Crop Companion Application

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Abstract

The agriculture industry is increasingly embracing technology to improve crop management, boost productivity, and ensure sustainable farming practices. This article presents “The Crop Companion Application**”** personalized assistant to farmer community. It is a digital tool designed to assist farmers, agricultural enthusiasts, researchers and agriculture enterprises (input providers) in optimizing crop production through data-driven insights and precise recommendations.

The application aims to simplify the farming process by providing real-time information on crop selection, market price, soil conditions, pest management, irrigation practices, and weather forecasts. By leveraging advanced algorithms and integrating agricultural best practices, the app helps users make informed decisions about crop management, thus improving yields and reducing environmental impact. Additionally, it offers guidance on sustainable farming practices, enhancing long-term productivity and resource conservation. This report outlines the development process, key features, technical architecture, and challenges faced during the implementation of the app, as well as its potential impact on modern agricultural practices. The application ultimately seeks to empower users with the tools necessary to adopt smarter, more sustainable farming techniques.

1.0 Problem Statement

Farmers face numerous challenges in modern agriculture, including unpredictable weather patterns, soil health issues, pest outbreaks, and the need for sustainable resource management. Due to the lack of awareness of farmers can lead subsequent significant challenges:

• **Unpredictable Environmental Factors**: Farmers face challenges such as unpredictable weather patterns, droughts, floods, and changing climate conditions, which affect crop yields and farming efficiency.

• **Pest and Disease Management**: Effective pest control and disease management remain complex for farmers, leading to crop damage and increased use of pesticides, which can harm the environment.

• **Soil Health and Fertility**: Degrading soil quality and insufficient knowledge about soil health leads to lower crop productivity and the overuse of fertilizers, which negatively impact the ecosystem.

• **Lack of Real-Time Decision Support**: Traditional farming practices often lack access to timely, data-driven insights, making it difficult for farmers to make informed decisions about planting, irrigation, and pest control.

• **Sustainability and Resource Efficiency**: There is an urgent need for sustainable farming methods that reduce resource waste (e.g., water, fertilizers) and lower the environmental impact of agriculture.

• **Access to Knowledge and Expertise**: Small-scale farmers, in particular, lack access to expert agricultural advice and may struggle to keep up with the latest advancements in farming technology and techniques**.** Unawareness towards government programs and subsidies also happens due to inaccessibility to information.

- **Lack of access to modern machineries and agricultural equipment:** As every farmer not aware about latest advancements in machineries and tools which is making them labour hard.

In brief, to reach each and every farmer especially small-landholders this application will act as a platform from where they can be informed, guided and advised. It will establish a mutually beneficial relationship between farmer community and agriculture enterprises through the implementation of innovative solution that utilises artificial intelligence to address these obstacles.

2.0 Customer/Business Model Assessment:

2.1 Target Audience Identification

- **Farmers:** Small, medium, and large-scale farmers seeking tools to improve crop management, yields, and sustainability.
- **Agricultural Advisors/Experts:** Professionals offering consultation services who require a platform to deliver tailored recommendations to farmers.
- **Researchers and Agronomists:** Individuals interested in monitoring crop performance and analysing trends across various agricultural regions.
- **Agricultural Enterprises:** Companies offering farming equipment, fertilizers, or seeds, looking to integrate their products into the app ecosystem for a more personalized user experience.

2.2 Customer Relationships

1. Support: Dedicated customer support team to assist farmers and agricultural experts with the application.

2. Training: Regular training sessions and workshops to educate farmers and agricultural experts on the application's features and benefits.

3. Feedback Mechanism: A feedback mechanism to collect user feedback and improve the application.

2.3 Revenue Streams

- **Freemium Model with Premium services:**

Crop Companion Application can provide free service as basic features like weather forecasting etc. Monthly/Yearly subscription can be provided for premium features.

- **Advertising:**

Targeted ads from agricultural companies, input providers, and equipment manufacturers. Cost-per-click (CPC) or cost-per-thousand impressions (CPM) pricing.

- **Data Analytics:**

Selling anonymized and aggregated data insights to agricultural institutions, research organizations, and government agencies. Customized data reports and consulting services.

- **Commission-based Services:**

Partnering with input providers (seeds, fertilizers etc.) for commission-based sales. Integrating payment gateways for transaction fees.

