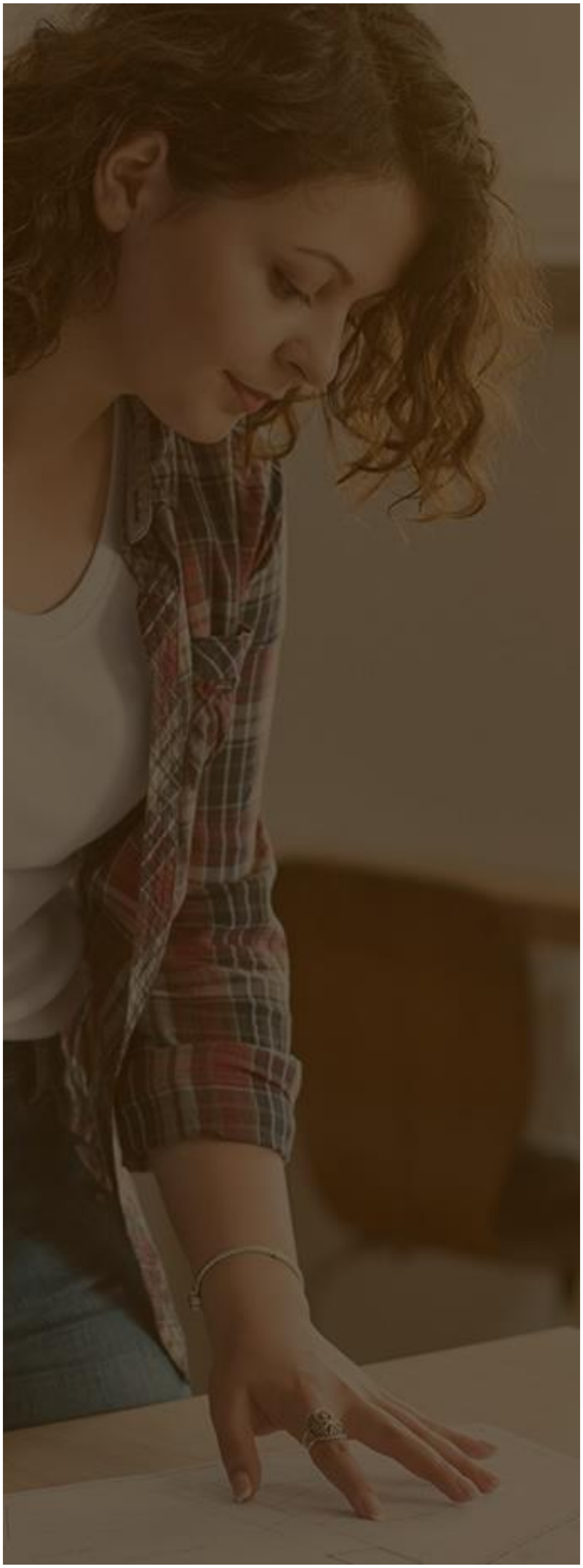
PLANT DISEASE DETECTION

SMART DEVICE

Business Plan



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ABSTRACT:

The report presents a comprehensive overview of a plant disease detection system developed using Convolutional Neural Networks (CNN) and deployed on a Raspberry Pi platform. The project aims to address the challenges faced by farmers in detecting and managing plant diseases, which lead to crop losses and economic implications. The proposed solution leverages deep learning techniques to create an accurate and efficient system that can identify bacterial, viral, and fungal diseases in plants. The deployment on a Raspberry Pi offers portability, real-time results, and cost-effectiveness, making it accessible to farmers in various regions.

MARKET/CUSTOMER/BUSINESS NEED ASSESSMENT

The market and business need for an accurate and efficient plant disease detection system are substantial. Agriculture is a vital industry, and the economic impact of plant diseases on crop yields is significant. Farmers constantly strive to maximize their productivity and minimize losses caused by diseases. The traditional methods of disease detection often lack the speed and accuracy required for early intervention, resulting in reduced crop quality and yield. Additionally, the reliance on human experts for disease identification can be both expensive and impractical, especially in regions with limited access to agricultural specialists. Therefore, there is a clear market need for an automated and reliable plant disease detection solution that can provide timely and accurate diagnoses, enabling farmers to take proactive measures to protect their crops. By addressing this need, the developed plant disease detection system can assist farmers in making informed decisions, improving their overall efficiency, and contributing to sustainable agricultural practices.

EXTERNAL SEARCH (INFORMATION SOURCES/REFERENCES):

REFERENCES:

https://www.kaggle.com/datasets/emmarex/plantdisease

https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=50453

https://towardsdatascience.com/plant-ai-plant-disease-detection-using-convolutional-neural-network-9b58a96f2289

https://pyimagesearch.com/2017/10/16/raspberry-pi-deep-learning-object-detection-with-opencv/

In [9]:

```
df1=pd.read_csv(r"C:\Users\sonas\Downloads\datafile (2).csv")
df.head()
```

