Introduction

Enhancing Agricultural Efficiency with a Farm Management System

Agricultural productivity relies on efficient crop and worker management, but many farms struggle with tracking planting schedules, monitoring crop health, and managing labor effectively. Our solution, AgriSuccess Management System, is a powerful tool designed to assist farmers, supervisors, and workers in optimizing farm operations. This system provides a comprehensive range of features, including real-time monitoring of crop growth, worker attendance tracking, task scheduling, and yield forecasting. By integrating technology and data-driven insights, our system ensures better decision-making, improved productivity, and sustainable agricultural practices.

Industrial Background

SANSA, the **The South African National Space Agency**, has significant role in leveraging satellite technology to support various industries, including agriculture. The research and work carried out at SANSA focuses on Earth observation, space science, space engineering and space space operation. Much of this work involves monitoring the Earth for policy and decision making, resource and disaster management, food security and national security. SANSA also provides state-of-the-art facilities to monitor space weather, provide launch support and data downloads as well as supporting the growth of the local space industry.

Since SANSA is a very resourceful organisation that support various industries. We have requested a few members of the organisation to guide us with producing a web application that will help farms operate efficiently while having less harmful impact to the enviroment such as soil degradaton and soil nutrient depletion. Farms have a many challenges in operation, such as crop rotation, worker management and crop management. These challenges all have a common issue, which is real-time updates. Unable to monitor the tasks assign to their workers, workers that cannot be informed immediately , tracking crop growth and making report takes time since they use spreadsheet or notes.

Current System(s) and/or Procedures Followed in Agricultural Management

Many farms currently rely on traditional record-keeping methods or basic management systems to oversee ,crop rotation, crop cultivation, worker assignments, and farm operations.Use manual approaches to track crop growth, soil health, worker attendance, irrigation schedules, and harvesting timelines. While these

methods may be functional, they often lack real-time monitoring, data accessibility, and automated decision-making. This can lead to inefficiencies in yeild use, soil degradation and labor productivity.

1. **Crop Management:**

- Farm workers manually track crop growth phases.
- Soil conditions, irrigation needs, and pest control measures are recorded in farm logs or spreadsheet-based systems.
- Farm workers rely on historical data and experience to determine optimal fertilization and harvesting times.
- There is no automated system to track optimal crop rotations to maintain soil fertility and prevent disease buildup.
- Reports on crop health, yield predictions, and resource use are compiled at the end of the season.

2. **Worker Management:**

- Workers check in manually at the farm and are assigned tasks by Managers.
- Attendance is recorded on paper or basic spreadsheets and submitted weekly.
- Payroll and labor efficiency reports are generated manually, which increases administrative workload.

3. **Scheduling and Planning:**

- Farm schedules, including crop rotation, planting, irrigation, and harvesting timelines, are maintained in physical notebooks or basic digital calendars.
- Managers announce task schedules verbally or via printed notices.
- Workers must manually keep track of tasks and deadlines without real-time digital updates.
- Farmers plan seasonal crop rotations manually, considering soil depletion and pest cycles, but often without scientific analysis of soil health.
- Decisions about crop succession and best field utilization are made at the beginning of the season, limiting flexibility if conditions change.

These procedures have limitations, as they lack real-time monitoring, automation, and accessibility, leading to delayed decision-making, resource mismanagement, and productivity gaps.

Problem Statement

The current farm management system primarily focuses on administrative tasks using MS excel for example, with limited access for farmers, making it difficult for them to manage crops efficiently and lack of real-time tracking. This results in challenges in farm operations, worker and crop management.

The farm faces difficulties in:

1. Tracking crop growth, yield, and rotation cycles – Farmers lack an integrated system to record crop progress, soil health, and rotational schedules, leading to soil depletion and reduced productivity.
2. Assigning and monitoring worker tasks – Farm managers struggle to track worker productivity and task completion, making it hard to implement and maintain crop rotation schedules effectively.
3. Managing crop rotation schedules – Without a structured system, crops may be planted in the same fields repeatedly, depleting soil nutrients and increasing pest risks. A lack of automated recommendations for crop rotation leads to inefficient land use and lower yields.‘
4. Communication gaps between farm owners and workers – Without a structured system, task assignments, performance tracking, and rotation schedules are difficult to manage.

To address these challenges, we propose an integrated Farm Management System that includes real-time tracking of crop growth, worker task management, and automated crop rotation scheduling based on soil health and previous crop cycles.

Proposed Solution

The proposed Agricultural Management System will help farmers efficiently track crop production, crop rotation schedules, and farm operations using digital record-keeping and automation instead of AI-based decision-making. The system will improve farm productivity by offering structured data management, automated scheduling, and real-time accessibility. This is in mind that there is a stakeholder that is going to receive report of the progress of the farm management.

1. Crop Management

Farm workers will be able to manage crop-related activities such as planting, irrigation, fertilization, and harvesting.

Functions:

- Farm workers can register crop types, planting dates, expected harvest times, and yield goals.
- Logs irrigation schedules and fertilizer applications.
- Keeps records of pest treatments and disease prevention methods.
- Logs harvested quantities for better production insights.