- **Premium Services:**

Customized advisory services for large-scale farmers and agricultural enterprises. Integration with precision agriculture tools and drones.

2.4 Key Resources

1. Development Team: A team of experienced developers, designers, and agricultural experts to develop and maintain the application.

2. Data Partnerships: Partnerships with weather services, soil testing laboratories, and other data providers to access high-quality data.

3. Server Infrastructure: A scalable server infrastructure to support a large user base and handle large amounts of data.

2.5 Success Metrics

- **User Engagement:**

Tracking active users, retention rates, and frequency of app usage (daily, weekly).

- **Customer Satisfaction:** Gathering feedback through surveys, app reviews, and direct communication to assess the quality of the app's recommendations and usability.
- **Impact on Yields:**

Monitoring if users report improvements in crop yields, resource efficiency, or sustainability practices due to using the app.

3.0 Benchmarking alternate Products:

Benchmarking is important to understand the competition and find ways for "Crop Companion application" to stand out. The analysis involves comparing products in market that offer weather forecasting, soil health analysis, experts advice and free or freemium services to farmers. The benchmarking process uncovers important aspects, advantages and possible shortcomings in already available products.

1. FarmGuide

Pros: Simple, user-friendly interface and freemium model make it accessible to medium-scale farmers.
Cons: Limited features and lack of personalized advice.

2. Kisan Suvidha

Pros: Free, government-backed, and widely available, making it a popular choice for all farmers.
Cons: Limited features, outdated interface, and lack of personalized advice.

3. MPOWER

Pros: Advanced analytics, financial integration, and high revenue growth potential make it suitable for large-scale farmers.
Cons: Complex interface, high pricing, and limited accessibility.

4. AgroStar

Pros: Modern interface, low customer acquisition cost, and high revenue growth make it attractive to young, tech-savvy farmers.
Cons: Limited features, limited scalability, and high dependency on internet connectivity.

5. CropIn

Pros: Professional features, customizable interface, and high customer lifetime value make it ideal for agricultural enterprises.
Cons: High pricing, complex interface, and limited accessibility.

"Crop Companion application" can differentiate itself by providing a comprehensive approach that combines general features, personalized recommendations and experts' advice.

4.0 External search

A complete external search was done to obtain insights and knowledge for "Crop Companion Application" development and placement in the precision farming and sustainable practices. Online sources, academic journal, market reports, and industrial databases were thoroughly researched. The purpose was to investigate regional soil condition , technology, trends, regional climatic conditions, farmer's behaviour and potential challenges.

4.1 Online Resources:

- Scientific Journals: Overview of current research on precision farming, machine learning and artificial intelligence in agriculture, and technology's impact on farming practices.
- Exploring farming Platforms and news channel: We examined blogs, forums, and expert opinions to understand farming community viewpoints, concerns, and preferences.

4.2 Academic Publications:

- **Agriculture Sciences Journals**: Research papers explore nutritional deficiencies in soil, regional climatic conditions, and technology in dealing with farming.
- **Cropping pattern Studies**: Studies on soil, particularly in nutrient availability and deficiencies for particular crop, need of operational machineries and preferences of farmers for cropping patterns.

4.3 Market reports:

- Market publications on the Agriculture Enterprises: These publications provide a broad overview of trends, challenges, and opportunities, such as the need for precision farming, personalized recommendations and expert advice.

5. Applicable patents:

- Found patents related to crop monitoring and management system, agriculture decision support systems, precision agriculture, Agricultural data analytics, agricultural e-commerce platforms and agricultural knowledge sharing platforms.
- Ensuring compatibility with current developments while adding novel features.
- Risk reduction through innovation promotion and infringement avoidance.

6. Applicable Regulations:

Respect for user privacy through adherence to data privacy laws (such as Information Technology Act 2000(India), General Data Protection Regulation (European Union), and International organisation for Standardization (ISO).

- Compliance with Ministry of Agriculture and Farmers Welfare and Ministry of Electronics and Information Technology to ensure accurate data.
- Clear guidelines for data processing and user permission.
- Creating a thorough structure for regulatory compliance.

7.Business Opportunities

A Crop Companion Application offers numerous business opportunities. It can generate revenue through subscription-based models, advertising, and sponsored content. Data analytics services, e-commerce integration can also provide additional income streams. Partnerships with agricultural institutions, supply chain management can further enhance revenue. Moreover, precision agriculture services, market research and insights can provide additional business opportunities. By leveraging these opportunities, a Crop Companion Application can create a sustainable business model and drive growth.