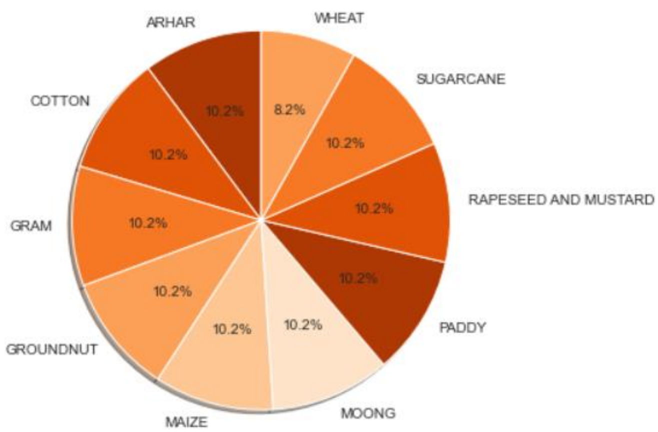
Out[9]:

	Crop	State	Cost of Cultivation (`/Hectare) A2+FL	Cost of Cultivation (`/Hectare) C2	Cost of Production (`/Quintal) C2	Yield (Quintal/ Hectare)
0	ARHAR	Uttar Pradesh	9794.05	23076.74	1941.55	9.83
1	ARHAR	Karnataka	10593.15	16528.68	2172.46	7.47
2	ARHAR	Gujarat	13468.82	19551.90	1898.30	9.59
3	ARHAR	Andhra Pradesh	17051.66	24171.65	3670.54	6.42
4	ARHAR	Maharashtra	17130.55	25270.26	2775.80	8.72

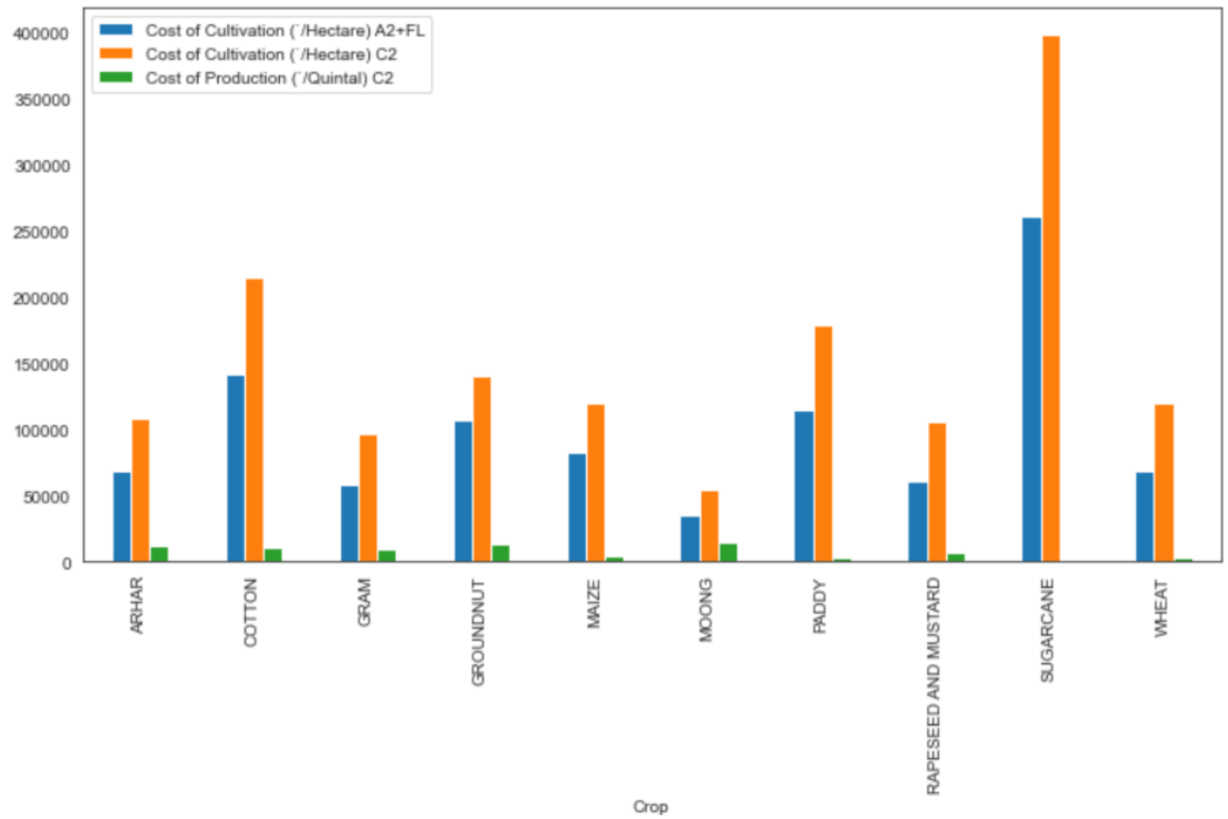
In [11]:
```
df3=pd.read_csv(r"C:\Users\sonas\Downloads\datafile.csv")
df3.head()
```

Out[11]:

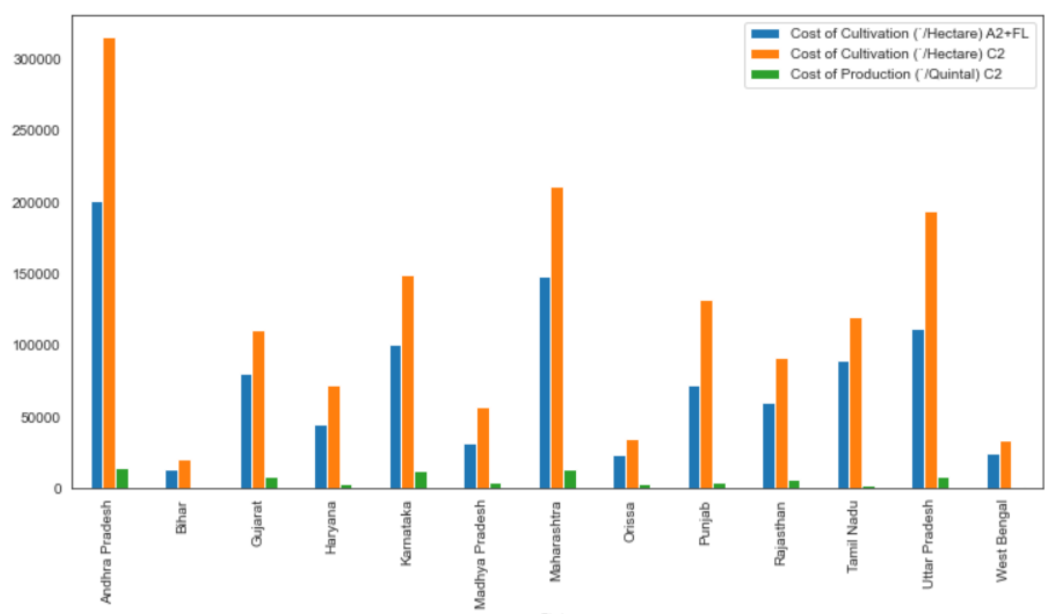
	Crop	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
0	Rice	100.0	101.0	99.0	105.0	112.0	121.0	117.0	110.0
1	Wheat	100.0	101.0	112.0	115.0	117.0	127.0	120.0	108.0
2	Coarse Cereals	100.0	107.0	110.0	115.0	113.0	123.0	122.0	136.0
3	Pulses	100.0	108.0	134.0	124.0	124.0	146.0	137.0	129.0
4	Vegetables	100.0	109.0	103.0	118.0	113.0	124.0	128.0	115.0