2. Crop Rotation Management

Crop rotation planning is essential for soil health, pest control, and productivity. This feature will help farm workers plan and track their rotation cycles.

Functions:

- Farm workers can assign crops to specific fields and schedule rotation cycles based on previous plantings.
- Allows input of soil test results to monitor nutrient levels over different seasons.
- Keeps historical records of crops grown in each field to prevent overuse of soil and disease buildup.
- When the farm worker tries to assign previously planted crops, they will be alerted that they need to change the current crops or plans.

3. Farmer & Farm Operations Management

This will help farm workers and manager to manage daily farm operations, workforce scheduling, and resource allocation.

Functions:

- Tracks seeds, fertilizers, pesticides, and tools (whether they are depleting, deteriorated or damaged)
- Assigns workers to specific tasks such as planting, watering, harvesting, and field maintenance.
- ~~Logs expenses for inputs (seeds, fertilizers) and income from sales.~~ this might not be included at the moment
- Generates simple reports on farm operations, yield, and resource use

This kind of information and report can be oversaw and managed by the shareholders.

Provide a webste where farmers and workers can check in and log tasks for the day. Use manual data entry forms to record work hours, tasks completed, and any incidents or notes relevant to farm operations.

Benefits of the Proposed System

By transitioning from purely paper-based methods to a digital log, records become easier to update, review, and share.

A dedicated crop rotation module helps in planning rotations effectively, reducing soil nutrient depletion and improving overall yield over time.

Digital attendance and task tracking reduce administrative overhead, leading to more efficient use of human resources on the farm.

Integrating basic real-time software provides farmers with up-to-date information, helping them make manual decisions based on current conditions.

Shareholders are able to receive reports in real-time update rather than on a weekly or monthly bases.

Requirements

General worker (Farmer)

- Must be able to login
- Must be able to check in and out to show transparent hours worked
- Must be able to see their daily,weekly tasks
- Must be able to see their hours worked and task completed
- Must be able to do a report after each daily task
- Must be able to input plant's name,when it was planted

Manager Requirements

- Must be able to login
- Be able to track every workers profile (which includes their rating ,all of thier tasks given ,and the reports they made)
- Be able to track the soil and the condition ensuring good conditions for crops planted
- Be able to track the yield of each harvest and record it
- Be able to see how many hours your workers worked
- Be able to gather all the progress made by the farm monthly and give a report about it
- Be able to track each workers tasks,and the reports made
- Be able to assign tasks to each and every worker in the farm
- Be able to give a report on additional cost or maintainace spent to keep the farm going

Shareholder Requirements

- Should be able to login including their password
- Should be able to track the tasks given to each worker and the manager who assigned the task
- Should be able to track the hours worked by farmer and farm manager
- Should be able to receive reports about the farm
- Should be able to track the crops harvested

Functional Requirements

- The system must be able to login 3 types of users with their respected passwords (Shareholder,Farm Manager and farmer(general worker))

- The system must be able to track every worker's stats according to tasks given,hours worked,reports made
- Manager must be able to assign tasks to workers
- System must be able to track the hours worked by each worker according to when did they check in and out also track tasks completed
- Farmer and Manager should be able to give daily,weekly reports about the farm and the crops

Non-functional Requirements

- Managing soil rotation and degration
- Recommend farmers on when to water the plants according to the weather experienced that week
- Manage the crops growth and making sure they growing in a healthy manner
- Give comparisons/analysis on the harvest expected and harvest yield
- Recommend on what to do next time when you plant a specific plant to get maximum yield
- Calculate the workers salary according to the hours worked

System Feasibility:

The crop rotation management system is a system that will enhance the agricultural efficiency by tracking plant schedules, monitor the crop health and manage labour. The system is designed to asssist shareholders, farm managers, and farm workers in a way such that they optimize farm operations.

The system also provides a range of features which include task scheduling, yield calculation, worker attendance tracking and the monitoring of crop growth, farm owners being able to assign task to farm workers, farm workers to give reports about the tasks that were given.The system ensures better desicion making, improved productivity and sustainable practices, thus, the system integrates technology and data-driven insights.

The system is feasible in a way such that it uses technology that can handle a large volume of users. This system can thus be developed using languages like React, JS, CSS, HTML, SQL and Flutter.

Although there exist some systems that are similar to ours in functionality (systems like FarmERP, OneSoil, Cropaia), our system shows innovation in a way such that it has crop rotation scheduling based on soil health and previous crop cycles.

