AquaSense: AI-Driven Groundwater Level Prediction for Sustainable Agricultural Water Management

Team members: Harrison CHANG, Yihui FANG, Matthew JOHNSON, Wenqing ZHANG, Joao QUINTANILHA, Merouane TALEB, Nardi XHEPI

1. Business Model

1.1 Problem Statement

Groundwater is an essential resource for French agriculture, supplying 36-40% of water needs for the industry. However, due to climate change sparking recent droughts, France has experienced significant aquifer depletion in areas with high agricultural activity. These dry spells are projected to increase in coming years, leaving farmers uncertain about water availability.
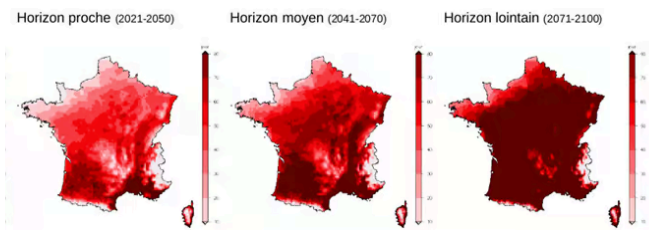

Figure 1. Projection with Number of days over 25°C / year from 2021 to 2100

Climate models forecast France becoming increasingly more arid by 2100, further straining water resources. Policymakers and activists are pushing for stricter water regulations, creating pressure on the agriculture sector, which accounts for 18% of Europe's agricultural production. Yet many farmers lack the financial means to adapt. There is an urgent need for innovative solutions to optimize groundwater usage and support sustainable agriculture, especially for farmers who cannot afford drastic changes.

1.2 Target Market

1.2.1 Market Estimation

In 2023, France's agricultural production was valued at €95.5 billion, with 45% of the utilized agricultural area relying on irrigation. Thus, the market size for advanced irrigation solutions is estimated to be substantial, representing a significant growth opportunity.

1.2.2 Market Segmentation

- Out of 389,800 **farms** in France, 92.5% are classified as **small** and **medium**-scale.
- Aquifers often represent the sole source of supply for small villages or agricultural farms.

1.2.3 Customer Positioning

- Despite the growing climate change, farmers refuse to reduce their water use due to the financial risks.
- Smaller farmers often lack the financial resources and openness to join environmental programs.
- These farmers require cost-effective, user-friendly tools to optimize water usage and reduce expenses.

1.3 Product Display

AquaSense is a web application for small and medium French farmers who lack reliable information about predicted groundwater availability. Farmers simply input their location and farm size, and our system does the rest:

I. Groundwater Prediction: Our machine learning model combines the farmer's location with weather API data to predict groundwater levels, which correlates to the availability of water for agricultural purposes, especially during predicted summer drought stress.

II. Profit Analysis: The system determines the location's hardiness zone (which indicates which plants can naturally thrive in that climate) and uses crop data from an API to calculate the complete costs for different crop types, including:

- A. How much extra water each crop will need beyond the predicted groundwater
- B. The cost of this additional water
- C. Other growing costs like seed prices

Farmers receive clear recommendations showing which crops will be most profitable for their specific location, based on natural water availability and all associated costs.
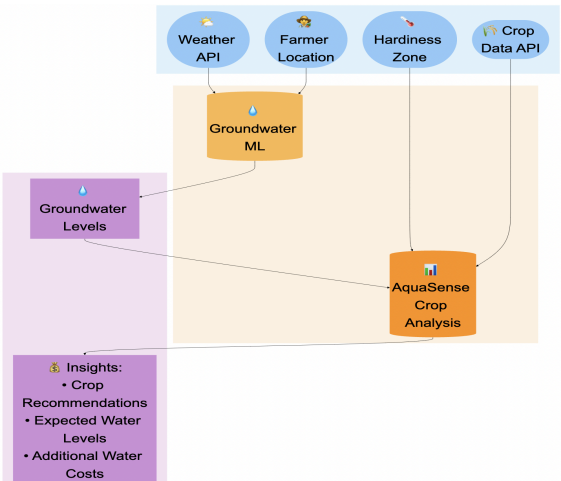

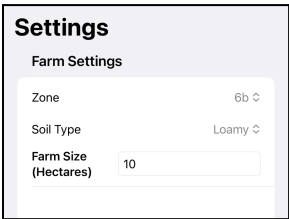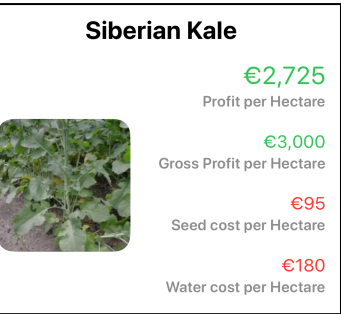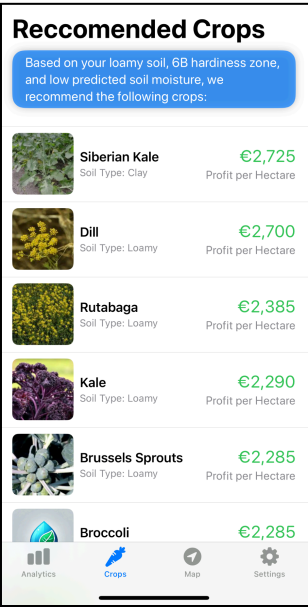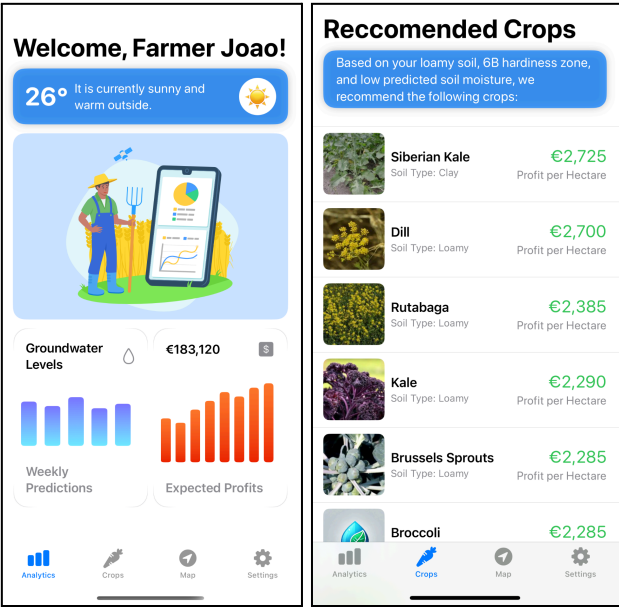*Figure 2. Technical Architecture of AquaSense*

