Developing an Agricultural AI-Powered App for Optimizing Crop Management and Enhancing Farmer Decision-Making: A Comprehensive Business Model and Implementation Strategy

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Abstract

In this report, I proposed how to use Machine Learning to increase profit of both farmers and fertilizer shop owners and also connects farmers with various local or national food processing companies. I used precision farming, a scientific methodology which helps to increase crops yield up to optimal level, which suggest how data analysis and AI can helps farmers and vendors of agricultural products maximize their profit.

1.0 Problem Statement

We know agriculture is backbone of our country and it provide two third of population depends on agriculture business for their livelihood and this sector accounts for 19% of India's GDP. In 1960s our country saw how technology in agriculture makes our country from net importer to net exporter within in less than 20years.But again as our population growing rapidly and lack of adaptation of modern technology and low income of farmers again alerting us. The problem lies in the inefficiency of small to medium-sized farmers due to inadequate access to real-time soil information, weather forecasts, and market connections. This hampers decision-making in fertilizer use, irrigation scheduling, weed control, and market sales. By leveraging AI, drones, and partnerships with government-subsidized providers and small to medium-sized food processors, our solution aims to empower farmers with timely data and personalized recommendations. This will optimize farming practices, boost crop yields, improve market access, and mitigate risks associated with weather and market variability.

2. ASSESEMENT

2.1) CUSTOMER NEED

1.) Soil Health: - As per 2018 document of National Academy of Agriculture Sciences (NAAS) showed that, due to bad health of soil, India is to lose 13.4 million tonnes of production annually, which is worth Rs. 205.32 billion and the 2019–2020 Soil Health Survey by the central government found that 55% of India's soil is deficient in nitrogen, 42% in phosphorus, and 44% in organic carbon. Factors like Drought or Water Shortage, Floods, Over-Farming, Infrequent crop rotation etc. makes soil lack of micronutrients which leads to reduction in crop yield. And due to insufficiency in lab testing of soil, farmers need new age technology which helps them to get corrects data to their soil health so they can use necessary amount of fertilizer in their field.

2.) Weeds: - As per Indian Council of Agriculture Research (ICAR) report, they estimated and suggested that weeds in India reduce crop yields by 31.5% (22.7% in winter and 36.5% in summer and Kharif seasons). In that

report it also shows some crop yield even reduces to 100%. After taking to some farmers, I found that it is very time-consuming process to identify weeds on the plant and for small and medium it is expensive for them to rent a highly sophistic drone which identify weeds and spray pesticide there. They only want that some technology helps them to identify weed's location they use pesticide only there.

3.) Weather Variations: As we know climate change has now start showing its effects on human activities and its worst effects is seen on Indian agriculture sector as more than 55% of population still depends on monsoon rain. So, alteration in monsoon pattern leads to sever condition like flood or drought in country, even if they have good irrigation system available but still temperature variation cause devastating effects. One agriculture student told that if you take for example cultivation of brinjal, which survive and produce good % of yield if mean temperature remains 17-21 degree Celsius and if temperature dip down below 15 degree its production severely affected. So, if somehow farmers can predict what should be the weather pattern be respective seasons, they can make plan according to save them from loses.

4.) Lack of Technical Knowledge: - This is the most important factor that plays a major role in poor condition of small and medium famers. Farmers may struggle to optimize crop yields due to insufficient understanding of modern farming techniques, soil health management, and pest control methods. Inadequate knowledge of irrigation practices and crop rotation can lead to water wastage and soil degradation. Without access to information on sustainable farming practices and emerging technologies, farmers may be unable to adapt to changing environmental conditions or market demands.

3.) Target Specification

The proposed model/service provide farmer and agriculture vendors to understand market demand, environment conditions which helps farmers to make a good plan so that they can increase their profitability and reduces their unnecessary workload so they can focus on more other important things. It Connects them with various fertilizers and pesticides vendors and also with local food processing industries.