8. Concept Generation

In all states thousands of various size group farmers indulge in agriculture and allied activities. There is a lot that machine learning and artificial intelligence can do for agricultural field and the opportunities are limitless here. Crop Companion Application involves identifying the target audience, researching market trends and user needs, and using ideation techniques like brainstorming and mind mapping. This process yields innovative concepts, such as crop monitoring, farm management, marketplace, decision support, and education and training. Feasibility analysis, user feedback, and prioritization refine and iterate on these concepts, ensuring the development of a user-centric and impactful application that addresses the needs of farmers and agricultural businesses.

Operating Plan: The important part of our operation is to have ML/DS engineers with a good amount of knowledge about the industry. The product developing team's size should be 3 to 4 where one of the members must be a full stack web developer and the remaining members must be ML engineers. It would be beneficial if almost all of the ML engineers had knowledge about the industry. The services should be included after discussing with all members of team. When we start providing this service, we have to set a low price to increase affordability and reach of this app's services. Once we have successfully implemented and launched application. Later on we can update the features as per market and technologies coming in and can update pricing also for our services.

Code Implementation (Small Scale)

GitHub link: pinkisharma07/Crop_companion_application_project

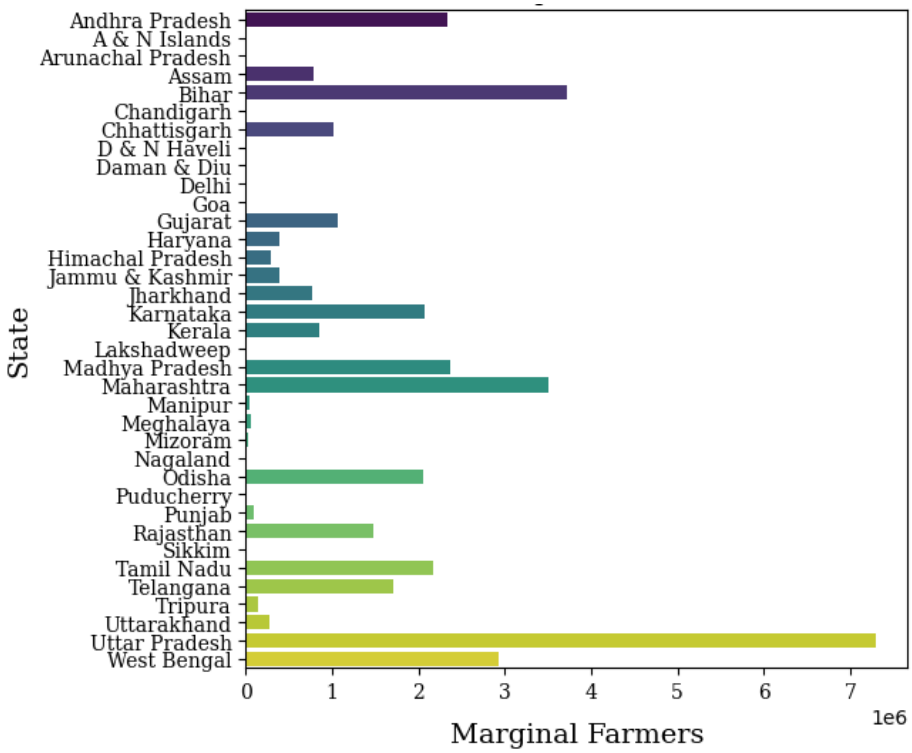
Data Visualization and Exploratory data analysis(EDA) was done on datasets related to farmers. Imported required dependencies for EDA and data visualisation.

