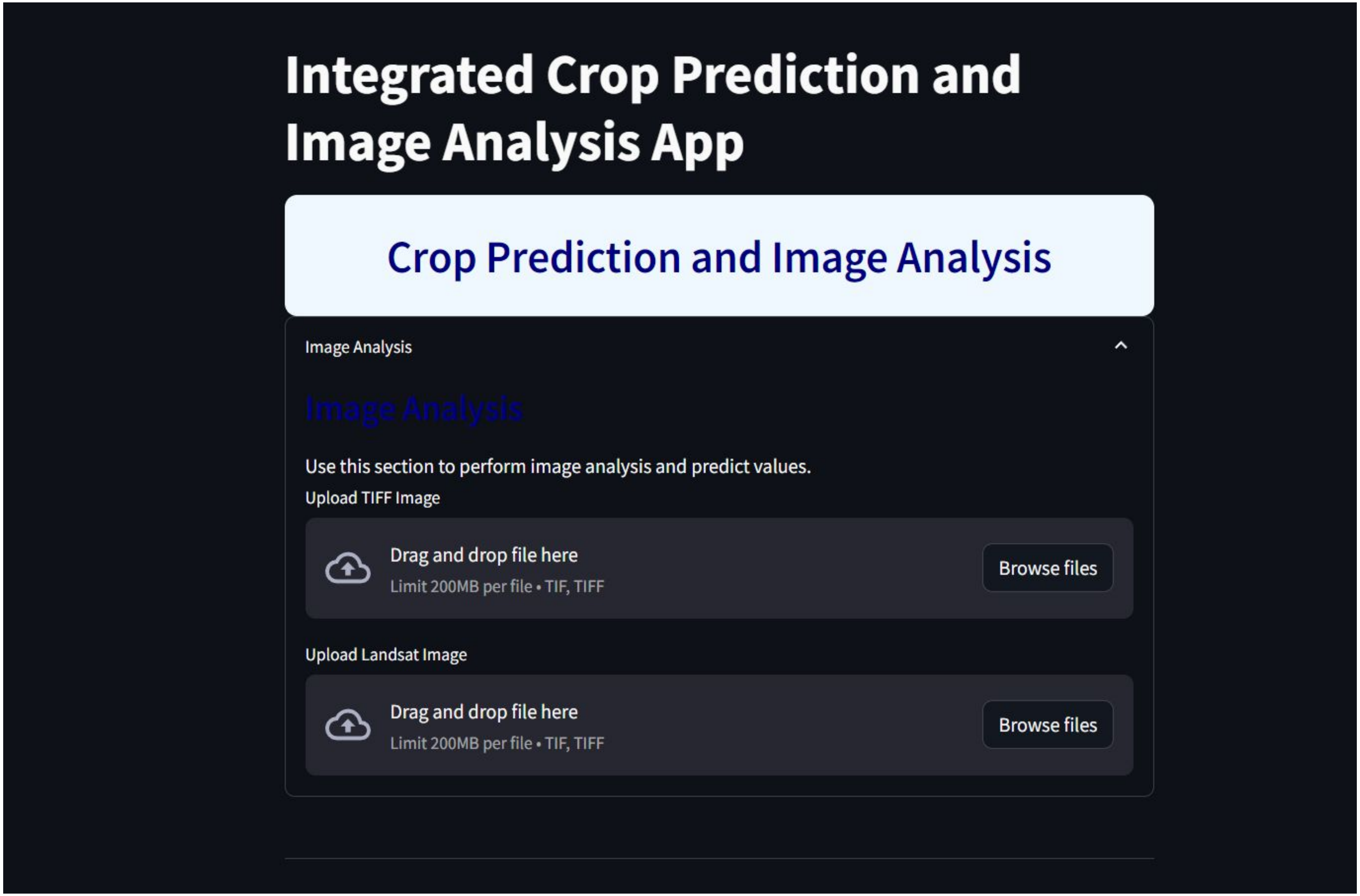
Region of Interest



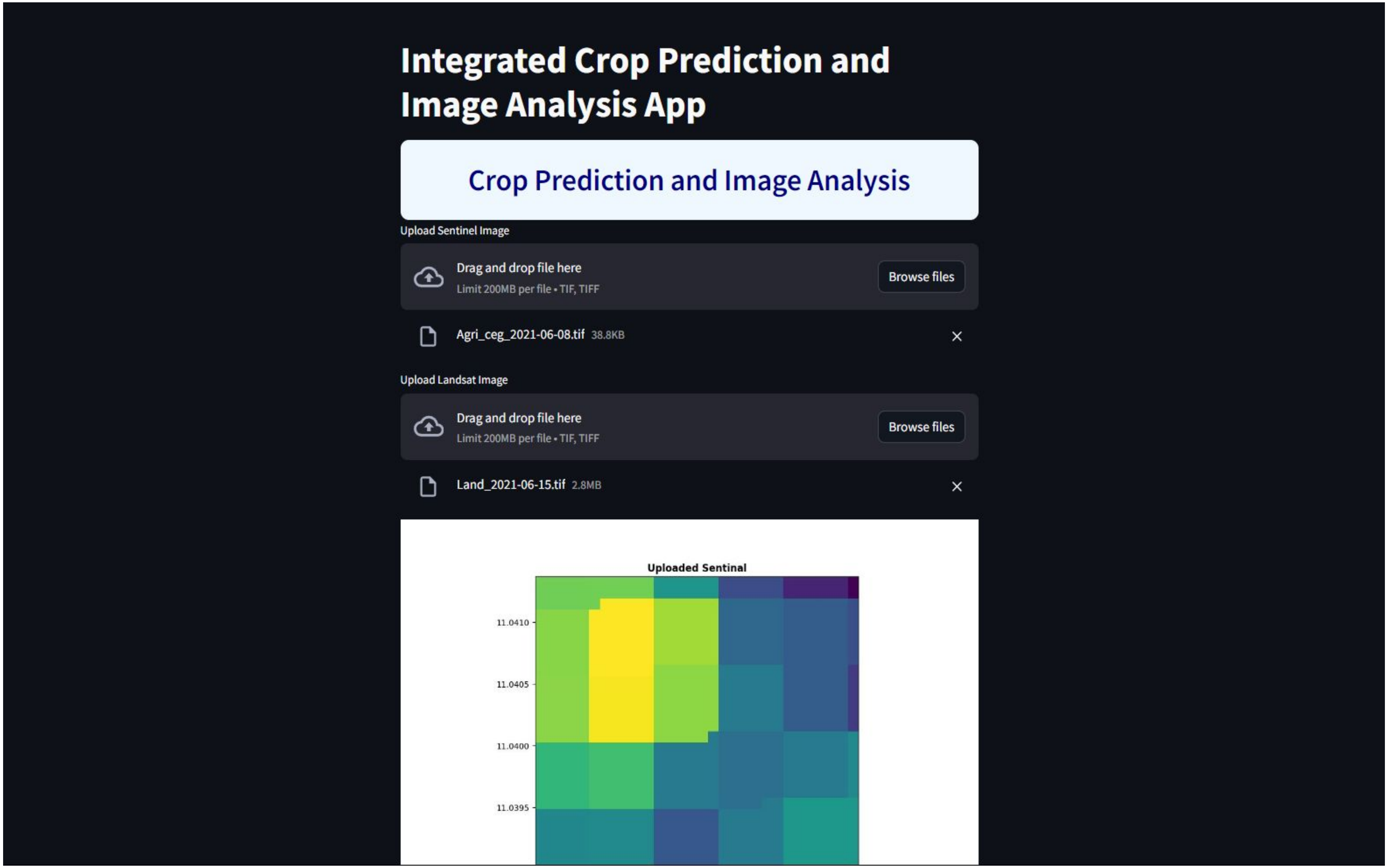
Data Collections



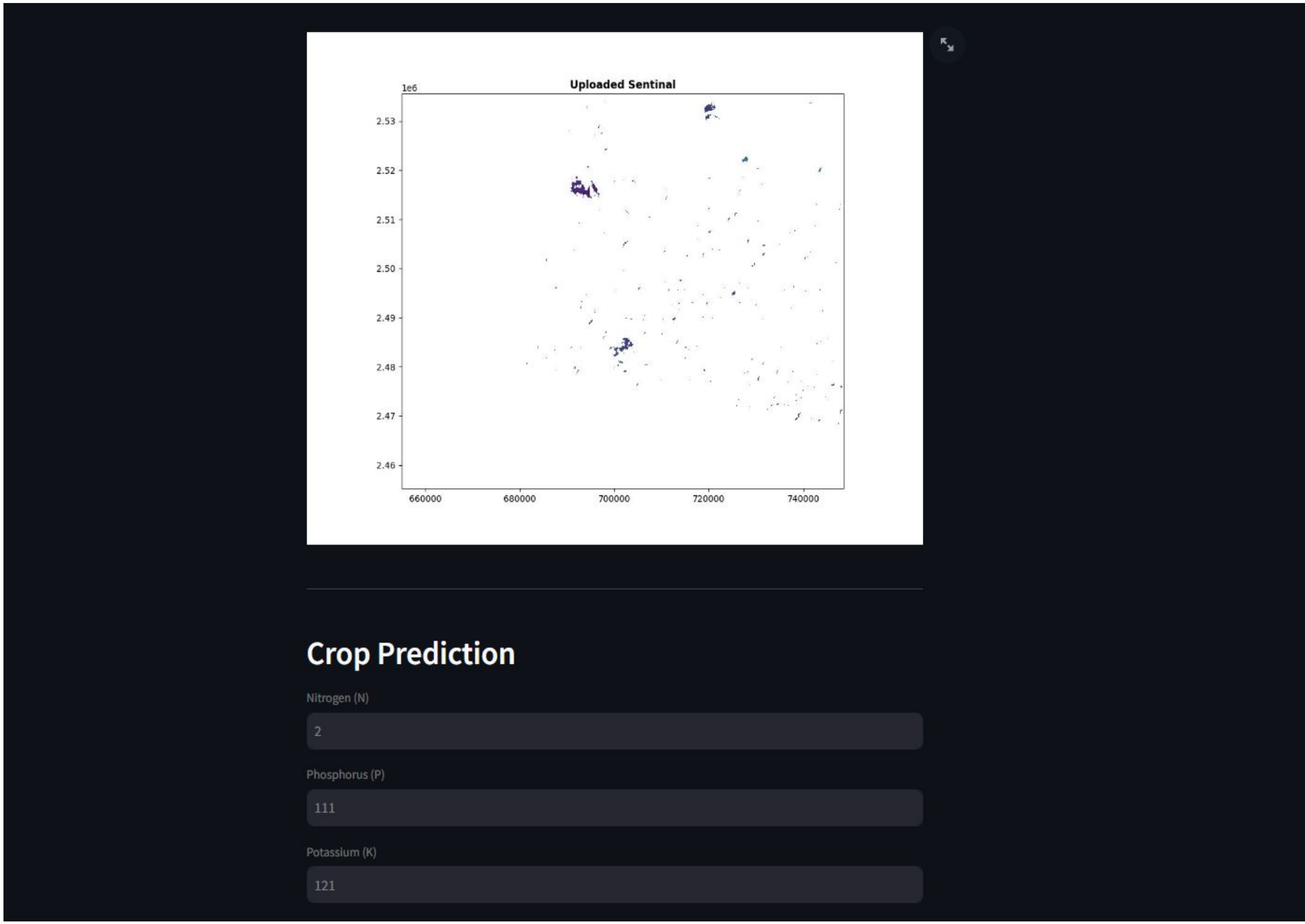
WEB UI


Integrated Crop Prediction and Image Analysis App
Crop Prediction and Image Analysis
Image Analysis
Image Analysis
Use this section to perform image analysis and predict values.
Upload TIFF Image
Drag and drop file here
Limit 200MB per file • TIF, TIFF
Browse files
Upload Landsat Image
Drag and drop file here
Limit 200MB per file • TIF, TIFF
Browse files