4.0) External Search

To understand how use of Machine Learning in agriculture and important data I use following references

- ICAR
- Soil Health
- Precision-Farming
- Machine Learning For Agriculture
- Machine Learning Application in Agriculture

5.0) Benchmark

In benchmarking against a competitor, it's essential to underscore our unique approach. While our competitors, like Bharatrohan , develops proprietary drone technology, we leverage partnerships with government-subsidized drone providers, optimizing costs. Furthermore, while they collaborate with big-brand food processors, we target small to medium-sized food processing industries, maximizing market reach and fostering community growth. This strategic approach ensures scalability and accessibility, setting us apart in the market.

6.0) Applicable Regulations

- Data Privacy Regulations
- The Kisan Drone Scheme
- Drone Law
- The Fertilizer (Control) Order (FCO)

7.0) Applicable Constrain

- Budget Constraints
- Technical Expertise
- Data Privacy and Security Regulations
- Infrastructure Limitations
- User Adoption and Behaviour:

8.0) Business Opportunity

8.1) Drone Rental Fees and Facilitation for FPOs:

- Farmers can rent drones equipped with specialized sensors and cameras for soil nutrient analysis and weed detection. We charge a rental fee for accessing this service. Additionally, we facilitate access to drones for FPOs (Farmer Producer Organization), which are eligible for a 75% subsidy on drone rentals. By serving as a bridge between FPOs and farmers, we streamline the process of accessing affordable drone services while ensuring a steady stream of revenue.

8.2) Commission from Partnerships:

- We collaborate with pesticide and fertilizer vendors, connecting them with farmers through the app. We earn a commission on sales made through these partnerships, incentivizing vendor participation and driving revenue.

8.3) Subscription Model:

- The app operates on a subscription-based model, offering different tiers of subscriptions with varying features and benefits. Users pay a recurring subscription fee to access premium features such as advanced data analytics and personalized recommendations.

8.4) Partnerships with Food Processing Industries:

- We partner with small to medium-sized food processing industries, facilitating connections between farmers and buyers through the app. We earn a commission on transactions made between farmers and food processors, expanding our revenue sources.

8.5) Crop Insurance Collaborations:

- We collaborate with crop insurance companies to offer insurance policies tailored to farmers' needs. We earn a commission for each policy sold through the app, providing farmers with valuable risk management solutions while generating additional revenue for our business.

9.0) Concept Generation:

In our agricultural AI-powered app, we focus on integrating drone technology for soil nutrient analysis and weed detection, complemented by real-time weather forecasting. Drones equipped with specialized sensors capture high-resolution aerial imagery of crop fields, facilitating soil nutrient mapping and weed identification. Machine learning algorithms analyse this data to offer farmers actionable insights into soil health, optimizing fertilizer application and soil management. Simultaneously, the app provides real-time weather forecasting, empowering farmers to make informed decisions based on current and predictive weather conditions. By integrating weather data like temperature, precipitation, humidity, and wind speed, farmers can plan activities, irrigation schedules, and pest management strategies effectively, reducing the impact of adverse weather on crop yields. Through this multifaceted approach, our app aims to provide farmers with a comprehensive toolkit to optimize production, enhance sustainability, and mitigate risks associated with weather variability and weed infestations.

10.0) Concept Development:

1) Key Features and Functionalities: Identify and list the core features and functionalities that the app will offer, such as soil nutrient analysis, weed detection, and real-time weather forecasting.

2) Design User Interface and Experience (UI/UX): Develop wireframes and mockups for the user interface, ensuring intuitive navigation and user-friendly design. Consider the user experience (UX) to ensure that farmers of varying technical proficiency can easily use the app.

3) Specify Data Sources and Algorithms: Determine the data sources required for soil nutrient analysis, weed detection, and weather forecasting, such as soil samples, drone imagery, and weather APIs. ML algorithms (mainly Random Forest (RF), K-nearest neighbour (KNN) and support vector machine (SVM)) for fertilizer quantity prediction and for weed prediction we can use SVM classifier, KNN classifier.