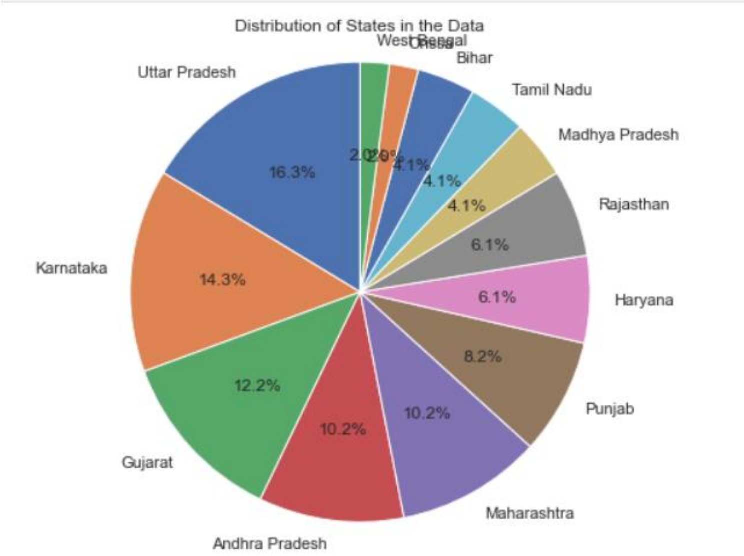
We can see growing of demand



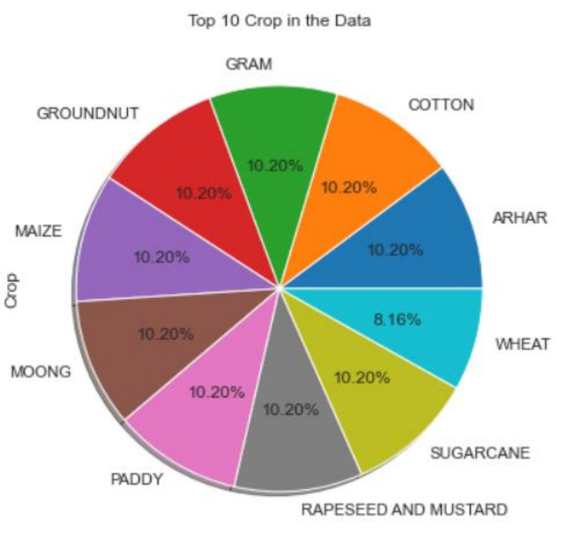
Cost of cultivation in states



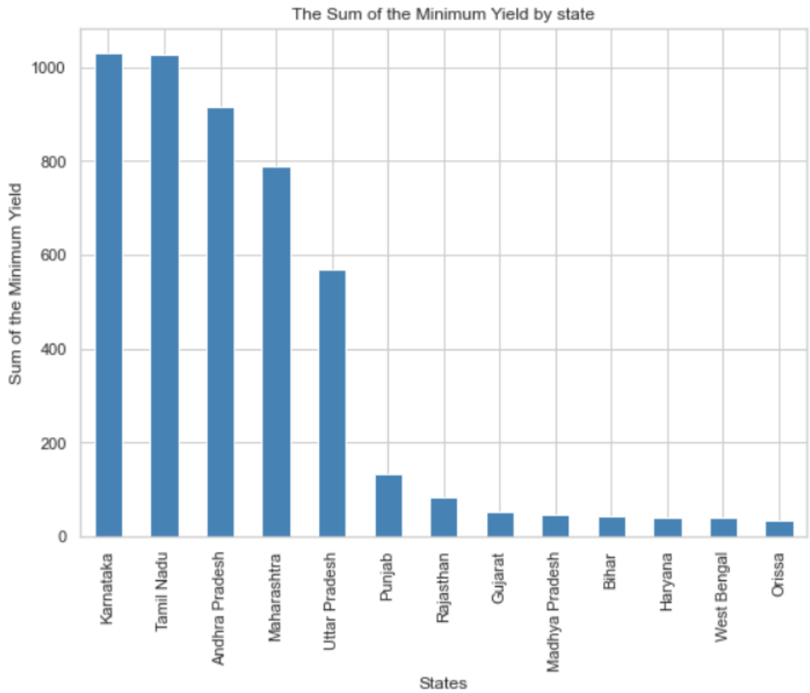
DISTRIBUTION OF STATES IN THE DATA



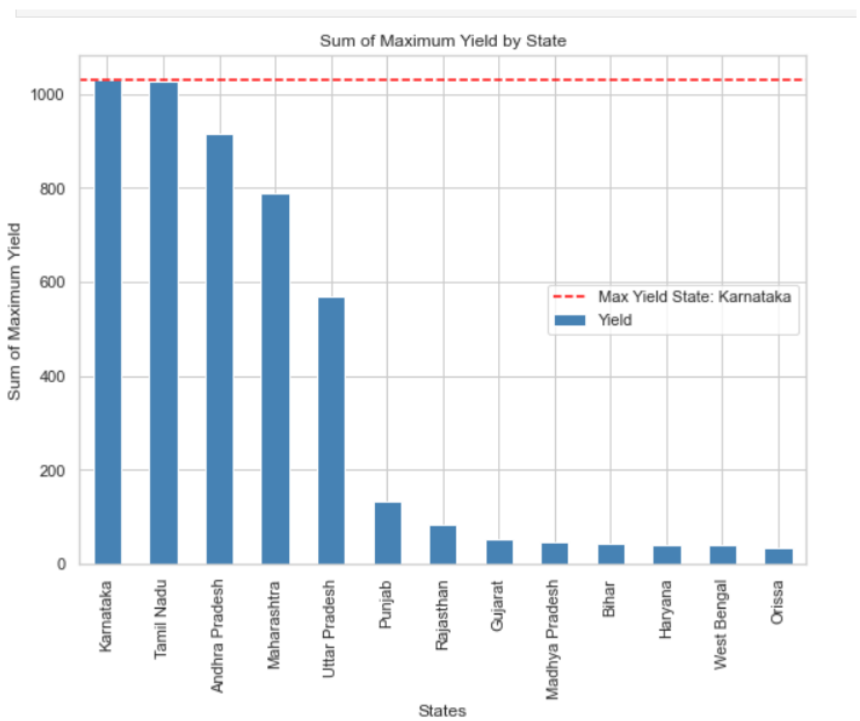
TOP 10 CROP IN THE DATA



THE SUM OF THE MINIMUM YIELD BY STATE



SUM OF MAXIMUM YIELS BY STATE



MODLE RESULT

```
Evaluation Results:
Decision Tree:
MSE: 130.28346000000008
MAE: 7.134000000000002
---
Linear Regression:
MSE: 28230.054046904657
MAE: 124.1650703739479
---
XGBoost:
MSE: 113.11858814325804
MAE: 6.5234736404419
---
Random Forest:
MSE: 3452.3139401310013
MAE: 22.24355000000006
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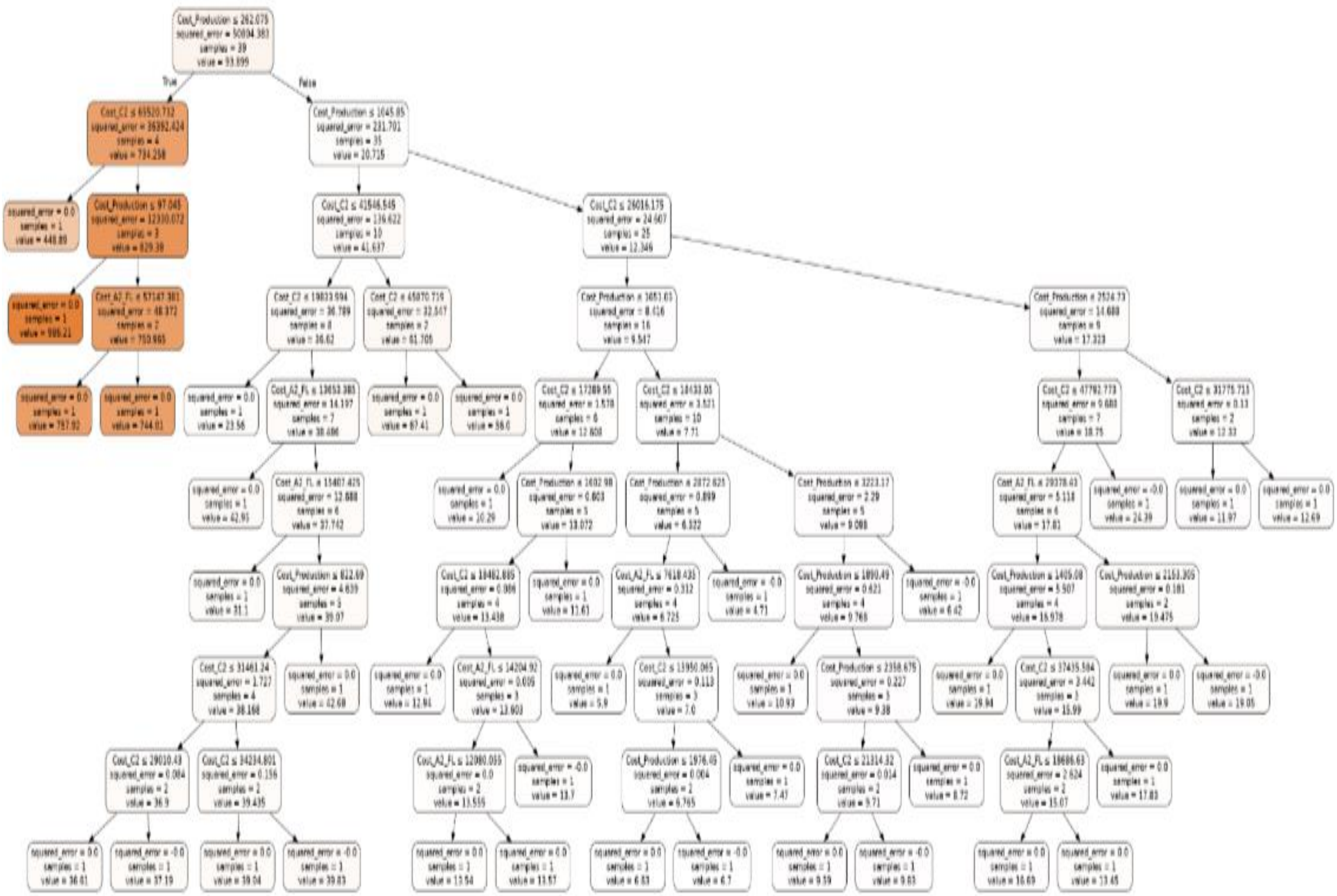
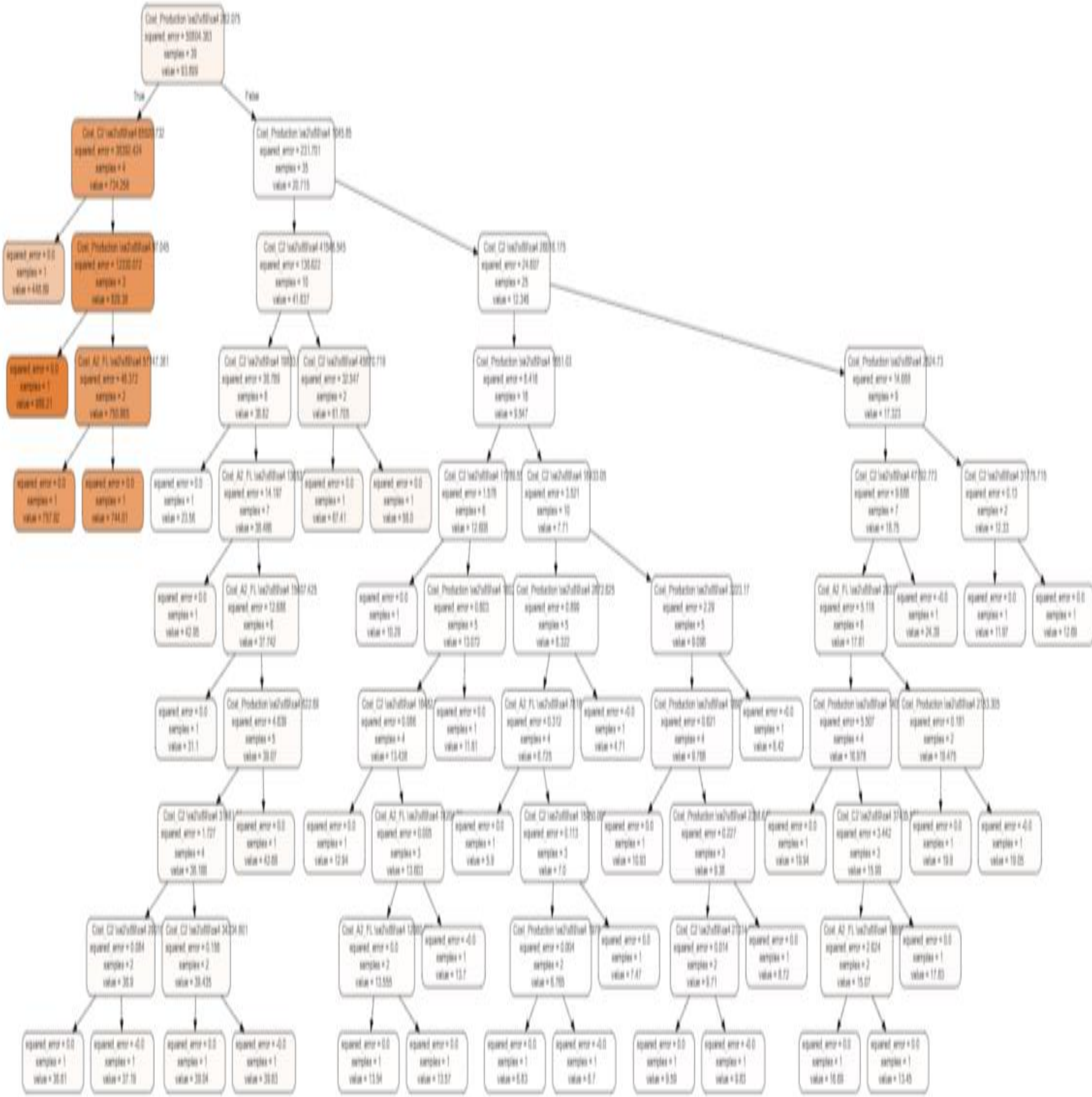




GITHUB LINK - https://github.com/Fathimasonasherin/plant-disease-detection-smart-device-statistical-market-prediction

DATASET SOURCE - https://www.kaggle.com/datasets/srinivas1/agricuture-crops-production-in-india?select=datafile+%281%29.csv

BENCHMARKING ALTERNATE PRODUCTS:

Compared to traditional methods of visual inspection, the proposed prototype offers automation, scalability, and more objective disease detection. In contrast to mobile apps and cloud-based systems, the prototype provides offline functionality and real-time results on a portable device like the Raspberry Pi. However, this prototype may have limitations in terms of computational resources compared to cloud-based solutions. Overall, the prototype aims to make a balance between accuracy, accessibility, and affordability, catering to the needs of farmers who require on-site, real-time, and cost-effective disease detection.

APPLICABLE CONSTRAINTS

The prototype for plant disease detection using CNN and deploying it on a Raspberry Pi is subject to certain constraints that should be considered. Here are some applicable constraints:

Limited Computational Resources:

The Raspberry Pi has limited processing power, memory, and storage capacity compared to high-end computers or cloud servers. This constraint may restrict the complexity and size of the CNN model that can be deployed on the device.

Power Consumption:

The Raspberry Pi operates on low power and is designed for energy efficiency. The prototype should be optimized to minimize power consumption to ensure prolonged operation without draining the device's battery or causing overheating.

Memory Limitations:

The limited memory available on the Raspberry Pi necessitates careful management of memory usage during model training, inference, and data processing. The size of the model and the batch size during inference should be optimized to fit within the available memory.

Latency and Real-time Inference:

