SPARK CHALLENGE

22/23

SPARK

ENTC
Electronic and Telecommunication Engineering

EC

1. Details of the team

1.1 Group name.

Tech hawks

1.2 Group leader's name.

K. Pahansith Tharuka

1.3 Group members' information.

Our github Repository : https://github.com/kavindukalinga/Spark-challenge-2023.git

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1.4 External support you received to derive the solution.

Industry
1. Jayani aluthge
2. Y.U.K.Subasinghe: agricultural instructor

During our discussion with an agricultural instructor, we received valuable feedback regarding our solution idea for optimizing plant growth and nutrient management. The instructor's expertise and insights provided us with a deeper understanding of the agricultural landscape and helped refine our project.

2. Problem description

2.1primary area of development.

Food production and preservation.

2.2 Other Supporting areas of development.

- Environmental conservation and preservation
- Power generation and efficiency
- Health care improvement

2.3 The problem statement.

Farmers waste a lot of resources and money because they are unable to choose the right plants to cultivate on a particular piece of land. Food production is diminished as a result, and agricultural sustainability is hampered. As a result, a solution is required that can reliably identify acceptable plants for a particular piece of land, track the plants' nutritional needs throughout their growth cycle, and save the current state of the nutrient levels for future use.

Problem description:
Farmers face challenges in selecting suitable plants due to factors like soil type, climate, and nutrient availability. This can lead to wasted time, resources, and financial losses. Current nutrient monitoring techniques are labor-intensive and prone to errors, limiting farmers' ability to provide proper care for optimal plant growth.

To address these challenges, a reliable system is needed. It should recommend appropriate plant selections, continuously monitor nutrient needs, and store data for future reference. Such a system would empower farmers to make informed decisions, allocate resources efficiently, and enhance overall agricultural sustainability.

Validation of the problem
1. Surveys and Interviews: we have conducted surveys and interviews with farmers and agricultural experts to understand their challenges and experiences in determining suitable plants for specific lands and monitoring nutrient requirements.

2. Data Analysis: Analyzing historical data on crop yield, resource usage, and financial losses to identify patterns and correlations between plant selection, nutrient management, and agricultural sustainability.

Identified Affected User Segments:
The problem affects several user segments involved in agriculture, including:

1. Farmers: Farmers who own or manage agricultural land face the challenge of selecting suitable plants and managing nutrient requirements effectively.
2. Agricultural Experts and Advisors: Professionals who provide guidance and expertise to farmers can benefit from a reliable solution that assists in plant selection and nutrient monitoring, allowing them to offer more accurate recommendations.
3. Agricultural Technology Companies: Companies developing agricultural technologies and solutions can identify the problem as an opportunity to create innovative tools that address the needs of farmers and contribute to agricultural sustainability.

2.4 impact of finding a solution to our problem to the causes of climate change.

1. Efficient Resource Allocation: Farmers can optimize resource management by recommending suitable plants, reducing waste of water, fertilizer, and pesticides. This minimizes the environmental impact of agriculture, including water use, chemical runoff, and greenhouse gas emissions.
2. Soil Health and Carbon Sequestration: Selecting plant species that enhance soil quality and sequester carbon indirectly contributes to carbon sequestration. Improved soil fertility and organic matter content act as a carbon sink, reducing atmospheric carbon dioxide levels and combating climate change.
3. Preventing Deforestation: Careful plant selection helps maximize land use and prevent deforestation. By suggesting crops suitable for existing areas, farmers can avoid the need to clear more forests or natural habitats for agriculture expansion. Preserving forests conserves biodiversity and prevents the release of carbon stored in trees, which contributes to climate change.
4. Sustainable Agricultural Practices: Promoting sustainable practices like crop rotation, intercropping, and agroforestry maximizes land utilization, improves soil health, manages water efficiently, and reduces reliance on synthetic inputs. Sustainable agriculture reduces greenhouse gas emissions, safeguards ecosystem services, and enhances climate resilience.
5. Knowledge Sharing and Adoption: Tracking nutrient status and providing guidance on plant selection facilitates knowledge sharing among farmers. The adoption of successful farming methods promotes widespread use of sustainable practices. By collectively adopting climate-smart behaviors, we can mitigate greenhouse gas emissions, protect natural resources, and mitigate the impacts of climate change.