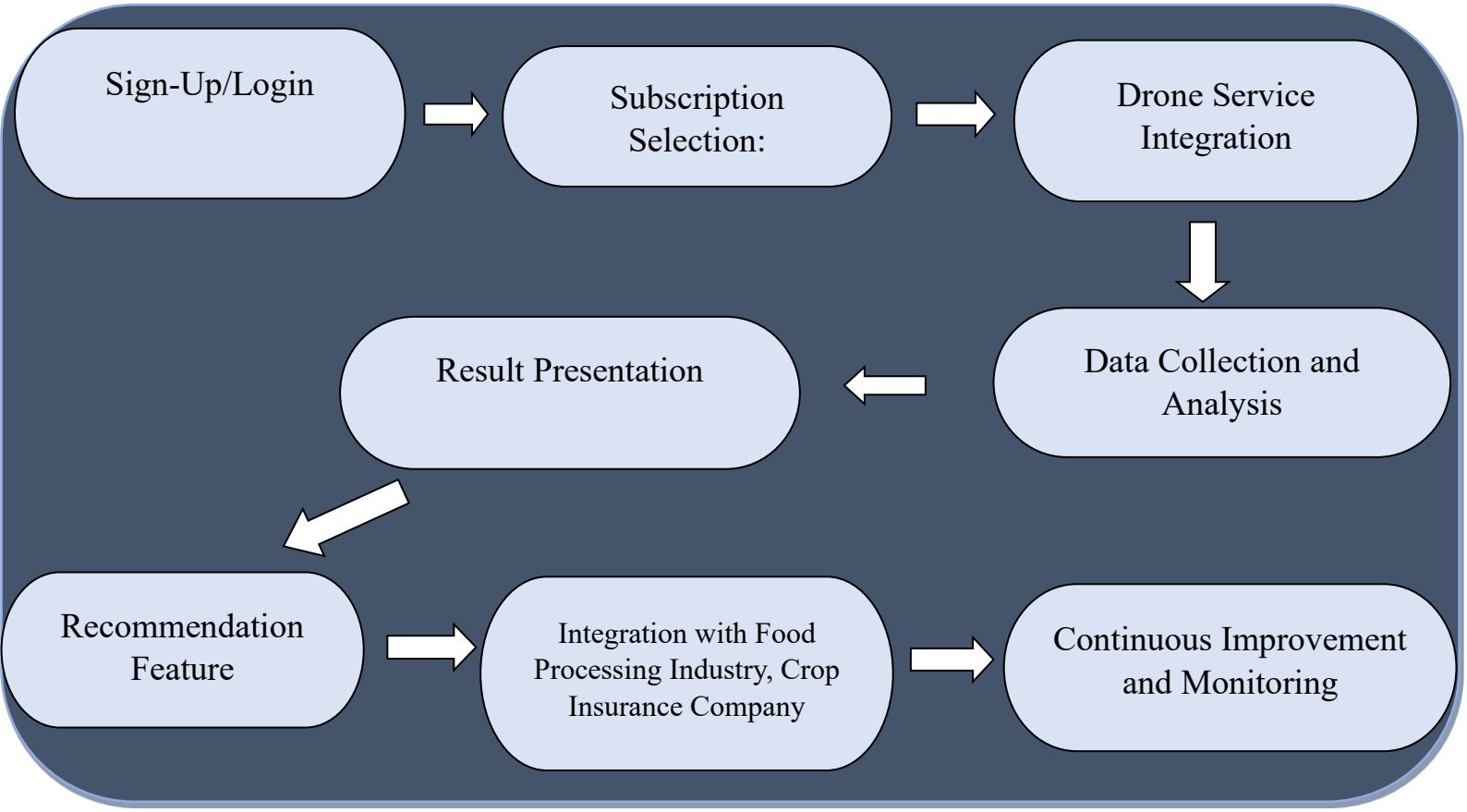
4) Outline Technology Stack and Infrastructure: Define the technology stack needed for app development, including programming languages, frameworks, and databases. Consider scalability and performance requirements to support the app's functionality and user base.

5) Identify Potential Partnerships and Collaborations: Explore partnerships with state agriculture institute and various FPO, weather data APIs, and agricultural experts to leverage expertise and resources. Establish collaboration agreements and communication channels to facilitate knowledge sharing and coordination.