State wise analysis of all size group marginal, small, medium, semi-medium and large farmers was done.

```
# importing the dependencies
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
from sklearn.cluster import KMeans
```

The features in the dataset are not correlated so there is no need to remove any feature.

```
# Data visualisation of statewise different size group of farmers
plt.figure(figsize=(6,6))
sns.barplot(data=df1, y= df1['State'].sort_values(ascending=True), x='Marginal', hue='State',palette='viridis' )
plt.ylabel('State', fontsize=14, family='serif')
plt.xlabel('Marginal Farmers', family='serif', fontsize=14, labelpad=10)
plt.xticks(family='serif')
plt.yticks(family='serif')
plt.title(label='statewise Marginal Farmers in India', weight=200, family='serif, size=15, pad=12')
plt.show()
```




```
# Data visualisation of statewise different size group of farmers
plt.figure(figsize=(6,6))
sns.barplot(data=df1, y= df1['State'].sort_values(ascending=True), x='Small', hue='State',palette='viridis' )
plt.ylabel('State', fontsize=14, family='serif')
plt.xlabel('Small Farmers', family='serif', fontsize=14, labelpad=10)
plt.xticks(family='serif')
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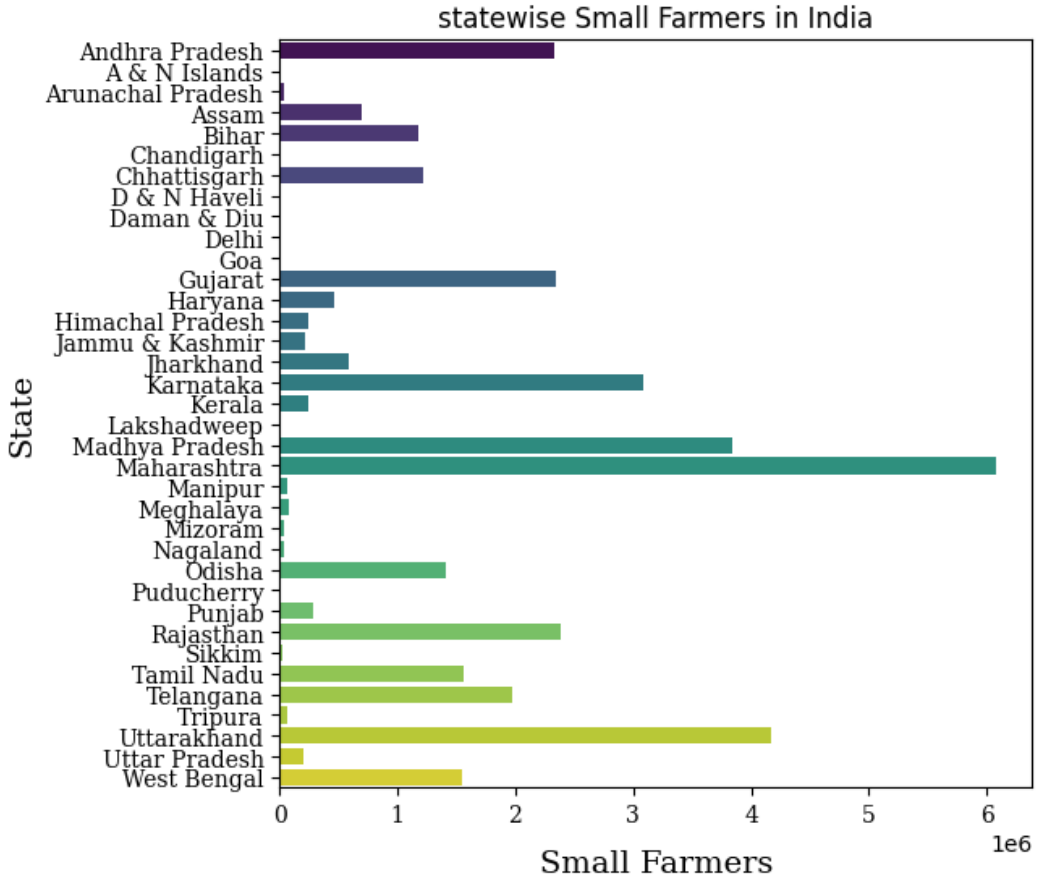
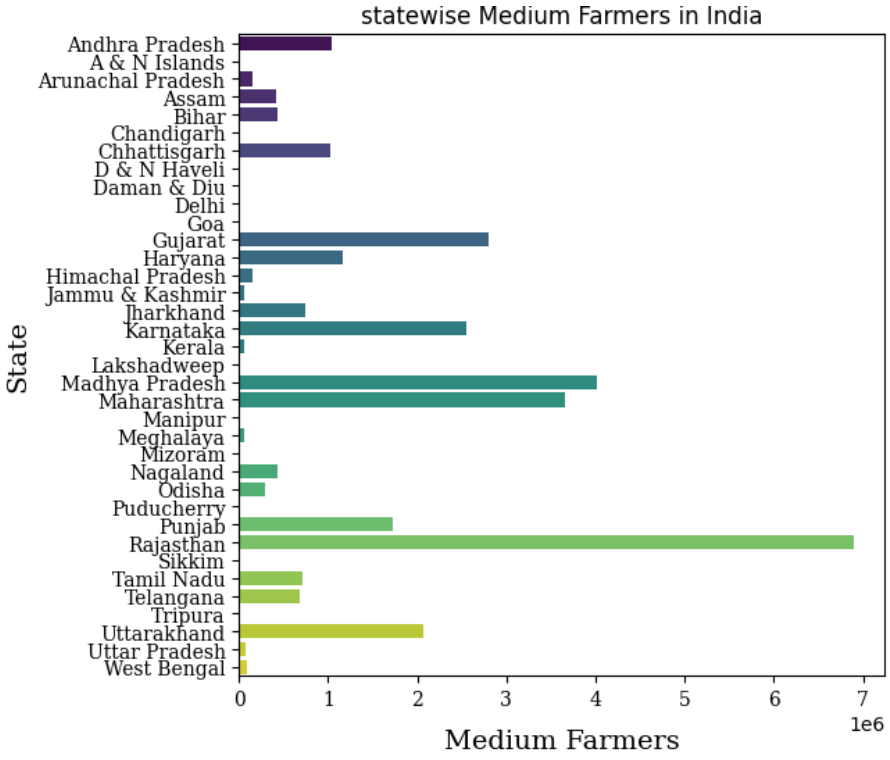
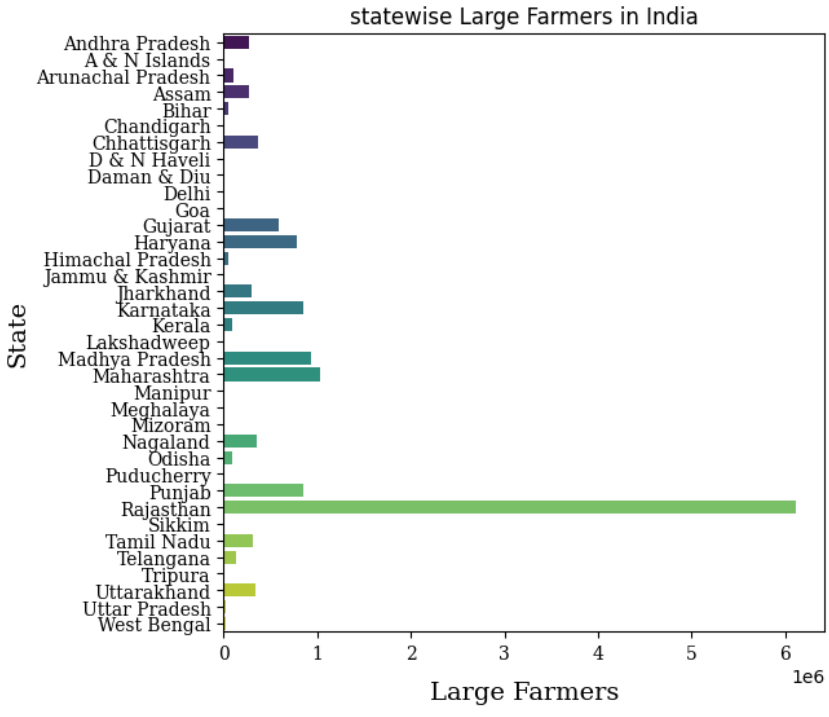