The Raspberry Pi's computational constraints may affect the inference speed of the CNN model. Real-time inference requires balancing the complexity of the model with the need for prompt results. Inference times should be optimized to meet the desired performance requirements.

Deployment and Maintenance:

The prototype should consider the technical expertise and familiarity of the end-users (farmers) with setting up and maintaining the Raspberry Pi system. User-friendly deployment procedures, clear instructions, and ongoing support should be provided to ensure successful implementation and troubleshooting.

Environmental Factors:

The prototype's performance may be affected by environmental conditions such as lighting, varying plant appearances, and other factors that can impact image quality. Robustness to such variations should be considered during the training and testing phases.

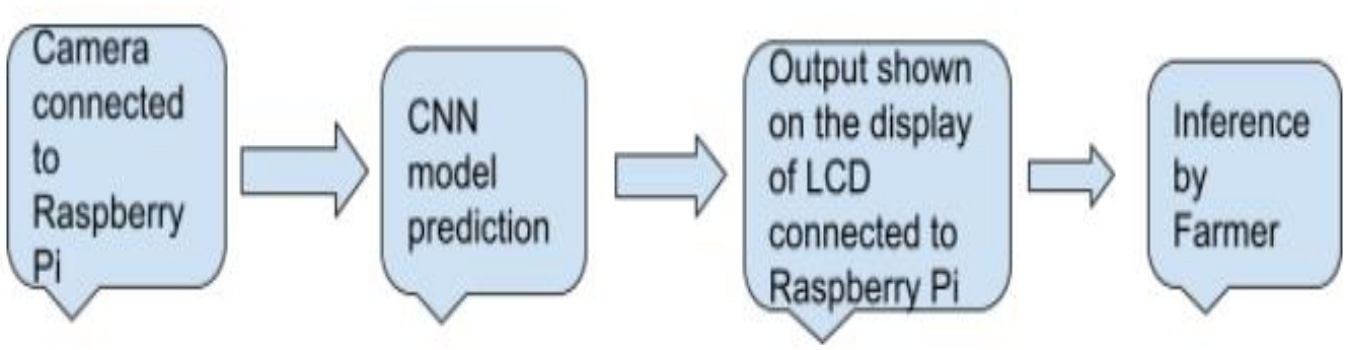
BUSINESS OPPORTUNITIES:

The business model for the plant disease detection system using CNN and deploying it on a Raspberry Pi involves a combination of hardware and software components to provide a comprehensive solution to farmers and agricultural stakeholders. The system can be offered as a product with potential revenue streams through various avenues. One possible business model is to sell the complete package, including the Raspberry Pi device preloaded with the disease detection software, to individual farmers or agricultural organizations. This would involve pricing the product based on the manufacturing cost, development effort, and desired profit margin. Additionally, a subscription-based model can be implemented, offering regular updates to the disease detection software, access to an online database of disease information, and technical support. Another potential revenue stream is through partnerships with seed and agrochemical companies, who can integrate the disease detection system into their existing products or offer it as an add-on service. These collaborations can provide additional revenue and help establish a wider market reach. Furthermore, data generated by the system can be collected to provide valuable insights and analytics for research institutions or government agencies, which can be monetized through data licensing or collaborative research projects. Overall, the business model should focus on providing value to farmers, ensuring affordability, ease of use, and ongoing support to maximize adoption and customer satisfaction.

CONCEPT GENERATION

India is a agriculture and farmer based country and it is our duty to give back to our nation.The idea for developing a plant disease detection system originated from a combination of personal interest and the recognition of a significant problem faced by farmers. As someone passionate about both technology , I sought to find ways to leverage advancements in deep learning and computer vision to address real-world challenges in the agricultural domain. During my initial