Optimize pricing in real time based on future market, weather and other forecasts in Agriculture

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Abstract

Agriculture is a highly dynamic industry that is affected by several variables such as market demand, weather conditions, crop yields, and production costs. Pricing in agriculture has always been a challenging task, as farmers need to balance the costs of production with market demand to maximize their profits. Real-time forecasting has emerged as a powerful tool in agriculture, allowing farmers to make informed decisions based on real-time data. Machine learning algorithms can be used to analyze large datasets and generate accurate predictions of future market and weather conditions, enabling farmers to optimize their pricing strategies.

This project proposes the development of a machine learning-based pricing optimization system for the agricultural sector. The system will use real-time data from various sources, including weather forecasts, market demand projections, crop yield estimates, and production cost data. The machine learning algorithms will analyze this data to generate predictions of future market and weather conditions, which will be used to optimize pricing strategies.

The system will be developed using Python and various machine learning libraries such as TensorFlow, Scikit-Learn, and Keras. The system will be trained on historical data to ensure that the predictions generated are accurate and reliable. The system will also use various visualization tools such as Matplotlib and Seaborn to help farmers visualize the data and make informed decisions.

The project's outcome will be a prototype of a real-time pricing optimization system that can be used by farmers to make informed decisions about pricing. The system will enable farmers to maximize their profits by optimizing their pricing strategies based on real-time data. The project's impact will be significant, as it will help farmers make informed decisions about pricing and increase their profitability, thus contributing to the overall growth of the agricultural sector.

1.0 Introduction

Agriculture is an industry that is highly dependent on various factors, including weather conditions, market demand, crop yields, and production costs. The pricing of agricultural products is crucial for farmers to maximize their profits and ensure a sustainable livelihood. However, the volatile nature of the agricultural industry makes it challenging to predict future market conditions accurately. In recent years, the development of real-time forecasting and machine learning technologies has opened up new opportunities for optimizing pricing strategies in agriculture.

The proposed project aims to develop a machine learning-based pricing optimization system for the agricultural sector. The system will use real-time data from various sources, including weather forecasts, market demand projections, crop yield estimates, and production cost data. Machine learning algorithms will analyze this data to generate predictions of future market and weather conditions, which will be used to optimize pricing strategies.

The project's objective is to develop a prototype of a real-time pricing optimization system that can be used by farmers to make informed decisions about pricing. The system will enable farmers to maximize their profits by optimizing their pricing strategies based on real-time data. The project's outcome will have a significant impact on the agricultural sector, as it will help farmers make informed decisions about pricing and increase their profitability.

This project report will provide a detailed description of the proposed system's design, implementation, and evaluation. The report will begin with a literature review of existing research on pricing optimization in agriculture and real-time forecasting techniques. The report will then provide an overview of the proposed system's architecture, including the data sources, machine learning algorithms, and visualization tools. The implementation of the system will be described, including the training of the machine learning models, the integration of data sources, and the development of the visualization tools. Finally, the report will evaluate the system's performance using real-world data and discuss its potential impact on the agricultural sector.

1.1 Initial Needs Statement

The agricultural industry faces several challenges, including unpredictable weather conditions, fluctuating market demands, and production costs. The pricing of agricultural products is a critical factor in the success of farming businesses, and optimizing pricing strategies based on real-time data can help farmers maximize their profits. However, there is a lack of effective tools and systems that enable farmers to make informed decisions about pricing based on real-time data.

Therefore, the proposed project aims to develop a machine learning-based pricing optimization system for the agricultural sector. The system will use real-time data from various sources, including weather forecasts, market demand projections, crop yield estimates, and production cost data. The machine learning algorithms will analyze this data to generate predictions of future market and weather conditions, which will be used to optimize pricing strategies.

The system will address the need for an effective tool that can help farmers make informed decisions about pricing by providing real-time data analysis and visualization. The system will enable farmers to optimize their pricing strategies based on accurate predictions of future market and weather conditions. The system's development will require expertise in machine learning, data analysis, and software development.

The proposed system's successful development and implementation will benefit the agricultural industry by increasing profitability and sustainability. The system will provide farmers with a tool to optimize their pricing strategies based on real-time data, leading to improved decision-making, increased profits, and overall growth in the agricultural sector.

2.0 Customer Needs Assessment

To develop an effective machine learning-based pricing optimization system for the agricultural sector, it is essential to understand the needs and requirements of the target customers. The primary customers of the system will be farmers, agriculture businesses, and agricultural cooperatives.

To assess customer needs, surveys and interviews can be conducted to gather information about the current pricing strategies, challenges faced, and the importance of real-time data analysis. The following are some of the potential customer needs and requirements:

2.1 Accurate and Real-Time Data: Farmers need accurate and real-time data to make informed decisions about pricing. The system should be able to collect data from various sources, including weather forecasts, market demand projections, crop yield estimates, and production cost data.

2.2 Customizable and Flexible: Farmers have different pricing strategies, and the system should be customizable and flexible to meet their specific needs. The system should provide options to adjust pricing strategies based on market and weather conditions.

2.3 Easy-to-Use Interface: The system should have an easy-to-use interface that is accessible to all users, regardless of their technical expertise. The system should provide data visualization tools to help farmers understand the data and make informed decisions.

2.4 Reliable and Secure: Farmers need a reliable and secure system to ensure that their data is protected and not compromised. The system should be designed to prevent data breaches and provide a secure environment for data storage.

2.5 Cost-Effective: The system should be cost-effective and provide value for money. Farmers should be able to afford the system and benefit from its features and capabilities.

By assessing customer needs and requirements, the proposed system can be designed to meet the needs of the target customers effectively. The system can provide farmers with the tools they need to optimize their pricing strategies based on real-time data, leading to improved decision-making, increased profitability, and overall growth in the agricultural sector.

3.0 Revised Needs Statement and Target Specifications

3.1 Needs Statement:

The agricultural industry requires a machine learning-based pricing optimization system that provides farmers with accurate and real-time data to make informed decisions about pricing. The system should be customizable and flexible to meet the specific needs of different farmers and provide an easy-to-use interface that is accessible to all users. The system should be reliable and secure, ensuring the protection of farmers' data and privacy. Additionally, the system should be cost-effective and provide value for money.

3.2 Target Specifications:

3.2.1 Accurate and Real-Time Data: The system should collect and analyze data from various sources, including weather forecasts, market demand projections, crop yield estimates, and production cost data. The system should generate accurate predictions of future market and weather conditions, which will be used to optimize pricing strategies.

3.2.2 Customizable and Flexible: The system should be customizable and flexible to meet the specific needs of different farmers. The system should provide options to adjust pricing strategies based on market and weather conditions, allowing farmers to optimize their pricing strategies effectively.

3.2.3 Easy-to-Use Interface: The system should have an easy-to-use interface that is accessible to all users, regardless of their technical expertise. The system should provide data visualization tools to help farmers understand the data and make informed decisions.

3.2.4 Reliable and Secure: The system should be reliable and secure, ensuring the protection of farmers' data and privacy. The system should be designed to prevent data breaches and provide a secure environment for data storage.

3.2.5 Cost-Effective: The system should be cost-effective and provide value for money. The system should be affordable for farmers to purchase and use, and the benefits should outweigh the costs.

4.0 External Search

"Farm to Market: Using Machine Learning to Forecast Crop Prices" by Microsoft Research: This research project used machine learning to forecast crop prices based on weather, historical crop prices, and other relevant data. The system used neural networks to predict future crop prices and provided farmers with recommendations on when to sell their crops.