6) Plan User Testing and Validation: Conduct user testing with farmers and stakeholders to gather

7) Iterate and Refine: Use feedback from user testing to iterate and refine the app's features, interface, and functionality. Continuously improve the app through iterative development cycles, incorporating user feedback and addressing any issues or challenges encountered.

11.0) Final Product Prototype (abstract) with Schematic Diagram



12.0) Product Details

1) Signup
    - New users sign up for an account by providing necessary details such as name, location, email, and password.
    - Existing users log in using their credentials.
2) Subscription Selection
    - Upon successful login, users are prompted to choose a subscription plan.
    - They are presented with different subscription tiers offering various features and benefits.
    - Users select their desired subscription model based on their needs and preferences.
    - User also provide which crop he wants to cultivate.
3) Drone Service Integration
    - After selecting a subscription plan, users can access the drone service for field analysis.
    - Users initiate the drone service from within the app, specifying the area of their field to be analysed.
4) Data Collection and Analysis
    - The app sends a request to the drone service provider, indicating the location and parameters for field analysis.
    - Drones equipped with specialized sensors capture aerial imagery of the specified field.
    - The captured data, along with weather data obtained from external APIs, is processed by machine learning algorithms to analyse soil nutrients, detect weeds, and provide recommendations.
5) Result Presentation
    - The analysed data and recommendations are presented to the user within the app's interface.
    - Users can view soil nutrient maps, weed infestation alerts, weather forecasts, and personalized recommendations for crop management practices.

6) Recommendation Feature
    - Based on the analysis results, the app recommends suitable fertilizer and pesticide vendors to users.
    - Users can explore the recommendations and connect with vendors directly through the app for purchasing agricultural inputs.

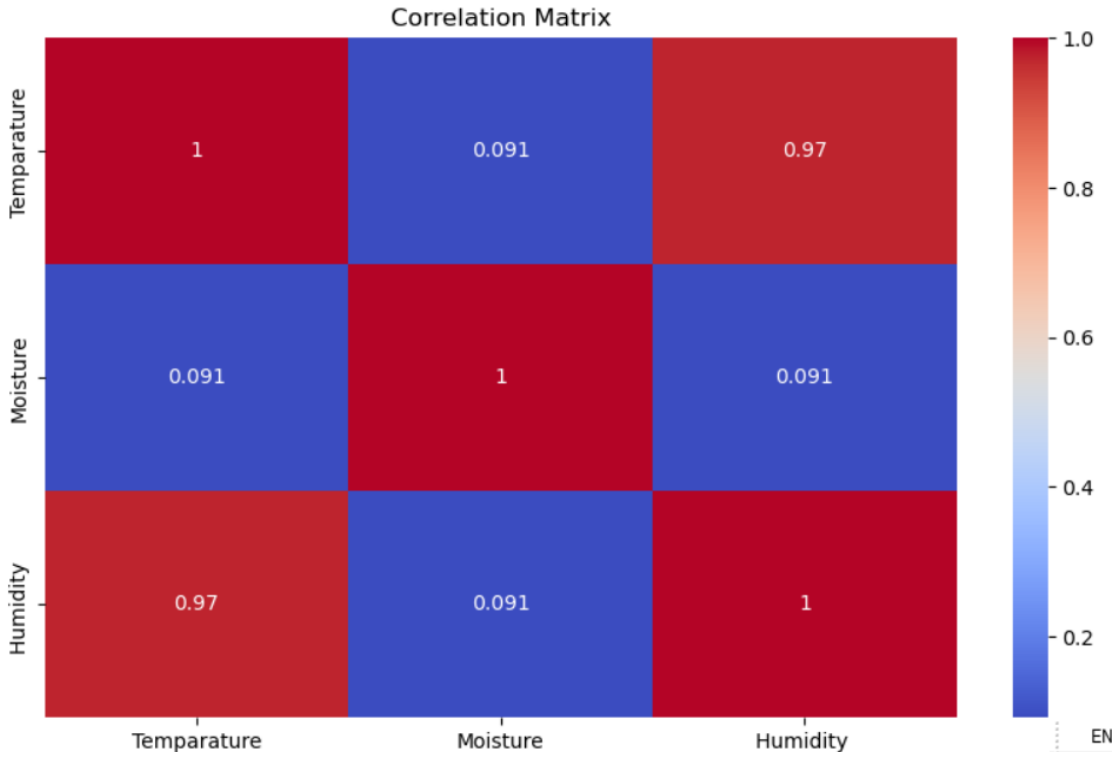
7) Integration with Food Processing Industry
    - The app also recommends connections with food processing companies based on the user's crop cultivation.
    - Users receive suggestions for potential buyers or collaborators in the food processing industry, facilitating market access for their agricultural produce.