This thus shows that our system offers much more easier solutions to the given problems because not only will our system allow the manager to assign or schedule tasks to our workers, but it will rate the workers based on their perfomance on

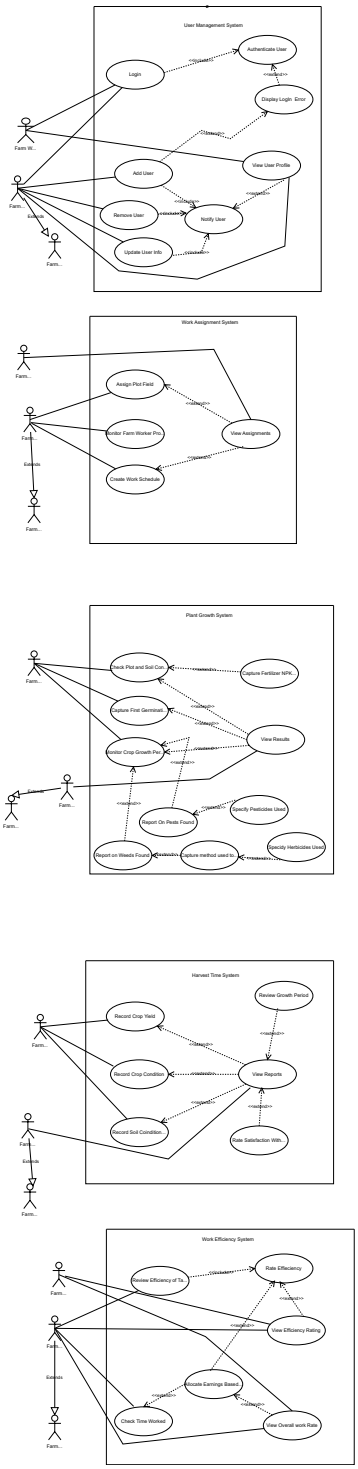

Figure 1: Use Case Diagram

the given tasks.

To conclude, the system provides convenience for every user.

Technical Feasibility:

For our web app, we plan to use a variety of technologies. These are the front-end and beck-end technologies

The front-end will use languages and tools like CSS, JS, HTML. We will also use frameworks like React, Angular, and Vue. This helps to style our system for users to interact with the system with ease.

The back-end will use a code editor or an IDE like Visual Studio Code (VS Code), and languages like SQL for database management, JavaScript which can also be used for back-end development, PHP, and a framework known as Express.js for third-party APIs.

For our mobile app, the system will use mobile app frameworks like jQuery mobile. The languages will be Java for android users and Swift for iOS users.

Economic Feasibility:

The system will be cost-effective to farmers as it will :

- Save the manager's valuable time of having to ask the farmers how far they are with their work because the system tracks the worker's performance and attendance
- The system maximizes operation uptime
- The system saves the manager's time of having to go directly to each worker to assign them their own task.
- The system will also help promote food productivity and will have a significant role in ensuring food security.

the system will be feasible in economic way, which will bring cost-effectiveness

Operational Feasibility:

The system will help improve work efficiently and productivity around the farm.Instead of waiting for a travelling/late manager, the manager can assign task from a distant and save time. The workers will be using mobile devices to do their task. They can be notified of any future plans that is shared on the schedules,.

The system is also convenient for farmers to be specific seeing as they will be able to:

- Schedule their tasks
- Track plant schedules
- Monitor crop health
- Forecast crop yield
- Track work attendance

The system will be feasible as it's optmized to manage the tasks of the farm and improves to maximize the operaions efficiently

Risk Management

Technical Risks

- **Scalability Issues:** The system may struggle to handle large amounts of data or multiple users simultaneously if the architecture is not optimized properly.
- **Compatibility Problems:** Since the system involves both web and mobile applications, ensuring seamless integration across different devices and operating systems (Android, iOS, desktop) could be challenging.
- **Security Concerns:** Protecting sensitive farm data, including schedules, crop health reports, and worker performance, from cyber threats requires robust security measures like encryption and secure authentication.
- **Data Loss or Corruption:** If not backed up properly, critical data related to farm operations might be lost due to system crashes or power failures.

Economic Risks

- **High Initial Development Costs:** Developing a system with web and mobile capabilities requires investments in software tools, developer expertise, and infrastructure.
- **Maintenance Costs:*** Regular updates, bug fixes, and security patches could require ongoing financial support.
- **Adoption Costs:** Farmers or farm managers may need to purchase compatible devices or train workers on how to use the system, adding to operational expenses.

Operational Risks

- **User Resistance:** Farmworkers or managers may be hesitant to adopt new technology, especially if they are not tech-savvy.

- **Training Challenges:** Proper training is required for users to effectively navigate and use the system; otherwise, it could lead to errors and inefficiencies.
- **Network Dependency:** If the system requires a stable internet connection, farms in remote areas with poor connectivity may face accessibility issues.

Environmental and Agricultural Risks

- **Inaccurate Crop Data:** If the system fails to provide accurate crop rotation recommendations due to outdated or incorrect data, it may negatively impact farm productivity.
- **Weather Dependencies:** The system may not fully account for unpredictable weather conditions that affect crop growth and yield. Pest and Disease Management: While the system tracks crop health, external factors like sudden pest infestations or soil degradation might require additional interventions beyond what the system offers.

Legal and Compliance Risks

Data Privacy Regulations: If the system collects and stores personal or farm-related data, it must comply with data protection laws such as GDPR or local agricultural regulations. **Software Licensing Issues:** Ensuring that all frameworks, APIs, and third-party integrations are properly licensed is crucial to avoid legal complications.

Conclusion

To mitigate these risks, it's essential to:

- Conduct thorough testing before full implementation.
- Provide training and support for users.
- Implement data backup and recovery strategies.

To the implementation of the farm system will be feasible due to given reasons.