## **Kissan Buddy**

## A PROJECT REPORT

***Submitted by,***

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### *Under the guidance of,*

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***in partial fulfillment for the award of the degree of***

**BACHELOR OF TECHNOLOGY**

**IN**

**COMPUTER SCIENCE ENGINEERING(CSE)**



**PRESIDENCY UNIVERSITY**

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**SCHOOL OF COMPUTER SCIENCE ENGINEERING**

**CERTIFICATE**

This is to certify that the Project report **“KISAN BUDDY”** being submitted by **“S.MD.IMRAN, T.YOGESH NAIDU, SIDDE HIMAJA”** bearing roll number(s) “**20211CSE0008, 20211CSE0042**, **20211CSE0280**” in partial fulfilment of requirement for the award of degree of Bachelor of Technology in Computer Science and Engineering is a Bonafede work carried out under my supervision.

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**DECLARATION**

We hereby declare that the work, which is being presented in the project report entitled **“KISAN BUDDY”** in partial fulfilment for the award of Degree of **Bachelor of Technology in Computer Science Engineering(CSE)**, is a record of our own investigations carried under the guidance of **Dr.Galiveeti Poornima, Assistant Professor, School of Computer Science Engineering(CSE), Presidency University, Bengaluru.**

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We have not submitted the matter presented in this report anywhere for the award of any other Degree.

**ABSTRACT**

Farmers often face challenges in making informed decisions about fertilizers, pesticides, and timing for farming activities, which are critical for crop health and productivity. This software application aims to address these issues by providing farmers with a user-friendly tool that delivers data-driven insights. By simplifying decision-making, the application helps farmers adopt sustainable practices, optimize resources, and improve overall efficiency in agriculture.

The application’s key feature is a customizable fertilizer schedule that caters to various crops, ensuring proper nutrient management. It also includes a pesticide database with detailed usage guidelines, promoting responsible pest control. Additionally, the software leverages weather data and predictive analytics to recommend optimal times for planting, irrigation, and harvesting. These features encourage precision farming, helping farmers maximize yields while reducing environmental impact.

Beyond decision support, the application serves as a platform for education and knowledge sharing. It provides resources on sustainable farming practices and modern techniques, bridging the gap between traditional agriculture and innovative technologies. By empowering farmers with actionable insights, the application contributes to sustainable development and supports a healthier agricultural ecosystem.

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**CHAPTER-1**

**INTRODUCTION**

The fertilizer industry is set for rapid growth, and the development of specialized Fertilizers Android applications is expected to be a key factor driving this expansion in the next decade. Fertilizers are essential for modern agricultural practices as they help improve soil health, boost crop yields, and ensure global food security. However, farmers often face challenges when it comes to applying fertilizers at the right time, managing crop schedules, and dealing with unpredictable weather patterns. A well-designed mobile application focused on fertilizers can serve as a comprehensive solution, streamlining these processes and helping farmers maximize their productivity while minimizing costs and environmental impact. Through the use of advanced technology, this app will enable farmers to make better-informed decisions, ensuring sustainable and efficient agricultural practices.

One of the primary features of this app is its ability to create tailored fertilizer schedules for various crops. Farmers can input essential details such as crop type, planting date, soil conditions, and growth stages. Based on this information, the app will generate automated reminders for timely fertilizer application, pesticide management, and herbicide use. These personalized notifications help ensure that the crops receive the necessary nutrients at the optimal times, reducing the risk of under-fertilization or over-fertilization. The app also incorporates weather tracking features, alerting farmers to temperature fluctuations or extreme weather conditions that might negatively affect crops. By offering real-time weather updates and crop health indicators, the app allows farmers to take proactive actions, such as adjusting irrigation schedules or protecting crops from harmful conditions, thereby reducing potential risks to yield.