```
# Data visualisation of statewise different size group of farmers
plt.figure(figsize=(6,6))
sns.barplot(data=df1, y= df1['State'].sort_values(ascending=True), x='Medium', hue='State',palette='viridis' )
plt.ylabel('State', fontsize=14, family='serif')
plt.xlabel('Medium Farmers', family='serif', fontsize=14, labelpad=10)
plt.xticks(family='serif')
plt.yticks(family='serif')
plt.title(label='statewise Medium Farmers in India', weight=200, family='serif, size=15, pad=12')
plt.show()
```




```
# Data visualisation of statewise different size group of farmers
plt.figure(figsize=(6,6))
sns.barplot(data=df1, y= df1['State'].sort_values(ascending=True), x='Large', hue='State',palette='viridis' )
plt.ylabel('State', fontsize=14, family='serif')
plt.xlabel('Large Farmers', family='serif', fontsize=14, labelpad=10)
plt.xticks(family='serif')
plt.yticks(family='serif')
plt.title(label='statewise Large Farmers in India', weight=200, family='serif, size=15, pad=12')
plt.show()
```



```
# selecting features for building a model
X = df1[['Marginal','Small','Semi-Medium','Medium','Large']]
```

```
# feature scaling
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
```

```
# applying Principle Component Analysis (PCA)
pca = PCA(n_components=5)
X_pca = pca.fit_transform(X_scaled)
df_pca = pd.DataFrame(X_pca, columns=['PC1', 'PC2', 'PC3', 'PC4', 'PC5'])
df_pca.head()
```

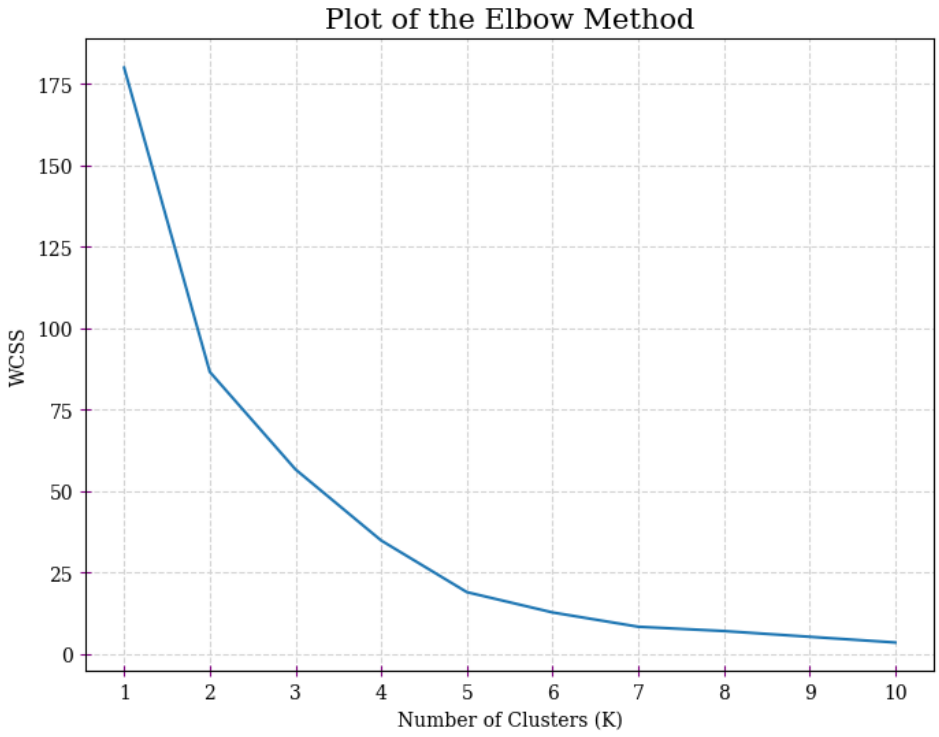
	PC1	PC2	PC3	PC4	PC5
0	1.026351	0.968389	-0.194101	-0.169057	0.058225
1	-1.341664	-0.400821	-0.107401	0.001342	0.000143
2	-1.212694	-0.468071	-0.065591	0.014760	-0.006443
3	-0.439465	-0.060037	-0.034916	-0.061658	0.119595
4	0.216626	1.623455	0.817468	0.028474	0.070563

```
# plotting the results of Elbow

wcss = []

for i in range(1, 11):
  kmean = KMeans(n_clusters=i, init='k-means++', random_state=90)
  kmean.fit(X_pca)
  wcss.append(kmean.inertia_)