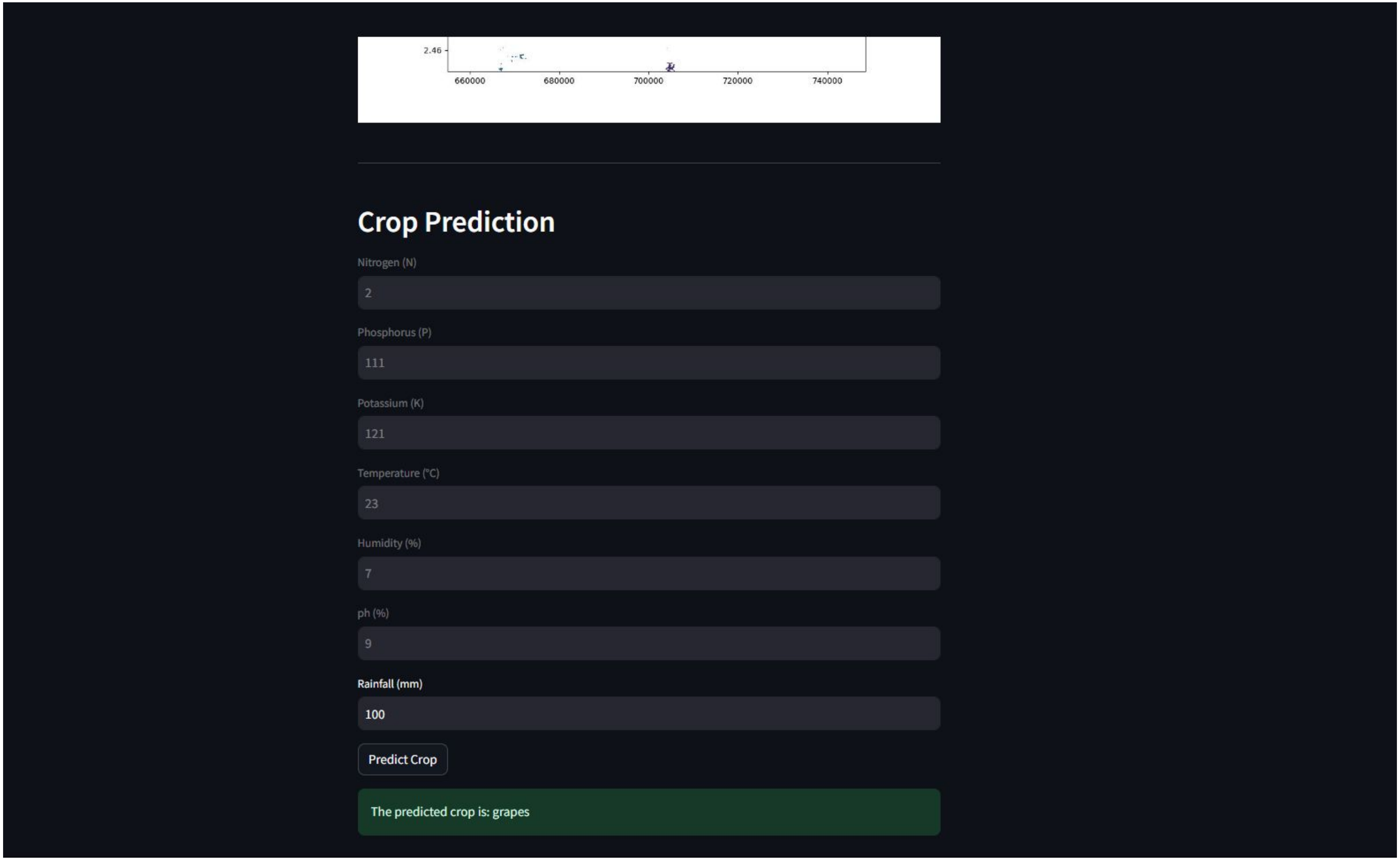
Sentinel Image Analysis



Landsat Image Analysis



OUTPUT (Crop Prediction)



References

1. Soil Texture Estimation Using Radar and Optical Data from Sentinel-1 and Sentinel-2 Authors: Dr. John Smith - Soil Scientist, Dr. Emily Johnson – Agronomist Published at Journal of Soil Science and Agriculture in September 2022

2. IoT-Enabled Soil Nutrient Analysis and Crop Recommendation Model for Precision Agriculture Authors: Murali Krishna Senapaty , Abhishek Ray, Neelamadhab Padhy Publisher: MDPI, Basel, Switzerland, 2023

3. Prediction of Soil Chemical Properties Using Neural Network Wavelet Model Authors: Chaitanya B. Pande Published: 2021 Published in: Journal of the Saudi Society of Agricultural Sciences

4. A hybrid approach for crop yield prediction using machine learning and deep learning algorithms, Authors: Sonal Agarwal and Sandhya Tarar, Published in: Journal of Physics, 2021