Impact of the problem :
1. Resource and Financial Wastage: Farmers waste time, money, and resources by planting plants that might not survive on their particular plot of land.
2. Lower Food Production: The inability to identify plants that will grow well on a particular piece of land might result in below-average crop yields and lower Food Production in general.
3. Agricultural Sustainability: Inaccurate plant selection and nutrient monitoring make agriculture less sustainable by using up resources, causing environmental deterioration, and making agricultural methods less effective.
4. Farmer Livelihoods: Financial setbacks and decreased food production can have a severe effect on farmers' livelihoods, reducing their earnings and long-term viability.

3. Solution description

3.1Arriving at our solution.

After conducting our research, we discovered that there are a number of things to take into account when selecting the best plant for a specific piece of land. It is crucial to take the features of the soil into account when selecting a plant for a particular piece of land. When it comes to providing the materials and support needed for plant growth, the soil is absolutely essential. Here's a quick breakdown of how the soil should be taken into account:
1. Soil Drainage:
   - Adequate drainage is crucial for plant growth.
   - Poor drainage can lead to waterlogged conditions.
   - Excessively well-drained soils may not retain enough moisture.
   - Choose plants adapted to the soil's drainage characteristics.
2. Soil Texture:
   - Soil texture refers to the proportions of sand, silt, and clay particles.
   - Different textures have varying water-holding capacities and drainage characteristics.
   - Sandy soils drain quickly but may not retain enough moisture.
   - Clay soils retain more water but can have poor drainage.
   - Select plants that can tolerate the specific water-holding and drainage conditions.
3. Nutrient Content:
   - Soil nutrient content is essential for plant growth and productivity.
   - Different plants have varying nutrient requirements.
   - Assess soil nutrient levels through testing.
   - Select plants that can thrive in the available nutrient conditions.
   - Implement appropriate fertilization strategies if needed.
4. Soil pH:
   - Soil pH refers to the acidity or alkalinity of the soil.
   - pH influences nutrient availability to plants.
   - Some plants prefer acidic soils, while others thrive in neutral or alkaline conditions.
   - Test soil pH to select suitable plants or adjust pH through soil amendments if necessary.

Denomination	pH range
Ultra acidic	< 3.5
Extremely acidic	3.5–4.4
Very strongly acidic	4.5–5.0
Strongly acidic	5.1–5.5
Moderately acidic	5.6–6.0
Slightly acidic	6.1–6.5
Neutral	6.6–7.3
Slightly alkaline	7.4–7.8
Moderately alkaline	7.9–8.4
Strongly alkaline	8.5–9.0
Very strongly alkaline	> 9.0

pH Correction: If the soil's pH is unsuitable for the plant you've chosen, pH correction may be required. The pH level can be raised or lowered by adding amendments to the mixture. For instance, adding lime to acidic soil will raise its pH, while adding sulfur or organic matter to alkaline soil might make it lower. The pH can be adjusted to the ideal range, which improves the plant's habitat and encourages nutrient uptake.

5. NPK Value:
   - NPK value refers to the concentrations of nitrogen (N), phosphorus (P), and potassium (K) in the soil.
   - These macronutrients are crucial for plant growth and productivity.
   - Different plants have varying NPK requirements.
   - Soil testing helps determine nutrient levels and guide fertilization strategies.

6. Organic Matter:
   - Organic matter content affects soil structure, water retention, and nutrient availability.
   - Soils with higher organic matter content are generally more fertile and have better water-holding capacity.

- Consider organic matter content when selecting plants.

7. Soil Compaction:
   - Soil compaction affects root development and nutrient uptake.
   - Compacted soils restrict root growth, requiring plants with deeper root systems.
   - Assess soil compaction levels and consider plant tolerance or soil management practices.

8. Soil Temperature:
   - Soil temperature affects seed germination, root development, and overall plant metabolism.
   - Different plant species have specific temperature requirements.
   - Warm soil promotes faster germination and root growth, while cold soil can inhibit growth.

9. Oxygen Content:
   - Oxygen is essential for root respiration, nutrient uptake, beneficial microbiology, soil structure, and disease prevention.
   - Insufficient oxygen can lead to nutrient deficiencies, compaction, waterlogging, and poor seed germination.
   - Regular soil testing and proper soil aeration are important for maintaining optimal oxygen levels.