plt.figure(figsize=(8,6))
plt.title('Plot of the Elbow Method', size=15, family='serif')
plt.plot(range(1, 11), wcss)
plt.xticks(range(1, 11), family='serif')
plt.yticks(family='serif')
plt.xlabel('Number of Clusters (K)', family='serif')
plt.ylabel('WCSS', family='serif')
plt.grid()
plt.tick_params(axis='both', direction='inout', length=6, color='purple', grid_color='lightgray', grid_linestyle='--')
plt.show()
```



Modelling of datasets taken from agricultural survey and census for various size group of farmers.

Source: Government of India Ministry of Agriculture & Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare, Directorate of Economics and Statistics

Financial Equation Modelling

Financial equation calculates the profit generated from the product or service. Crop Companion application which will be Mobile-based application which will be based on revenue from freemium based services, advertisements and commission from input providers. Cost structure includes cost of development, server and infrastructure cost, Personnel cost and marketing cost.

Suppose cost of premium services per unit = Rs.400

Number of services sold per month = 1000 units

Advertisement charges per unit = Rs.10

Number of advertisements done per month = 1000

Total Revenue = product/service unit cost * total number of sales - cost to produce

Cost of running and updating application per month = Rs.15000

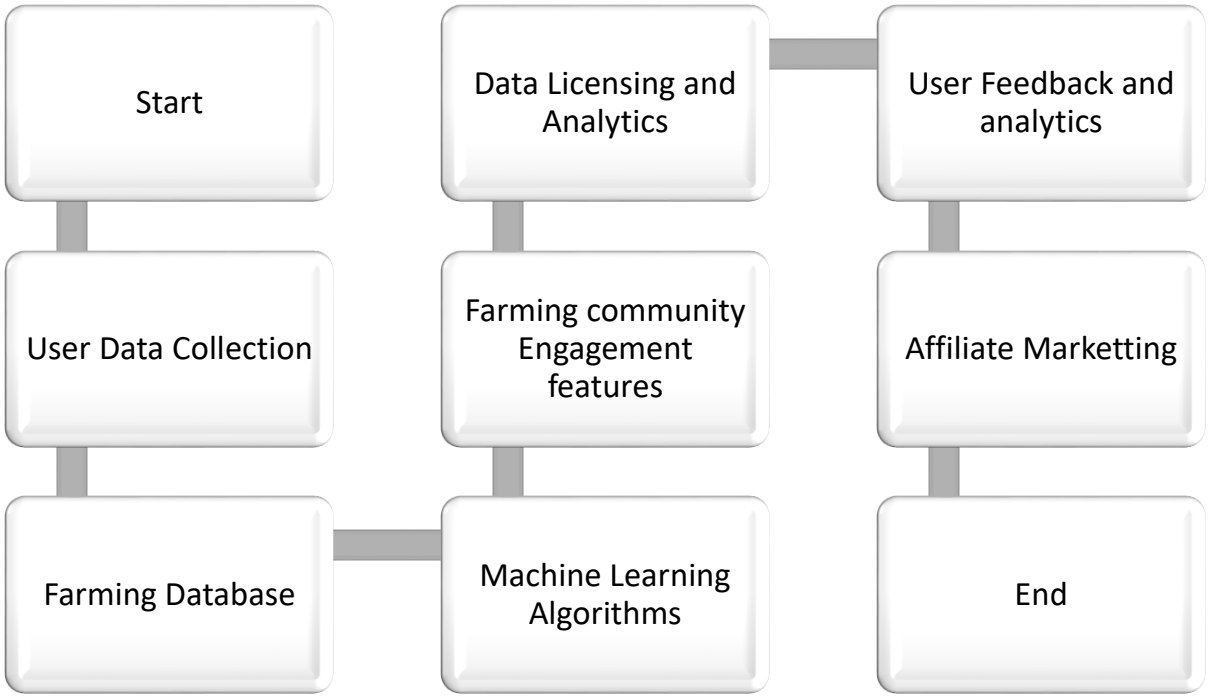
Calculating Revenue for a month (Example: month of June)

Total Revenue = 400*1000 + 10*1000 – 10000 = 400000+10000 – 15000 = Rs.395000

So, Financial Equation for the Crop Companion Application Services will be considering x as number of services, y number of advertisements done:

400x(t) + 10y(t) -15000

x(t), y(t) are shows growing customer base with time. So, the financial equation is function of services and advertisements provided.



Flow chart for Crop Companion Application Development

Conclusion:

Agriculture contributes almost 17% to Indian economy and gives employment to almost 58% of workforce. Therefore, agriculture has to go hand in hand with technologies especially artificial intelligence and machine learning to reach each and every farmer.

The Crop Companion Application integrates cutting-edge technologies to enhance agricultural practices, improve farmer livelihoods, and contribute to precision farming. Monetization opportunities exist through subscription-based services, data analytics sales, and strategic partnerships. Future development will focus on expansion, integration, and security enhancements to drive scalability and revenue growth.