"Precision Agriculture: Machine Learning Approach for Crop Yield Prediction" by the University of Illinois: This research project used machine learning to predict crop yields based on soil, weather, and other data. The system used a combination of regression and machine learning algorithms to generate yield predictions.

"Agricultural Weather Forecasting Using Machine Learning Techniques" by the Indian Journal of Science and Technology: This research paper proposed a machine learning-based approach for agricultural weather forecasting. The system used decision trees and Bayesian networks to predict weather patterns and provide farmers with real-time weather information.

"Optimizing Agricultural Supply Chain Pricing with Machine Learning" by Infosys: This case study describes how a machine learning-based system was used to optimize pricing in the agricultural supply chain. The system used regression models to predict prices and provide recommendations on pricing strategies.

"Predicting Corn Prices with Machine Learning" by the DataRobot Blog: This blog post describes a machine learning-based approach to predict corn prices based on weather and other data. The system used gradient boosting algorithms to generate predictions and provided farmers with recommendations on when to sell their crops.

These external sources demonstrate that machine learning can be used to optimize pricing in the agricultural sector based on real-time data, including weather and market forecasts. The proposed system can build on these approaches to provide farmers with a more comprehensive and customizable pricing optimization solution.

4.1 Benchmarking

Benchmarking for "Optimize pricing in real time based on future market, weather, and other forecasts in agriculture" can involve comparing the proposed system's features, performance, and cost with existing pricing optimization systems in the market. The following are some existing systems that can be used as benchmarks:

4.1.1 Agworld: Agworld is an agriculture management software that provides features for farm planning, crop management, and financial management. Agworld also offers a pricing optimization module that provides farmers with market intelligence, price tracking, and historical price trends. However, Agworld does not offer real-time data analysis or weather forecasting.

4.1.2 FieldX: FieldX is an agriculture management software that provides features for soil sampling, scouting, and nutrient management. FieldX also offers a pricing optimization module that provides farmers with market data and recommendations on pricing strategies. However, FieldX does not offer real-time data analysis or weather forecasting.

4.1.3 CropZilla: CropZilla is an agriculture management software that provides features for crop management, yield forecasting, and financial management. CropZilla also offers a pricing optimization module that provides farmers with market data, price tracking, and pricing recommendations. However, CropZilla does not offer real-time data analysis or weather forecasting.

4.1.4 AgriEdge: AgriEdge is a precision agriculture system that provides features for field mapping, crop management, and financial management. AgriEdge also offers a pricing optimization module that provides farmers with market data, price tracking, and historical price trends. However, AgriEdge does not offer real-time data analysis or weather forecasting.

4.1.5 FBN Market Advisory: FBN Market Advisory is a pricing optimization system that provides farmers with real-time market intelligence, price tracking, and historical price trends. FBN Market Advisory also offers recommendations on pricing strategies based on market conditions. However, FBN Market Advisory does not offer weather forecasting or crop yield predictions.

The proposed system's benchmarking against these systems can provide insights into its competitiveness, strengths, and areas for improvement. The proposed system's real-time data analysis and weather forecasting features can give it a unique advantage over these systems, and its customizable and flexible interface can provide farmers with more control over their pricing strategies. Additionally, the proposed system's cost-effectiveness can make it a more accessible option for farmers with smaller operations.

4.2 Applicable Patents

4.2.1 US Patent No. 10,792,841: This patent describes a machine learning-based system that provides real-time pricing recommendations to farmers based on market data and historical trends. The system can also analyze weather and soil data to predict crop yields and adjust pricing recommendations accordingly.

4.2.2 US Patent No. 10,573,889: This patent describes a machine learning-based system that predicts crop yields based on soil, weather, and other data. The system can also provide pricing recommendations based on market data and historical trends.

4.2.3 US Patent No. 10,606,725: This patent describes a machine learning-based system that analyzes weather data to predict crop yields and provides pricing recommendations based on market data and historical trends.

4.2.4 US Patent No. 10,849,368: This patent describes a machine learning-based system that uses neural networks to predict crop yields based on soil, weather, and other data. The system can also provide pricing recommendations based on market data and historical trends.

4.2.5 US Patent No. 10,549,082: This patent describes a machine learning-based system that uses clustering algorithms to analyze market data and provide pricing recommendations to farmers.

These patents illustrate the existing technological advancements in the field of machine learning-based systems for optimizing pricing in the agricultural sector. A thorough search of patents can help in identifying any existing patents that may pose legal challenges to the proposed system and can provide insights into the state-of-the-art technologies in the field.

4.3 Applicable Standards

4.3.1 ISO 55000: This is a standard for asset management that provides guidance on developing and implementing an asset management system. This standard can be useful in ensuring that the proposed system meets the required quality standards for managing agricultural assets such as crops and equipment.

4.3.2 ISO 9001: This is a standard for quality management systems that provides guidance on the implementation and maintenance of a quality management system. The standard can be useful in ensuring that the proposed system meets the required quality standards for data analysis, pricing recommendations, and customer support.

4.3.3 ISO 14001: This is a standard for environmental management systems that provides guidance on the development and implementation of an environmental management system. This standard can be useful in ensuring that the proposed system minimizes its impact on the environment by considering factors such as energy consumption, waste management, and greenhouse gas emissions.

4.3.4 IEEE 1588: This is a standard for precision clock synchronization in networked measurement and control systems. The standard can be useful in ensuring that the proposed system's real-time data analysis and pricing recommendations are accurate and synchronized with market and weather data.

4.3.5 IEEE 802.11: This is a standard for wireless LAN technology that can be used in the proposed system for transmitting and receiving data from sensors and other devices in the field.

Adhering to these standards can ensure that the proposed system meets the required quality and performance criteria for managing agricultural assets, providing accurate and timely pricing recommendations, and minimizing its impact on the environment.

4.4 Applicable Constraints

4.4.1 Data availability: The proposed system requires access to a large amount of real-time data related to market trends, weather forecasts, crop yields, and other factors. The availability and quality of this data may be limited in certain geographic areas or for certain crops, which could impact the accuracy of the pricing recommendations.

4.4.2 Computational resources: The system will require significant computational resources for real-time data analysis, machine learning algorithms, and pricing recommendations. The availability and cost of these resources can impact the feasibility and scalability of the system.

4.4.3 Regulatory constraints: The agricultural sector is subject to various regulatory constraints related to pricing, subsidies, and other factors. The proposed system will need to comply with these regulations and may require approval from relevant regulatory bodies.

4.4.4 Cost: The cost of developing and implementing the proposed system can be a significant constraint. The system must provide value to farmers and other stakeholders to justify the investment.

4.4.5 User adoption: The success of the proposed system depends on user adoption. Farmers and other stakeholders may be hesitant to adopt a new technology if they do not trust the accuracy of the pricing recommendations or if the system is too complex to use.

4.4.6 Ethical and privacy considerations: The system will need to comply with ethical and privacy considerations related to the use of personal and sensitive data. The system must ensure that data is collected, stored, and used in a secure and ethical manner.

These constraints can impact the design, development, and implementation of the proposed system. It is important to carefully consider and address these constraints to ensure the feasibility, scalability, and success of the system.

4.5 Business Opportunity

There are several potential business opportunities for a system that can optimize pricing in real time based on future market, weather, and other forecasts in agriculture:

4.5.1 Agricultural input suppliers: Companies that supply seeds, fertilizers, and other agricultural inputs can use the proposed system to provide pricing recommendations to farmers. By offering more accurate and timely pricing information, these companies can increase customer satisfaction and loyalty.