8) Integration with Crop Insurance Company
    - Additionally, the app recommends crop insurance companies to users, helping them mitigate risks associated with crop failures or losses.
    - Users can explore insurance options and policies tailored to their specific crop cultivation practices and geographical location.
9) Continuous Improvement and Monitoring
    - Continuous Improvement and Monitoring involve refining through user feedback, performance tracking, and regular updates.
    - Quality assurance, user support, security monitoring, and industry trend awareness ensure the app remains effective, secure, and aligned with evolving user needs and industry standards

13.0) Code Implementation/Validation on Small Scale

Basic code to get amount of N,P, K composition required for cultivation of given crop, at given temperature , given type of soil and rainfall.

Some code snippets


Correlation Matrix
Temparature
Moisture
Humidity
1
0.091
0.97
0.091
1
0.091
0.97
0.091
1
Temparature
Moisture
Humidity
1.0
0.8
0.6
0.4
0.2
EN

In [61]:
```
df.sample(5)
```

Out[61]:

	Temparature	Humidity	Moisture	Soil Type	Crop Type	Nitrogen	Potassium	Phosphorous	Fertilizer Name
33	36	68	38	Sandy	Barley	7	9	30	14-35-14
19	29	58	52	Loamy	Wheat	13	0	36	DAP
47	29	58	43	Clayey	Paddy	24	0	18	28-28
60	28	54	41	Clayey	Paddy	36	0	0	Urea
43	34	65	60	Black	Sugarcane	35	0	0	Urea

In [62]:
```
df.describe()
```

Out[62]:

	Temparature	Humidity	Moisture	Nitrogen	Potassium	Phosphorous
count	99.000000	99.000000	99.000000	99.000000	99.000000	99.000000
mean	30.282828	59.151515	43.181818	18.909091	3.383838	18.606061
std	3.502304	5.840331	11.271568	11.599693	5.814667	13.476978
min	25.000000	50.000000	25.000000	4.000000	0.000000	0.000000
25%	28.000000	54.000000	34.000000	10.000000	0.000000	9.000000
50%	30.000000	60.000000	41.000000	13.000000	0.000000	19.000000
75%	33.000000	64.000000	50.500000	24.000000	7.500000	30.000000
max	38.000000	72.000000	65.000000	42.000000	19.000000	42.000000

EN English (India)

In [75]:
```
y_pred = model.predict(X_test)
```

In [76]:
```
accuracy = accuracy_score(y_test, y_pred)
print(f'\nAccuracy: {accuracy * 100:.2f}%')
```

```
Accuracy: 96.97%
```

In [79]:
```
#Predicating Fertilizer according to Temparature, Humidity ,Moisture ,Soil Type , Crop Type, Nitrogen, Potassium, Phosphorous tak
```

In [78]:
```
new_data = pd.DataFrame({
    'Temparature': [25],
    'Humidity ': [40],
    'Moisture': [60],
    'Soil Type': label_encoder_soil.transform(['Black']),
    'Crop Type': label_encoder_crop.transform(['Cotton']),
    'Nitrogen': [15],
    'Potassium': [5],
    'Phosphorous': [20]
})

predicted_fertilizer = model.predict(new_data)
predicted_fertilizer_name = label_encoder_fertilizer.inverse_transform(predicted_fertilizer)
print(f'Predicted Fertilizer: {predicted_fertilizer_name[0]}')
```

```
Predicted Fertilizer: 17-17-17
```

Github Link for the full code [Code]