10. Soil Depth:
   - Soil depth refers to the thickness of the soil layer available for root growth.
   - Different plants have varying root system requirements.
   - Shallow soils may limit the selection of plants with deep-rooting requirements.
   - Consider soil depth when selecting plants for optimal root development.

These factors collectively contribute to the suitability of the soil for plant growth and should be considered when selecting plants and implementing appropriate soil management practices.

Existing solutions

Existing solutions for plant selection and nutrient management in agriculture include farmer training and education, agricultural extension services, TV programs and social media, soil testing kits, and sensor-based nutrient monitoring.

Farmer training and education programs enhance farmers' knowledge of plant selection, nutrient management, and sustainable practices. These programs provide workshops and training to equip farmers with practical skills, empowering them to make informed decisions.

Agricultural extension services offer guidance and information to farmers, providing access to experts who advise based on best practices in plant selection and nutrient management.

TV programs and social media platforms share valuable agricultural information, expert advice, and practical demonstrations. Farmers learn about suitable plant varieties, planting techniques, and soil management practices.

Soil testing kits assess soil properties, enabling farmers to determine nutrient levels and pH. This knowledge helps in selecting appropriate plants and determining the need for soil amendments or fertilizers.

Sensor-based nutrient monitoring systems continuously measure soil and plant parameters, such as nutrient levels and moisture content. Farmers analyze this data to make informed decisions on fertilization and nutrient maintenance.

These solutions improve plant selection and nutrient management, empowering farmers with knowledge, guidance, and tools to enhance plant growth and agricultural productivity.

Alternative solutions

Agricultural Expert Networks:
Establish networks of experts, agronomists, and local farmers for guidance on plant selection and nutrient management. Their knowledge contributes to the recommendation system, ensuring accuracy. Experts assist in interpreting sensor data and provide on-ground insights to empower farmers.

Integrated Farm Management Systems:
Develop systems that integrate data from multiple sources like soil sensors, weather stations, and crop monitoring tools. This provides a comprehensive overview of nutrient status, environmental conditions, and crop performance. Farmers can access real-time insights, receive alerts, and optimize farming practices.

Mobile Applications and Online Platforms:
Provide mobile apps and online platforms with information on plant selection, nutrient requirements, and best practices. These platforms use data, expert knowledge, and analytics to offer personalized recommendations based on location and farming conditions.

Implementing these solutions enables informed decisions, accurate nutrient monitoring, and sustainable practices. Leveraging data and expert knowledge, farmers optimize resource utilization, increase food production, and promote a profitable agricultural sector.

Our solution

Introduction

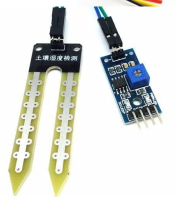
The purpose of our solution is to provide instruction for farmers who lack knowledge about selecting suitable plants for their land and using fertilisers for their plantation. So, our team involved the development of a soil monitoring device equipped with various sensors to measure critical soil parameters such as NPK value, pH value, soil temperature, moisture content, organic matter content, oxygen content of soil and other specifications essential for plant growth. This device communicates with a mobile app via Bluetooth, which is further connected to a database containing plant-specific information. By leveraging the collected data, the mobile app suggests the most suitable 10 plants for the given soil conditions and provides guidance on optimal farming practices.

Soil Monitoring Device
The soil monitoring device serves as the foundation of the proposed solution. It incorporates electronic sensors which are capable of measuring the following parameters:

a. NPK Value: The device has a NPK sensor to quantify the levels of nitrogen (N), phosphorus (P), and potassium (K) in the soil. This data is crucial for determining the soil's nutrient composition.

b. pH Value: A pH sensor is integrated into the device to measure the acidity or alkalinity of the soil.

c. Soil Temperature: The device includes a temperature sensor to monitor the soil's temperature.



d. moisture Content: Through a moisture sensor, the device measures the water content in the soil. This data aids farmers in understanding the soil's moisture levels, enabling effective irrigation practices.

e.Oxygen sensor: Measures the oxygen content of soil.