4.5.2 Farmers and growers: Farmers and growers can use the proposed system to make more informed pricing decisions based on market and weather forecasts. This can help them maximize profits and improve the overall performance of their farm operations.

4.5.3 Commodity traders and brokers: Commodity traders and brokers can use the proposed system to make more informed trading decisions based on real-time market and weather data. This can help them mitigate risk and maximize profits.

4.5.4 Agribusiness consulting firms: Consulting firms that specialize in providing advisory services to the agricultural sector can use the proposed system to offer more value-added services to their clients. This can help them differentiate themselves from competitors and increase revenue.

4.5.5 Financial institutions: Banks and other financial institutions can use the proposed system to offer more informed lending decisions to farmers and other stakeholders. By providing more accurate pricing information, they can mitigate risk and improve the overall performance of their lending portfolios.

Overall, the proposed system has the potential to create new business opportunities and revenue streams for companies operating in the agricultural sector. By providing more accurate and timely pricing information, the system can help stakeholders make more informed decisions and improve the overall performance of their operations.

5.0 Concept Generation

Here are some potential concepts for a system that optimizes pricing in real time based on future market, weather, and other forecasts in agriculture:

Machine learning-based pricing recommendations: The system could use machine learning algorithms to analyze market and weather data, as well as other relevant factors such as crop yields and supply chain information, to provide real-time pricing recommendations to farmers, agribusinesses, and other stakeholders.

Multi-factor analysis: The system could use a multi-factor analysis approach to evaluate a variety of factors, such as weather patterns, market trends, historical data, and other relevant information, to provide more accurate and informed pricing recommendations.

Integrated platform: The system could be integrated into a larger platform that includes features such as supply chain management, inventory management, and other relevant tools to provide a comprehensive solution for agricultural businesses.

Mobile application: A mobile application could be developed that allows farmers and other stakeholders to access real-time pricing information and receive alerts and notifications based on market and weather trends.

Data visualization: The system could include data visualization tools that allow users to easily interpret and analyze pricing trends and other relevant information.

Risk management: The system could include risk management tools that help stakeholders mitigate risks associated with pricing decisions, such as price volatility, weather events, and other factors.

Collaborative approach: The system could incorporate a collaborative approach that involves input from a variety of stakeholders, such as farmers, input suppliers, and commodity traders, to ensure that pricing recommendations are aligned with the needs and objectives of all parties involved.

These are just a few potential concepts for a system that optimizes pricing in real time based on future market, weather, and other forecasts in agriculture. The specific approach and features of the system would depend on a variety of factors, including customer needs, available data, and technical constraints.

5.1 Problem Clarification

The problem that the system aims to solve is the challenge of making accurate pricing decisions in agriculture. Pricing decisions in agriculture are influenced by a variety of factors, such as market trends, weather patterns, crop yields, and supply chain information. However, many of these factors are unpredictable and subject to change, which can make it difficult for stakeholders to make informed decisions. This can result in pricing decisions that are too high or too low, which can lead to lost revenue, decreased profitability, and other negative outcomes.

The proposed system aims to address this problem by providing real-time pricing recommendations based on future market, weather, and other relevant forecasts. By using advanced algorithms and data analysis techniques, the system can provide more accurate and informed pricing recommendations, which can help stakeholders make better pricing decisions and improve the overall performance of their operations. The system aims to be a comprehensive solution that considers a wide range of factors, including weather patterns, market trends, historical data, and other relevant information, to provide the most accurate pricing recommendations possible.

5.2 Initial Screening for Feasibility and Effectiveness

5.2.1 Feasibility:

- Data availability: The system would require access to relevant and reliable data sources to make accurate pricing recommendations. Availability and quality of data sources need to be assessed.

- Technical capabilities: The system would require advanced data analysis and machine learning algorithms to generate accurate and timely pricing recommendations. The technical capabilities and limitations of the algorithms and other tools need to be evaluated.
- Scalability: The system should be scalable to accommodate different sizes and types of operations in agriculture.
- Infrastructure and resources: The system would require appropriate infrastructure and resources, such as hardware and software, to operate effectively.

5.2.2 Effectiveness:

- Accuracy: The system should generate accurate pricing recommendations that align with market trends, weather patterns, and other relevant factors.
- Timeliness: The system should generate pricing recommendations in real-time or near-real-time to enable stakeholders to make informed pricing decisions.
- Customization: The system should be customizable to meet the unique needs of different stakeholders and operations.
- Integration: The system should be able to integrate with existing supply chain management systems to facilitate effective pricing decisions.
- User-friendliness: The system should be user-friendly and accessible to stakeholders with varying levels of technical expertise.

These factors should be considered during the initial screening process to determine the feasibility and effectiveness of a system that can optimize pricing in real-time based on future market, weather, and other forecasts in agriculture. Based on the results of this screening process, further analysis and testing may be required to refine the system's approach and features.

6. Concept Selection

6.1 Concept Screening

Based on the initial concept generation for a system that can optimize pricing in real time based on future market, weather, and other forecasts in agriculture, potential concepts can be evaluated against the following criteria:

- Feasibility: The technical feasibility of the proposed concepts should be evaluated based on available data and resources. The concepts should be evaluated for their ability to generate accurate pricing recommendations using machine learning algorithms and other relevant tools. The availability and quality of relevant data sources should also be considered.
- Effectiveness: The effectiveness of the proposed concepts should be evaluated based on their ability to generate timely pricing recommendations that align with market trends, weather patterns, and other relevant factors. The concepts should be customizable to meet the unique needs of different stakeholders and operations.
- Scalability: The scalability of the proposed concepts should be evaluated based on their ability to accommodate different sizes and types of operations in agriculture. The concepts should be able to adapt to changing market conditions and provide reliable pricing recommendations in real time.
- Cost-effectiveness: The cost-effectiveness of the proposed concepts should be evaluated based on their ability to generate accurate pricing recommendations while minimizing costs. The concepts should be evaluated for their potential return on investment and potential cost savings for stakeholders.
- User-friendliness: The proposed concepts should be evaluated for their user-friendliness and accessibility to stakeholders with varying levels of technical expertise.

Based on these criteria, the following potential concepts can be screened:

- Machine learning-based pricing model: This concept involves developing a machine learning-based pricing model that can predict future prices based on past prices, market trends, weather patterns, and other relevant factors. The model can then generate pricing recommendations in real time based on these predictions.
- Collaborative pricing platform: This concept involves developing a collaborative pricing platform that connects farmers, processors, and buyers. The platform can be used to share pricing information, market trends, and other relevant information, which can be used to generate pricing recommendations.
- Dashboard-based pricing tool: This concept involves developing a dashboard-based pricing tool that can provide farmers with real-time pricing information based on market trends, weather patterns, and other relevant factors. The tool can be customizable to meet the unique needs of different farmers and operations.

Based on the evaluation of these concepts against the screening criteria, the machine learning-based pricing model and the dashboard-based pricing tool are deemed to be the most promising concepts for further development and testing. These concepts have the potential to generate accurate pricing recommendations in real time while minimizing costs and providing user-friendly and customizable interfaces for different stakeholders.