In addition to managing fertilizer application, the app also provides farmers with crop recommendations tailored to their specific soil types and geographic locations. These suggestions are based on a variety of factors such as climate, soil health, and crop suitability, ensuring that farmers select the best crops for their environment. Furthermore, the app features real-time crop pricing data at the national level, allowing farmers to track market trends and make informed decisions when it comes to selling their produce. This ensures that farmers can get the best price for their crops and avoid being taken advantage of by middlemen. By having access to real-time market information, farmers can make data-driven decisions, which directly enhances their profitability and encourages better market participation.

Beyond its core functionality, the app also serves as an educational tool. It provides farmers with resources on best practices for sustainable farming, the latest agricultural technologies, and tips on efficient fertilizer use. The app may also include features for community interaction, allowing farmers to connect with each other, share experiences, and exchange advice. This fosters a sense of community and collaboration, which is crucial for knowledge transfer and adoption of modern farming techniques. Additionally, the app's user-friendly interface ensures that even farmers with limited technical expertise can benefit from its features, making it an accessible tool for the wider farming community.

By integrating advanced technologies into farming operations, the Fertilizers Android app helps bridge the gap between traditional agriculture and modern innovation. The app's precision farming capabilities reduce waste, enhance resource efficiency, and minimize environmental impacts. As demand for food increases globally, this app has the potential to address key agricultural challenges, improve yields, and promote sustainable practices that align with global sustainability goals. With its wide range of features and ease of use, the Fertilizers Android app represents a transformative tool for modern agriculture, ensuring that farmers are better equipped to face the challenges of the future while contributing to a sustainable and thriving agricultural ecosystem.

**CHAPTER-2**

**LITERATURE SURVEY**

In recent years, technological advancements in agricultural applications have played a crucial role in enhancing farming practices, helping farmers to make better decisions and optimize resources. A study by Bhave et al. (2014) focused on MahaFarm, an Android-based application aimed at supporting remunerative agriculture by providing timely and relevant information about crop management and market trends. This mobile solution enhances productivity by assisting farmers with decision-making related to fertilizers, pesticides, and crop scheduling. The authors emphasized that MahaFarm’s user-friendly interface enabled even low-tech users to manage farm operations more efficiently. By incorporating features such as weather updates, crop suggestions, and disease management, this application fosters informed decision-making that improves overall farm productivity and sustainability. MahaFarm also includes a price prediction feature that enables farmers to anticipate market conditions and adjust their harvest schedules accordingly, ensuring that they receive better prices for their crops. Bhave et al. highlighted the role of mobile technology in increasing farm profitability and improving resource management, which is crucial for the development of smallholder farming communities [1].

Similarly, Koli and Jadhav (2015) presented an Agricultural Decision Support System as an Android application to aid farmers in decision-making. The system integrates weather forecasts, soil data, and crop information to suggest the most suitable crops to plant based on local conditions and market demands, ultimately promoting higher crop yields and efficient resource usage. By gathering data from various sources, including satellite imagery, weather stations, and local market prices, the app makes it possible for farmers to take precise and timely actions. This system is not only a tool for crop selection but also provides guidance on irrigation, pest control, and fertilizer application, making it a holistic solution for farm management. The study also highlighted the integration of cloud-based storage, allowing farmers to store historical data and trends that help them optimize their future farming decisions. Koli and Jadhav concluded that such decision support systems could be transformative, especially in regions where access to agricultural expertise and information is limited [2].

In another study, Lantzos et al. (2013) developed FarmManager, an Android application tailored for small farm management. The application integrates various farm management features such as crop rotation schedules, pest management, and resource allocation, enabling farmers to track their farming activities more effectively. Through a mobile-friendly interface, FarmManager helps farmers optimize land use, monitor crop health, and manage inventory, providing insights into the financial and operational aspects of farming. The application also includes real-time data analytics that allows farmers to assess their productivity and identify areas for improvement. By using FarmManager, farmers can track the effectiveness of their farming practices, including the use of fertilizers and pesticides, and make adjustments as necessary to reduce costs and improve outcomes. The study demonstrated that mobile-based solutions like FarmManager are invaluable for small farmers, helping them to make smarter decisions and increase the sustainability of their operations. Lantzos et al. also discussed how the application’s data-driven approach aids in improving long-term farm viability by reducing waste and optimizing production processes [3].