Mobile App and Database Integration

The mobile app acts as a user-friendly interface for farmers, allowing them to interact with the soil monitoring device and provide valuable information about plants which are most suitable for the particular land. The key features of the mobile app include:

a. Bluetooth Connectivity: The mobile app communicates with the soil monitoring device via Bluetooth to collect the necessary data about the soil.

b. Location Access: The app utilises location services to determine the specific geographic location of the farm. This information is used to provide localised plant recommendations and farming instructions.

c. Database Integration: The mobile app is linked to a database containing detailed information about various plants and their environmental requirements for growth, special nutrient requirements, optimal temperature and soil type for each plant, and recommended water levels. The app retrieves relevant data from the database to offer personalised recommendations to farmers.

Validation Process

To validate the effectiveness of the provided solution from an end user perspective, the following steps were taken:

a.Requirements Gathering: The validation process began by engaging with agricultural instructors who have direct experience working with farmers. Through interviews, surveys, and workshops, their requirements and problems regarding plant selection and soil monitoring were collected. This step ensured that the solution was aligned with the actual needs of end users.

b.Stakeholder Collaboration: The collected requirements were reviewed and analysed to identify common and essential features we should provide in our solution. Continuous collaboration with agricultural instructors and domain experts helped refine the solution and ensure its practicality and effectiveness.

End User Perspective

a. User-friendly: The mobile app was designed with a simple interface, allowing farmers with limited technical knowledge to easily connect the sensor, access soil data, and receive plant recommendations.

b. Customizable and adaptable: The solution accommodated diverse farmer needs and varying soil conditions. The extensive plant database provided tailored recommendations based on specific soil and geographical factors.

c. Knowledge enhancement: The app served as a comprehensive knowledge hub, offering detailed information on suitable plants, nutrient requirements, soil amendments, and farming instructions to empower farmers in making informed decisions.

d. Cost-effective: The solution aimed to optimize resource usage, reduce input costs, and improve crop yields, providing farmers with targeted recommendations on fertilizers, water usage, and plant selection to minimize financial risks and maximize returns on investment.

Through a validation process involving farmers and agricultural instructors, the soil monitoring device and mobile app were refined to address user requirements. The user-centric approach resulted in a user-friendly and comprehensive product that empowers farmers, enhances decision-making, and improves agricultural practices and productivity.

3.2 Proof of Concept.

3.3 Sustainability

1. SDG 1: No Poverty - The product helps farmers increase crop yields, reducing poverty and improving livelihoods.
2. SDG 2: Zero Hunger - The product suggests suitable plants, optimizing nutrient management, and reducing food waste to achieve zero hunger.
3. SDG 3: Good Health and Well-being - The product promotes safe and nutritious food production, improving health outcomes.
4. SDG 6: Clean Water and Sanitation - The product minimizes water pollution by optimizing nutrient management.

5. SDG 7: Affordable and Clean Energy - The product promotes sustainable practices, reducing energy requirements.
6. SDG 8: Decent Work and Economic Growth - The product stimulates economic growth and creates employment opportunities.
7. SDG 12: Responsible Consumption and Production - The product promotes responsible resource use and sustainable practices.
8. SDG 13: Climate Action - The product reduces greenhouse gas emissions and enhances climate resilience.
9. SDG 15: Life on Land - The product supports biodiversity conservation and ecological balance.
10. SDG 17: Partnerships for the Goals - The product fosters collaboration and knowledge exchange among stakeholders.

Overall, the product contributes to the SDGs by improving productivity, reducing waste, ensuring food security, promoting sustainability, protecting the environment, and fostering partnerships.

4. Social and Environmental Impact Assessment

a. Farmer Empowerment: The solution empowers farmers with accurate, real-time soil data for informed plant selection, improving yields and livelihoods.

b. Reduce crop failures: The app suggests suitable plants based on soil analysis, minimizing crop failures and financial losses.

c. Water Conservation: Monitoring soil moisture enables efficient water management, conserving resources and minimizing environmental impact.

d. Reduction of Chemical Inputs: The solution optimizes fertilizer usage, minimizing pollution and environmental harm.

e. Optimal Nutrient Management: Accurate soil nutrient measurements guide fertilizer application, reducing waste and pollution.

f. Efficient land usage: The app recommends crops suited to the soil, maximizing productivity and minimizing crop failure risks.

5. Logistics

5.1 Task breakdown and time frame.

Kalinga :- research data.
Venuri :- data collection for data base.
Pasindu :- Software implementation.
Pahansith :- hardware implementation and project planning.

5.2 Our contribution to Pi-Mora and the Raspberry Pi-related activities

We all actively Participated in pimora workshops and sessions.