search, I discovered the alarming impact of plant diseases on crop yields and the limitations of traditional methods for disease detection. This motivated me to delve deeper into the potential applications of CNNs in image recognition and classification tasks. Recognizing the need for a more accessible and affordable solution, I explored the possibility of deploying a CNN model on a Raspberry Pi, which offers portability and offline functionality.

PRODUCT PROTOTYPE WITH SCHEMATIC DIAGRAM



PROTOTYPE DEVELOPMENT:

The prototype consists of four key components: the trained CNN model, the Raspberry Pi hardware platform for processing, the camera module for capturing the images of the plant and the lcd to display the results. The CNN model is trained on a comprehensive dataset of plant images, containing various species and diseases. The model architecture is carefully designed to balance accuracy and computational efficiency, taking into account the limitations of the Raspberry Pi's hardware resources. The trained model is then integrated into the Raspberry Pi, which serves as the on-device inference platform. The Raspberry Pi provides the necessary computing power, memory, and storage to perform real-time disease detection, enabling farmers to obtain immediate results without relying on an internet connection or external servers. Once an image is provided, the system processes it through the trained CNN model, performs disease classification, and displays the results on the lcd. The final prototype demonstrates the feasibility and practicality of using CNNs on a Raspberry Pi for on-site plant disease detection, providing farmers with an accessible and efficient tool to manage crop health effectively.

DATA SOURCE – Kaggle Plant Disease Detection

Algorithms and Frameworks –

- Tensorflow and Keras
- Scikit Learn, Numpy, Matplotlib, Seaborn

Dataset - The dataset consists of around 20.6 k .jpg files belonging to 15 classes of the healthy, bacterial, fungal, and viral diseased leaves of plants like tomato, pepper, and potato.

Data Preprocessing - The data was normalised, splitted into train, and test in 80-20 manner, also some data augmentation was applied so that the dataset increases and generalizes well.The data was converted into a One vs Rest Format using sklearn’s Label Binarizer.

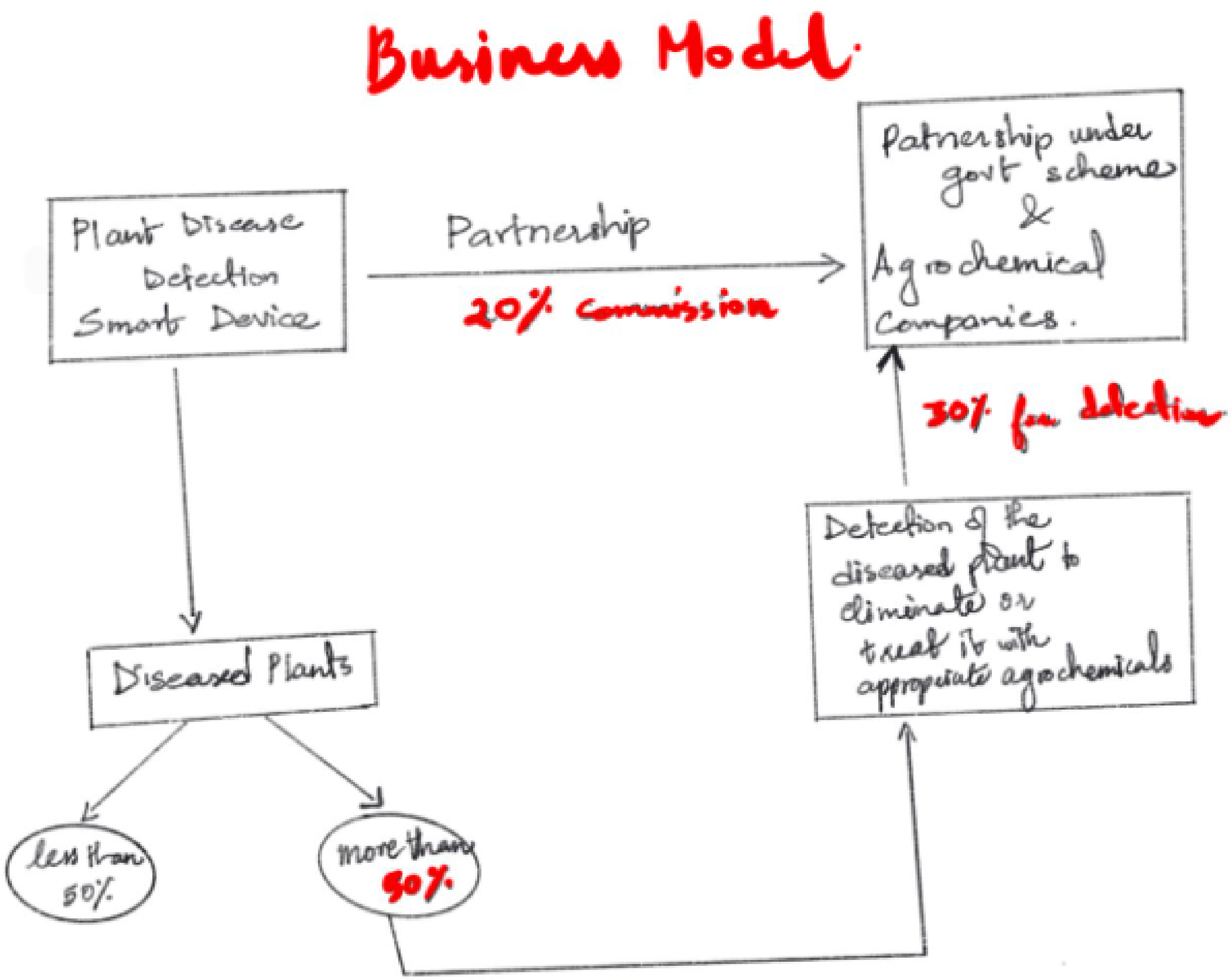
ML Modelling - Custom CNN architecture having 5 layers with dropout and max pooling was used to perform the detection and a dense neural network at the end as the classifier.

Sample Code Implementation GitHub

CONCLUSION