Figure 3. Screens of the Aquasense application.
(a) Main interface for farmers. (b) Interface with the list of suggested crops for better use of the land. (c) More crop analytics shown when crop clicked (d) Farm settings

1.4 Value Proposition

1.4.1 Primary Value

- **Data-Driven Profit Optimization:** Helps farmers maximize profits by recommending the most suitable crops based on local groundwater conditions and associated water costs.
- **Future-Proofing Operations:** Enables farmers to adapt to increasing water regulations and climate challenges like drought through predictive water availability insights.
- **Democratizing Agricultural Intelligence:** Gives small farmers access to sophisticated water management insights through a simple location-based input system.

1.4.2 Environmental & Economic Impact

- **Risk and Resource Management:** Helps farmers reduce crop failure risks and optimize water usage while staying ahead of stricter environmental regulations.
- **Climate-Resilient Agriculture:** Enables sustainable farming practices by aligning crop choices with France's environmental goals and local water availability predictions.

1.4.3 Existing Solutions

Other Solutions	AquaSense App
<u>Pumping more water</u> over the winter when resources are more abundant to relieve pressure during the summer months.	The app enables farmers to predict seasons ahead, allowing them to make decisions over production under a more reliable base, anticipating the depletion of the aquifers.
<u>Reservoirs</u>, which directly deplete groundwater, provide water to large-scale farms, being the most reliable solution for periods of drought.	Only 7% of French farmland has access to reservoirs, ignoring smaller farmers who depend on groundwater. AquaSense allows these farmers to better navigate through this absence of assistance.
RiverFox AI Irrigation Planning <u>Mobile App</u>: provides satellite and weather data for farmers to plan their crops and water use.	AquaSense predictive modeling on groundwater is tailored to the French market, assisting smaller farmers with their specific deficiency of information on groundwater availability.

Table 1. Benchmarking: Comparison of solutions to AquaSense solution

1.5 Subscription-Based Revenue Stream

The platform offers tiered subscription plans:

- **Free-Trial**:
  A one-month free trial ensures farmers with limited financial resources can still benefit from AquaSense in the short term, showing them the value of our service.
- **Individual-Tier (5k€/yr):**
  A plan tailored to meet the water insights needs of small and medium-sized farmers.
- **Cooperative-Tier (4k€/yr):**
  Targets the ¾ of French farmers who participate in agricultural cooperatives, offering an attractive price point to increase adoption among more hesitant individual users.

The product requires at minimum 25 subscriptions for full ROI. Very achievable considering the massive consumer base (+90% of over 400,000 farms).

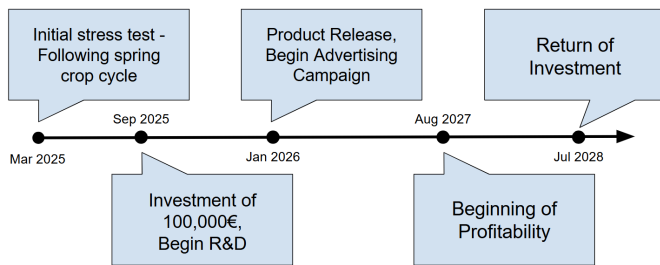## 1.6 Timeline of Business Development

Figure 4. Timeline of product development

---

2. Conclusion

This project delivers a socially impactful solution that leverages advanced AI technologies for sustainable irrigation management. By combining robust business modeling with state-of-the-art data science, we ensure the product is both innovative and viable. Through collaboration with stakeholders and continuous improvement, our solution has the potential to revolutionize groundwater management and contribute to global sustainability goals:

- **Adapting to Future Water Scarcity:** With global water resources projected to decline by 40% by 2040, AquaSense can help farmers adapt to worsening droughts through enhanced groundwater predictions, potentially reducing water use by 20%. Its role will grow as drought events in Europe are expected to triple by 2100, ensuring agricultural resilience in arid conditions.
- **Expanding Application Horizons:** The project has the potential to expand beyond agriculture, offering solutions for efficient urban water distribution during droughts, optimizing water usage in industrial manufacturing to reduce waste, and supporting ecosystem restoration through precise water allocation for wetlands and degraded areas.