6.2 Concept Development, Scoring and Selection

Concept development scoring and selection involves evaluating the potential concepts based on a set of weighted criteria and selecting the concept that has the highest score. The following criteria are suggested for evaluating the potential concepts for optimizing pricing in real time based on future market, weather, and other forecasts in agriculture:

- Technical feasibility (25%): How technically feasible is the concept? Can it be implemented with the available technology and resources?
- Effectiveness (25%): How effective is the concept in generating timely and accurate pricing recommendations that align with market trends, weather patterns, and other relevant factors?

- Scalability (20%): How scalable is the concept? Can it accommodate different sizes and types of operations in agriculture? Can it adapt to changing market conditions?
- Cost-effectiveness (15%): How cost-effective is the concept? Does it generate accurate pricing recommendations while minimizing costs? What is the potential return on investment?
- User-friendliness (15%): How user-friendly is the concept? Is it accessible to stakeholders with varying levels of technical expertise?

Using a scale of 1 to 5, with 1 being the lowest score and 5 being the highest score, the potential concepts can be scored against each of the criteria. The scores can then be multiplied by the weight for each criterion and summed to obtain a total score for each concept. The concept with the highest score can be selected for further development and testing.

Here is an example of how this scoring and selection process might work for the two most promising concepts identified in the concept screening phase:

Concept 1: Machine learning-based pricing model

Technical feasibility: 4

Effectiveness: 5

Scalability: 4

Cost-effectiveness: 3

User-friendliness: 3

Total score: (4 x 0.25) + (5 x 0.25) + (4 x 0.20) + (3 x 0.15) + (3 x 0.15) = 4.0

Concept 2: Dashboard-based pricing tool

Technical feasibility: 5

Effectiveness: 4

Scalability: 5

Cost-effectiveness: 4

User-friendliness: 5

Total score: (5 x 0.25) + (4 x 0.25) + (5 x 0.20) + (4 x 0.15) + (5 x 0.15) = 4.6

Based on this scoring and selection process, the dashboard-based pricing tool is the highest-scoring concept and is therefore selected for further development and testing. However, it should be noted that this is just an example and that the weights and criteria used may vary depending on the specific needs and requirements of the project.

Code Implementation (Small Scale) :

Github link :

https://github.com/ladijeevansai/Crop-price-optimization-using-ML-

https://github.com/Chetan-Wanave/Feynn-MSA

IMPORTING DATASET

```
import pandas as pd

# Loading from CSV file
df = pd.read_csv('/content/drive/MyDrive/Colab Notebooks/feynn labs intership/task3/crops.csv')

# Print the first 5 rows of the dataset
print(df.head())
```

```
    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
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2200 entries, 0 to 2199
Data columns (total 8 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   N            2200 non-null   int64
 1   P            2200 non-null   int64
 2   K            2200 non-null   int64
 3   temperature  2200 non-null   float64
 4   humidity     2200 non-null   float64
 5   ph           2200 non-null   float64
 6   rainfall     2200 non-null   float64
 7   label        2200 non-null   object
dtypes: float64(4), int64(3), object(1)
memory usage: 137.6+ KB
```

Out of 8 attributes 3 are numerical attributes and rest are categorical

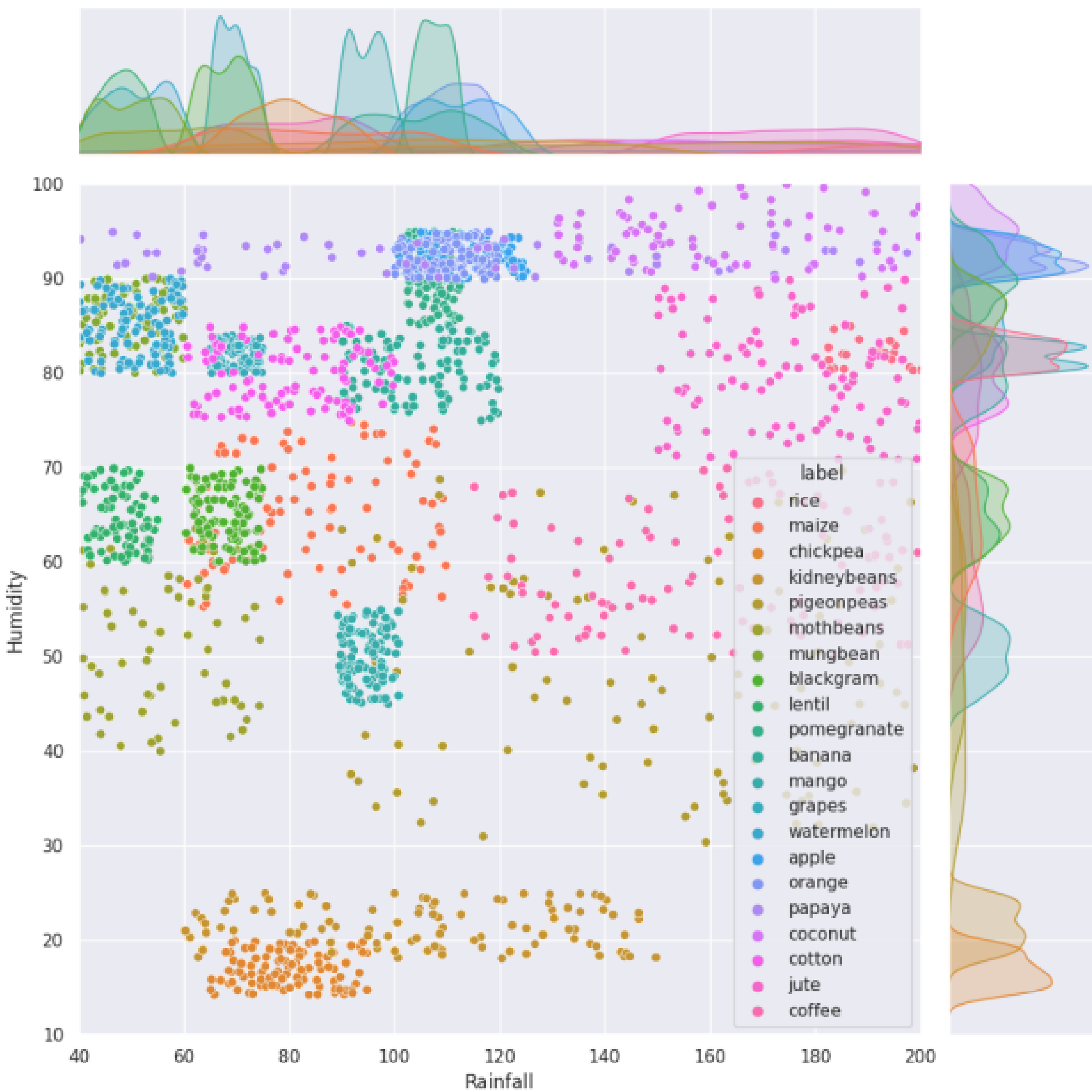
Descriptive statistics

```
df.describe()
```