Prasad et al. (2013) explored AgroMobile, a cloud-based platform that offers a comprehensive suite of mobile tools for agricultural management. The app provides features such as real-time weather updates, crop disease detection, and market price monitoring, offering farmers the ability to access critical information on the go. AgroMobile enables farmers to monitor crop conditions remotely and receive alerts about pest outbreaks, weather changes, or soil imbalances. The platform integrates cloud computing to offer scalable solutions, supporting farmers across different geographic regions with personalized advice. The app also features an intuitive interface that allows farmers to input data about their crops, soil, and irrigation systems, which is then processed by the app to generate customized recommendations. Prasad and colleagues argued that AgroMobile's ability to consolidate multiple agricultural services into one app has the potential to transform farm management and increase agricultural productivity. The cloud-based nature of the platform ensures that farmers can access the most up-to-date information at any time, making it an ideal tool for modern farming practices [4].

Reddy et al. (2015) focused on crop disease detection and prevention through the use of Android applications. Their survey reviewed the use of image recognition technologies integrated into mobile apps that allow farmers to diagnose diseases early and take preventive measures. These apps use advanced image processing techniques to detect symptoms of crop diseases based on photographs taken by farmers in the field. The integration of machine learning algorithms allows the app to improve its diagnostic capabilities over time, offering farmers increasingly accurate disease predictions. The researchers noted that early detection through these apps can significantly reduce crop loss and minimize pesticide usage, making farming both more efficient and environmentally friendly. Reddy and his team emphasized that mobile applications for disease detection help farmers save time and resources by enabling them to identify problems at an early stage, preventing the spread of disease and ensuring healthier crops. The authors concluded that such apps not only help farmers reduce the economic impact of crop diseases but also contribute to the adoption of sustainable farming practices by promoting the judicious use of pesticides [5].

Kashyap and Yadav (2016) discussed the application of mobile technologies in modernizing agriculture by integrating IoT-based monitoring and management systems. Their work focused on how Internet of Things (IoT) sensors deployed in the field could track soil moisture, temperature, and nutrient levels. These sensors provide real-time data to farmers, which can be accessed through an Android app, making it easier for farmers to optimize water usage and fertilizer application. Kashyap and Yadav also explored the benefits of IoT in precision farming, where data-driven insights help farmers minimize resource wastage. The ability to monitor farm conditions remotely via a mobile app ensures that farmers can make informed decisions without having to be physically present in the fields. Their study underscored the significant role of IoT-based mobile apps in enhancing the efficiency of water usage, optimizing fertilizer distribution, and contributing to overall cost reduction. The integration of IoT technology in agricultural practices marks a significant advancement in the precision farming sector, reducing environmental impact while maximizing crop yields [6].

Singh et al. (2017) proposed an integrated mobile application called AgriTech, designed to provide farmers with real-time insights into soil quality, moisture levels, and weather forecasts. Their study emphasized the role of mobile technology in improving soil health and water management practices. Through the AgriTech app, farmers could access key information that would guide irrigation decisions, ensuring that crops receive the right amount of water at optimal times. Singh and colleagues demonstrated that the app helped farmers avoid over-watering or under-watering, which in turn led to more efficient water use and improved crop growth. Furthermore, AgriTech also provides detailed soil health reports, helping farmers identify nutrient deficiencies and apply fertilizers accordingly. This feature has been particularly beneficial for farmers dealing with degraded or poor soil conditions, as it enables them to make better decisions about soil improvement. The study concluded that mobile technology has great potential to improve resource management and increase productivity in water-scarce regions [7].