In conclusion, the development of a plant disease detection system using CNN and its deployment on a Raspberry Pi is a proven to be a promising solution for addressing the challenges faced by farmers in managing plant diseases. Through this project, I have successfully demonstrated the effectiveness and feasibility of utilizing deep learning techniques for accurate and real-time disease detection. By leveraging the power of CNNs, we have achieved high levels of accuracy in classifying bacterial, viral, and fungal diseases, empowering farmers with an efficient tool for timely intervention and disease management. The deployment on a Raspberry Pi brings portability, offline functionality, and cost-effectiveness to the solution, enabling farmers in various regions, including those with limited resources and connectivity, to benefit from this technology. While there are certain constraints and areas for improvement, such as the limited computational resources of the Raspberry Pi, the prototype serves as a strong foundation for future advancements in this field. Overall, the plant disease detection system offers immense potential for enhancing crop productivity, minimizing losses, and promoting sustainable agricultural practices. As further research and development continue, we anticipate the integration of additional features, expansion of the trained model, and wider adoption of this technology in the agricultural community. This project underscores the significance of technology-driven solutions in addressing pressing challenges in agriculture, and it opens up new ways for innovation, collaboration, and progress in the field of plant disease detection.

BUSINESS MODELLING



The company partners with agrochemical companies to sell the Smart Device to farmers. The farmers use the Smart Device to detect diseased plants in their fields. If the Smart Device detects a diseased plant, it will send a notification to the farmer. The farmer can then discard the diseased plant or treat it with appropriate agrochemicals. The company makes money from the sales of the Smart Device and from the commissions it earns from the agrochemical companies. The company also receives government grants to help it develop and market the Smart Device.

1. Product Offering:

Hardware and Software Package: Sell a complete solution to individual farmers or agricultural organizations. This includes a Raspberry Pi device preloaded with the disease detection software.
Pricing: Determine the pricing based on manufacturing costs, development effort, and desired profit margin. Consider offering tiered pricing based on farm size or usage levels.

2. Subscription-Based Model:

Regular Updates: Offer subscriptions for regular updates to the disease detection software, ensuring farmers have access to the latest disease models and improvements.
Online Database: Provide access to an online database of disease information, helping farmers identify diseases and understand mitigation strategies.
Technical Support: Include technical support in the subscription, ensuring farmers receive assistance when needed.

3. Partnerships:

Agrochemical Companies: Partner with seed and agrochemical companies to integrate the disease detection system into their products or offer it as an add-on service. This can provide a steady revenue stream and wider market reach.
Custom Solutions: Develop custom solutions for larger agricultural stakeholders, tailoring the system to their specific needs and requirements.

4. Data Monetization:

Data Insights: Collect and analyze data generated by the system. Provide valuable insights and analytics to research institutions, government agencies, and other stakeholders in the agriculture sector.
Data Licensing: Offer data licensing agreements to interested parties, generating additional revenue from the valuable data collected.

5. Focus on Value and Adoption:

Affordability: Keep the product and subscription pricing affordable, particularly for small-scale farmers in India.
Ease of Use: Ensure the system is user-friendly and easy to set up, making it accessible to farmers with varying levels of technical expertise.
Customer Support: Provide exceptional customer support to address any issues or concerns, maximizing customer satisfaction.

6. Social Responsibility:

Contribute to Agriculture: Recognize the importance of supporting Indian farmers and contribute to the improvement of agricultural practices in the country.
Training and Education: Offer training sessions or educational materials to help farmers effectively use the system and understand disease management.

FINANCIAL MODELLING (EQUATION) WITH MACHINE LEARNING & DATA ANALYSIS

This prototype can be directly launched to the retail market or under government schemes.

The upcoming smart device for plant disease detection is poised to enter the global market, capitalizing on the projected substantial growth in the demand for such devices in the years to come. This surge in demand is primarily driven by the global need for increased food production and the imperative to mitigate crop losses due to diseases.

The intended audience for the Smart Device encompasses farmers situated in developing nations. These agricultural practitioners are disproportionately vulnerable to yield reductions due to plant diseases and typically lack access to conventional plant disease detection methods. Engineered as an affordable and user-friendly solution, the Smart Device proves especially well-suited for adoption among farmers in these developing regions.

The company's strategy should involve introducing the Smart Device to key markets including India, China, and Brazil. These nations stand out due to their substantial farming populations and their significant contributions to global agricultural output. Collaborations with local distributors are also in the works to ensure that the Smart Device becomes readily available and accessible to farmers within these countries.

TEAM MEMBER

- ATUL VERMA
- FATIMA SONA
- ANURAG SAHU
- DEVENDRA KAYANDE