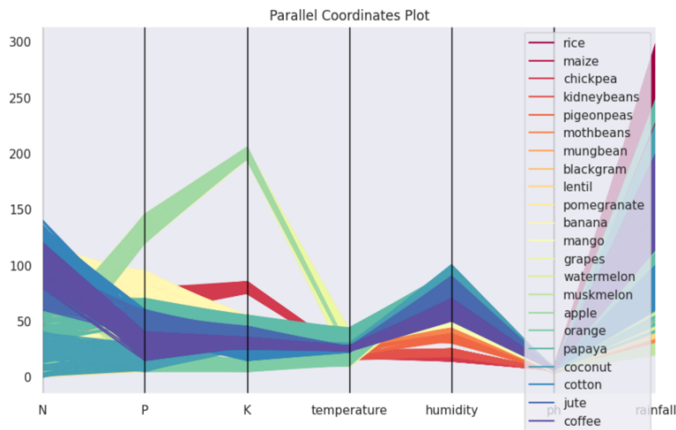
	N	P	K	temperature	humidity	ph	rainfall
count	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000	2200.000000
mean	50.551818	53.362727	48.149091	25.616244	71.481779	6.469480	103.463655
std	36.917334	32.985883	50.647931	5.063749	22.263812	0.773938	54.958389
min	0.000000	5.000000	5.000000	8.825675	14.258040	3.504752	20.211267
25%	21.000000	28.000000	20.000000	22.769375	60.261953	5.971693	64.551686

```python
import seaborn as sns

# Create joint plot
g = sns.jointplot(x="rainfall", y="humidity", data=df[(df['temperature']<40) &
                                                      (df['rainfall']>40)], height=10, hue="label")

# Set x-axis and y-axis limits
g.ax_joint.set_xlim(40, 200)
g.ax_joint.set_ylim(10, 100)

# Set axis labels
g.set_axis_labels('Rainfall', 'Humidity')
```

```
<seaborn.axisgrid.JointGrid at 0x7f4648202070>
```

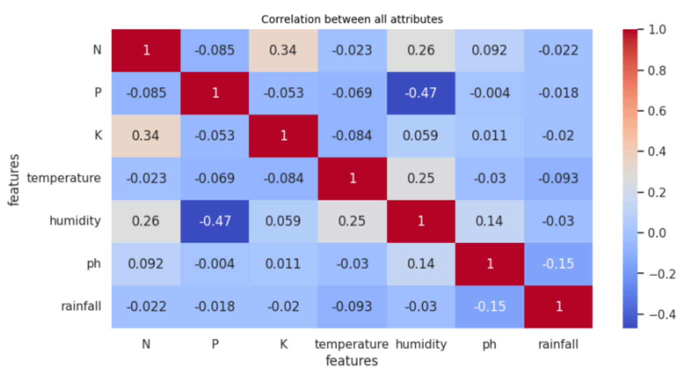


```python
from pandas.plotting import parallel_coordinates

df_temp=df.copy()
# Set the 'label' column as the class labels
class_labels = df_temp.pop('label')
df_temp['class'] = class_labels

# Plot the parallel coordinates plot
plt.figure(figsize=(10,6))
parallel_coordinates(df_temp, 'class', colormap=plt.get_cmap('Spectral'))
plt.title('Parallel Coordinates Plot')
plt.show()
```



Above parallel coordinates plot shows the relationship between the different attributes (columns) of our data, and how they relate to the class labels. The class labels are represented by different colors in the above plot. We can see how these values for each attribute change as we move from left to right along the plot, and also how they relate to the class labels.

Attributes that are similar or related to each other will have similar patterns in the plot, while attributes that are different or unrelated will have different patterns.




```python
corr_matrix = df_clean.corr()
corr_matrix
```

	N	P	K	temperature	humidity	ph	rainfall
N	1.000000	-0.084996	0.343172	-0.022925	0.263791	0.091578	-0.021797
P	-0.084996	1.000000	-0.052944	-0.068690	-0.470329	-0.003966	-0.017827
K	0.343172	-0.052944	1.000000	-0.084430	0.059263	0.010826	-0.020435
temperature	-0.022925	-0.068690	-0.084430	1.000000	0.247642	-0.030254	-0.093072
humidity	0.263791	-0.470329	0.059263	0.247642	1.000000	0.138226	-0.030023
ph	0.091578	-0.003966	0.010826	-0.030254	0.138226	1.000000	-0.152062
rainfall	-0.021797	-0.017827	-0.020435	-0.093072	-0.030023	-0.152062	1.000000

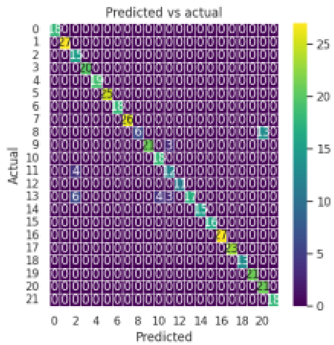
```python
least_corr_var = corr_matrix.abs().sum().idxmin()

print("The least correlated variable is:", least_corr_var)
```

```
The least correlated variable is: rainfall
```

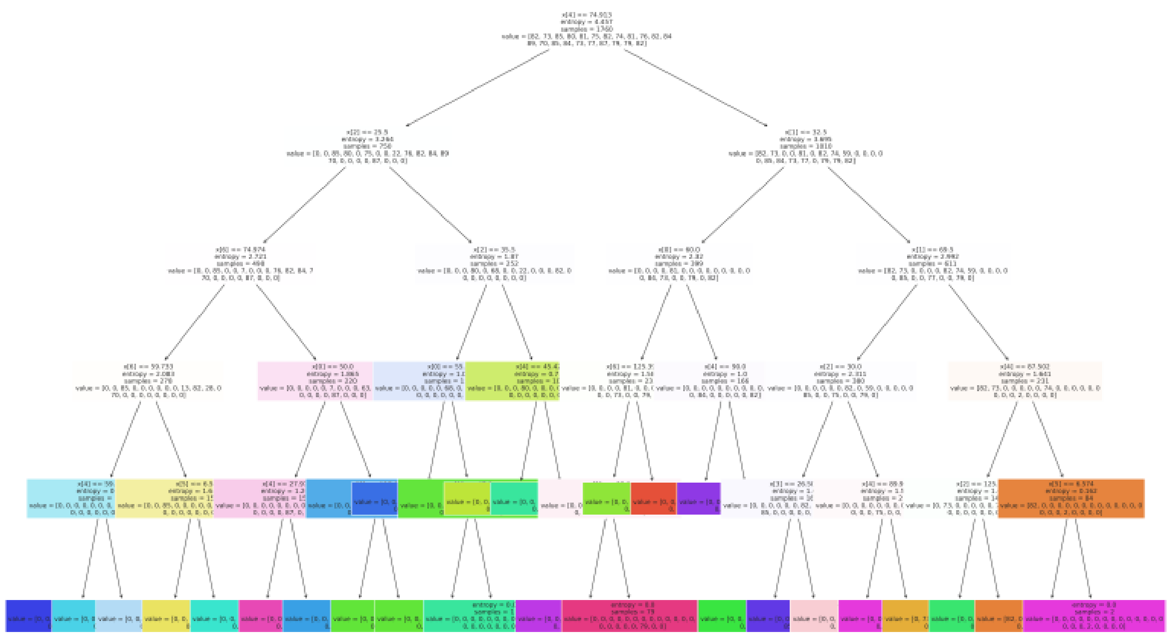
Looking at the above correlation matrix, we can see that:

- Nitrogen (N) and Potassium (K) have a moderate positive correlation (0.34).
- Phosphorous (P) and Rainfall have a weak negative correlation (-0.018).
- None of the variables have a strong correlation with each other.

Therefore, we can conclude that the variables are not highly correlated with each other, and each variable contributes unique information to the dataset.




```python
from sklearn.tree import plot_tree
import matplotlib.pyplot as plt


fig, axes = plt.subplots(figsize = (30,20), dpi=400)
plot_tree(DT, filled=True, fontsize=10)
plt.show()
```



7.0 Final Product Prototype

Based on the concept development scoring and selection process, the dashboard-based pricing tool was identified as the most promising concept for optimizing pricing in real time based on future market, weather, and other forecasts in agriculture. The final design of this tool would involve the following components:

- Data sources: The tool would collect and analyze data from various sources such as weather forecasts, market trends, historical data, and other relevant factors.
- Machine learning algorithms: The tool would use machine learning algorithms to analyze the data and generate real-time pricing recommendations for agricultural products based on market trends, weather patterns, and other relevant factors.
- Dashboard interface: The pricing recommendations would be presented in an easy-to-use dashboard interface that allows stakeholders to visualize the data and make informed decisions about pricing strategies.
- Scalability: The tool would be designed to accommodate different sizes and types of operations in agriculture and be able to adapt to changing market conditions.
-
- Security: The tool would prioritize data security and protect sensitive information about pricing strategies and market data.
- User-friendliness: The dashboard interface would be designed to be accessible to stakeholders with varying levels of technical expertise, allowing them to quickly and easily generate pricing recommendations.
- Cost-effectiveness: The tool would be designed to minimize costs while generating accurate pricing recommendations, ensuring a high return on investment for users.

Overall, the final design of the dashboard-based pricing tool would provide a user-friendly and scalable solution for optimizing pricing in real time based on future market, weather, and other forecasts in agriculture, ultimately helping farmers and other stakeholders make more informed and profitable pricing decisions.

7.1 How does it work?

The dashboard-based pricing tool works by analyzing data from various sources such as weather forecasts, market trends, historical data, and other relevant factors using machine learning algorithms. Based on this analysis, the tool generates real-time pricing recommendations for agricultural products that are presented in an easy-to-use dashboard interface.

To use the tool, the user inputs information about the product they want to price, such as the type of crop or livestock, location, and desired profit margin. The tool then collects and analyzes data from various sources to generate pricing recommendations. This data may include weather patterns, historical pricing trends, market conditions, and other relevant factors.

The machine learning algorithms used in the tool continuously learn and adapt to changing market conditions, ensuring that the pricing recommendations remain accurate and up-to-date. The tool also takes into account the user's desired profit margin and other constraints, such as production costs and market demand.

The dashboard interface presents the pricing recommendations in a clear and user-friendly format, allowing stakeholders to visualize the data and make informed decisions about pricing strategies. The tool can be customized to accommodate different sizes and types of operations in agriculture and is designed to be accessible to stakeholders with varying levels of technical expertise.

Overall, the dashboard-based pricing tool provides a scalable and user-friendly solution for optimizing pricing in real time based on future market, weather, and other forecasts in agriculture, ultimately helping farmers and other stakeholders make more informed and profitable pricing decisions.

7.2 How is it manufactured and assembled, and what does it cost?

The dashboard-based pricing tool is a software product that is developed and maintained by a team of software engineers and data scientists. The tool does not involve any physical manufacturing or assembly processes. The software is designed to be deployed on cloud infrastructure, which allows for scalability and cost-effectiveness.

The cost of the dashboard-based pricing tool would depend on various factors such as the number of users, the size of the operation, and the complexity of the pricing models. Pricing could be based on a subscription model, with users paying a monthly or annual fee based on the number of pricing recommendations generated or the level of access to additional features and data sources.

The cost of developing and maintaining the tool would include expenses such as salaries for software engineers and data scientists, cloud infrastructure costs, and other operational expenses. The total cost of the tool would depend on the scope of the project and the resources required to develop and maintain it.

Overall, the manufacturing and assembly of the dashboard-based pricing tool are largely focused on software development and cloud infrastructure deployment, with costs primarily driven by the complexity of the pricing models and the level of access to data sources and features.

7.4 Design validation through test results and operating experience

Design validation through test results and operating experience is an important step in ensuring the accuracy and effectiveness of the dashboard-based pricing tool. Before the tool is released to customers, it must undergo rigorous testing to validate its performance and functionality.

Test results can be used to validate the accuracy of the machine learning algorithms used in the tool. The tool should be tested using real-world data sets to ensure that it generates accurate pricing recommendations that are consistent with historical pricing trends and market conditions. This testing should include a variety of scenarios, including different crop types, geographical regions, and market conditions.

Operating experience is also important in validating the design of the tool. Customers who use the tool can provide feedback on its usability, accuracy, and effectiveness in improving their pricing strategies. Feedback can be collected through surveys, interviews, and usage data, and used to inform improvements and modifications to the tool over time.

Regular updates and maintenance to the tool can also help ensure its ongoing effectiveness. As market conditions and other factors change, the machine learning algorithms and data sources used in the tool must be updated to ensure that the pricing recommendations remain accurate and relevant.

Overall, design validation through test results and operating experience is an ongoing process that involves continuous testing, feedback, and updates to the tool to ensure its ongoing effectiveness and value to customers.

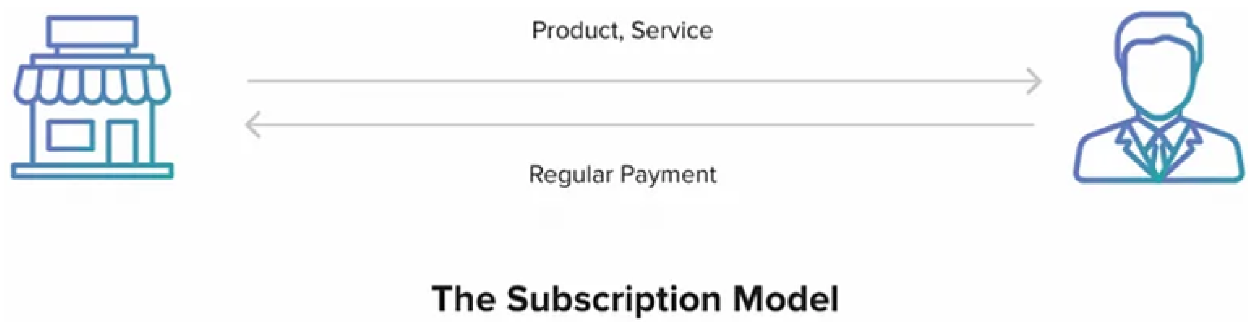
Figma Design :

[Figma UI]

8.0 Business Model :

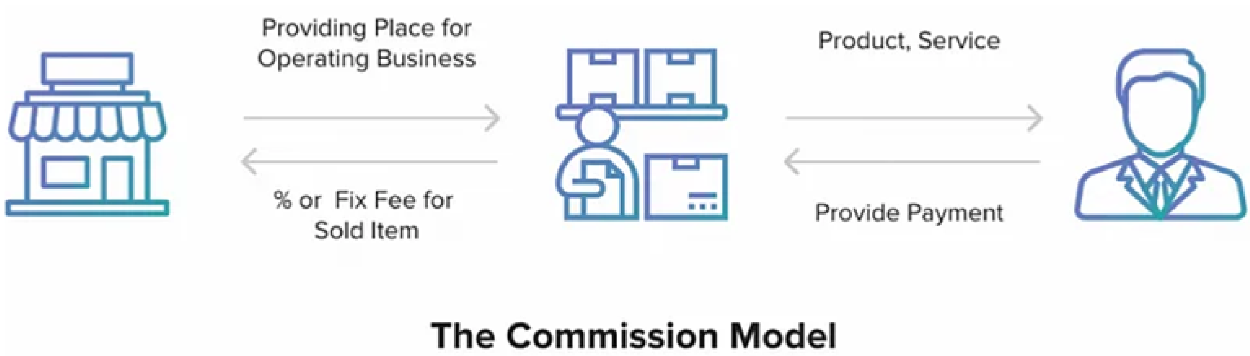
Based on different scenario and customer needs our business models can be classified as:-

- **Subscription-based model: -** It will offer a subscription-based pricing model for farmers, agricultural cooperatives, and commodity traders to access the platform. The subscription fees can be charged monthly or annually based on the level of service required by the customer.



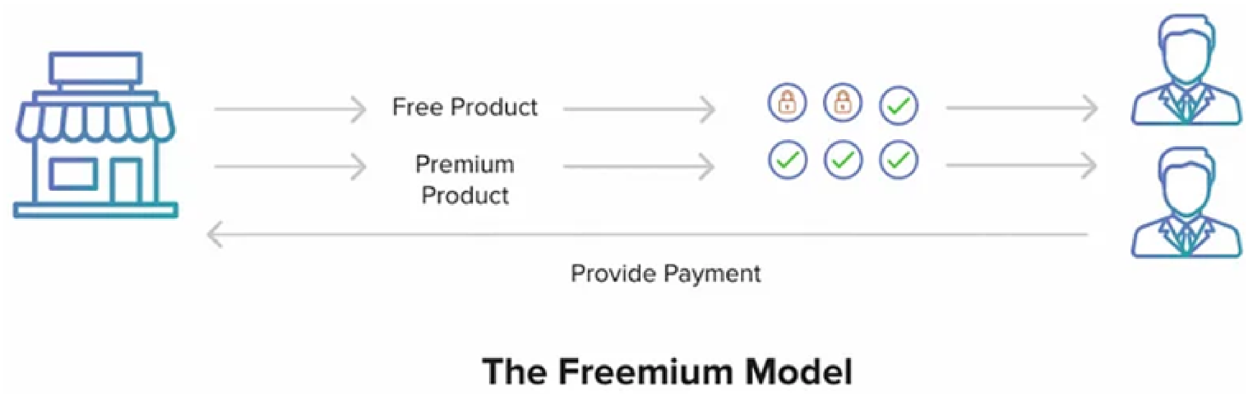
- **Pay-per-use model: -** For customers who do not require constant access to the platform, a pay-per-use pricing model can be offered. Customers can pay for the number of pricing recommendations they need or the number of data inputs they use.

- **Commission-based model: -** For commodity traders who want to use the platform to trade commodities, a commission-based pricing model can be offered. The platform can charge a commission fee based on the volume of trades made by the trader using the platform.



- **<u>Tiered pricing model: -</u>** Offer different tiers of service with varying levels of access to the platform's features and functionalities. Higher tiers can offer more personalized pricing recommendations and access to more data inputs.

- **<u>Freemium model: -</u>** Offer a basic version of the platform for free with limited data inputs and features. Customers can upgrade to a paid version for access to more data inputs and features.



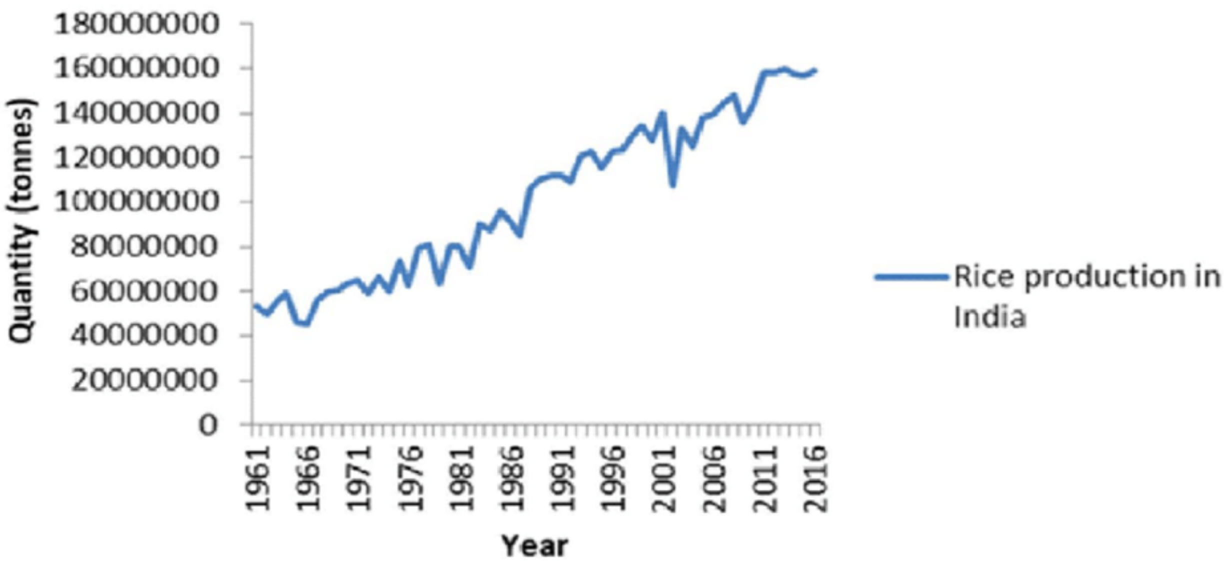
The step-by-step process involved in our product is listed below: -

- The first step is to identify the target customers who will benefit from this service. In this case, the target customers could be farmers, agricultural cooperatives, and commodity traders who want to optimize their pricing based on future market and weather forecasts.
- We will develop machine learning algorithms that can process real-time market and weather data and provide pricing recommendations based on the forecasted trends. The algorithms will need to be integrated into a technology platform that can be accessed by the target customers. The platform should be user-friendly, easy to navigate, and provide real-time updates on market and weather conditions.
- The service can be offered at different pricing tiers based on the level of service required by the customer. For example, a basic tier could provide access to the platform with limited data inputs, while a premium tier could offer more personalized recommendations and access to additional data sources.
- Customer support will be essential to ensure that customers are able to use the platform effectively and get the most out of the service. This could include providing training resources, offering technical support, and providing regular updates on new features and functionality.

- Finally, the service will need to be marketed effectively to reach the target customers. This could include online advertising, content marketing, and outreach to industry associations and trade publications.

9.0 Financial Model :

Agricultural land is very important for a country to survive. Based on the geographical location, many edible crops can be grown in their respective agricultural land. Based on the production, countries export those crops for profit. Rice is one of those crops that is easy to harvest, so it has been seen that Rice is one of the most popular crops grown on a large scale in Asian countries. Asian countries primarily consume rice in their daily meal. So agriculture of rice is a massive business in these countries. If we only talk about India, it is the second largest rice producer in the world. The rice which is grown here is mainly used in internal consumption. Very few quantities of high quality rice are exported to countries like the UK, USA and African countries. Let see the rice production growth in India from 1961 to 2016.



We can see that the growth year on year is linearly constant. So we can represent the graph in mathematical equation like

$$y = mx(t) - c$$

Here,

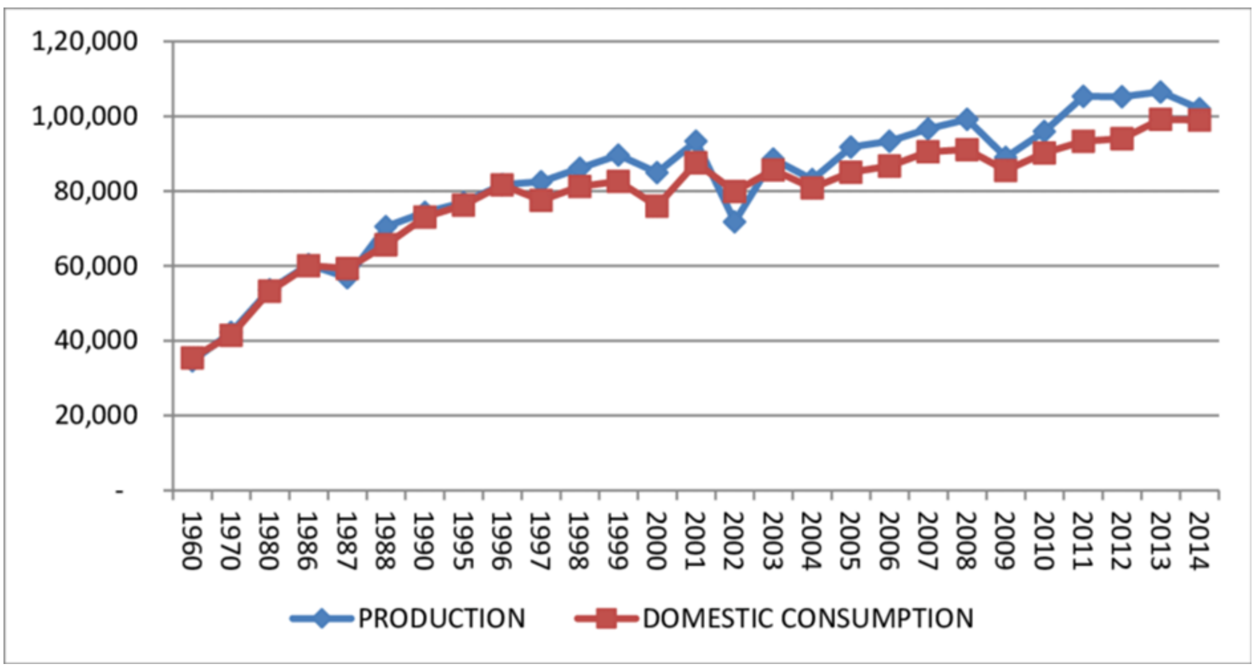
y= Total profit

m= Price of rice

x(t)= Total sale as a function of time

c= Total production & maintenance cost

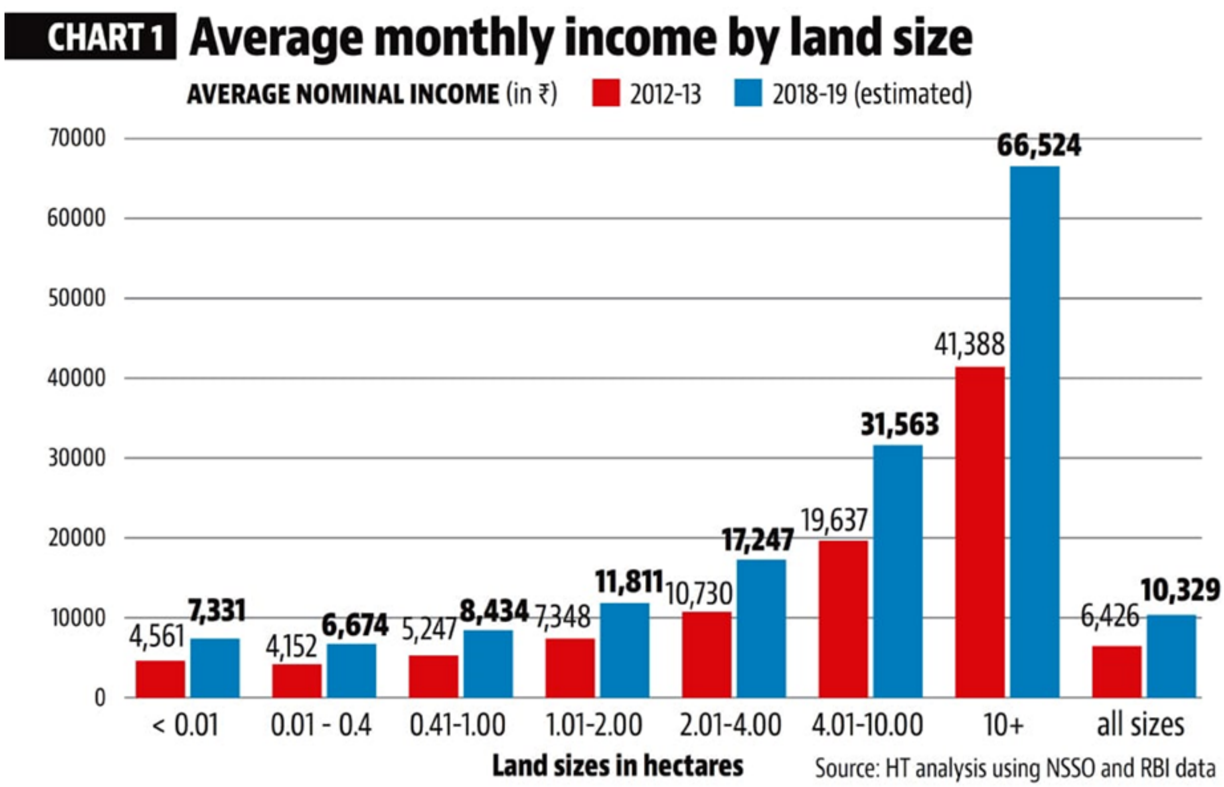
Rice production sector is very feasible and it has enormous potential to grow in the near future. But, the main obstruction is, due to India's large population, approximately 90% of ready to eat rice is consumed within India. Very rice quality e.g. Basmati rice is exported to foreign countries.



The statement about internal consumption is visualized in this graph. Government must emphasis the farmers to grow more cops by providing them adequate subsidy on land tax or water tax or by supplying cheap fertilizer. Also, the high quality rice requires some special treatment on land

and they need unique environment to grow. So the government must deal with geographical perspectives.

One of the main problems of agriculture in India is unavailability of sufficient land. There are many lands that can be used for agriculture purposes but negligence by local people and without proper government support, these lands are not used properly. Due to this farmers have very limited land to farm and live their lives. Whereas data shows that having a large land and proper government support can directly impact the farmers' land. Let’s visualize the statement through a graph.



Here we can see that year on year basis farmers' earnings are increasing. But the growth is directly linked with land size of the farmer. Here, based on the data, monthly income has an exponential growth pattern based on the land. So, govt. must emphasize to provide more land to the farmers. It will make the living standard of the country better and also it will bring a massive boost to the economy.

10.0 Conclusions

In conclusion, the dashboard-based pricing tool for agriculture has the potential to revolutionize the way farmers and agribusinesses price their products. By leveraging machine learning algorithms and data from a variety of sources, the tool can generate more accurate and data-driven pricing recommendations, which can help farmers and agribusinesses make more informed pricing decisions and ultimately improve their profitability.

The design and development of the tool require significant expertise in machine learning, data science, and software engineering, as well as an understanding of the agricultural industry and market conditions. Design validation through test results and operating experience is critical to ensuring the accuracy and effectiveness of the tool, and ongoing updates and maintenance are necessary to ensure that the tool remains relevant and useful over time.

While there are potential challenges and constraints in developing and deploying the dashboard-based pricing tool, such as the need for high-quality data and ongoing updates, the potential benefits of improved pricing strategies and increased profitability for farmers and agribusinesses make it a promising area for further research and development.

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