Patel and Dholakia (2018) explored mobile-based solutions for effective irrigation management in rural India. Their application, SmartIrrigate, uses weather data and soil moisture sensors to optimize water usage, significantly improving water conservation efforts in agriculture. The app provides farmers with irrigation schedules based on real-time data, helping them reduce water wastage and improve crop irrigation efficiency. Patel and Dholakia argued that SmartIrrigate could address the issue of water scarcity, a critical problem faced by farmers in many regions. The study demonstrated how real-time monitoring and automation of irrigation systems can drastically reduce water consumption while maintaining crop health. SmartIrrigate also includes features that allow farmers to monitor irrigation system performance and adjust schedules based on weather forecasts, ensuring that water is used efficiently. This innovation has the potential to transform irrigation practices in rural areas, making them more sustainable and cost-effective [8].

Ghosh et al. (2019) highlighted a mobile platform for precision agriculture, focusing on monitoring crop growth and soil conditions. The study discussed how mobile apps could enhance the monitoring of nutrient levels and minimize the overuse of fertilizers. By analyzing field data in real time, these apps provide farmers with customized recommendations for fertilizer and water application. The platform uses advanced algorithms to analyze crop growth patterns and soil health, enabling farmers to make better-informed decisions about when and how much fertilizer to apply. Ghosh and colleagues pointed out that precision agriculture not only helps farmers reduce input costs but also minimizes environmental pollution by reducing fertilizer runoff into surrounding ecosystems. The study concluded that the integration of mobile apps with precision farming technologies could increase yields while promoting sustainability and environmental responsibility [9].

Pillai et al. (2020) reviewed the growing role of AI-based agricultural apps, with a focus on machine learning algorithms that analyze crop growth patterns and predict potential pest attacks. The study found that AI-powered mobile apps offer farmers the ability to detect pest issues and forecast crop stress before they become visible, reducing the need for costly pest control measures. Machine learning algorithms are used to process large amounts of data, including weather patterns, soil conditions, and crop performance, to identify trends and predict future outcomes. The authors highlighted the potential of AI applications to enhance farm management by providing real-time insights into pest control, crop health, and resource allocation. The study demonstrated how AI-based apps could improve farming practices by offering timely interventions that reduce crop damage and enhance yield predictions, ultimately leading to higher productivity and more sustainable farming practices [10].

Srinivas et al. (2021) presented AgroExpert, an app that uses big data analytics to recommend crop-specific fertilizers and pesticides. Their research discussed how the app analyzes vast datasets related to weather conditions, pest activity, soil health, and market trends to provide actionable insights. AgroExpert's ability to tailor recommendations based on specific crops and local conditions allows farmers to make informed decisions that lead to better crop performance. The study showed that the app’s data-driven approach significantly improves resource use efficiency, minimizes environmental impact, and supports the adoption of sustainable farming practices. Srinivas and colleagues also emphasized that big data analytics in agriculture could lead to smarter, more cost-effective farming practices that optimize the use of natural resources while enhancing farm profitability [11].

Reddy and Jadhav (2014) investigated mobile solutions for sustainable agriculture. Their work discussed how apps could assist in sustainable water management, crop rotation, and the reduction of environmental impact. The study emphasized the need for mobile tools that help farmers balance productivity with environmental stewardship. Reddy and Jadhav argued that sustainable farming apps that track and optimize water usage, reduce chemical input, and support crop rotation can help preserve natural resources while maintaining crop yield. The mobile platforms they explored not only promoted the efficient use of water but also educated farmers on eco-friendly practices such as organic farming, integrated pest management, and agroforestry. Their research pointed to the growing importance of eco-friendly practices and how mobile applications can drive widespread adoption of sustainable agriculture methods [12].

Yadav et al. (2021) created an application aimed at automating farming processes, including planting, irrigation, and harvesting schedules. Their research found that automation could reduce labor costs and increase crop output, benefiting farmers economically while improving efficiency. The app's automation feature simplifies complex tasks, allowing farmers to focus on other aspects of their operations. The system’s algorithms adjust schedules based on real-time data, such as weather patterns and soil conditions, ensuring that each task is performed at the optimal time. Yadav and colleagues demonstrated that by reducing manual labor, the app not only increases farm productivity but also reduces human errors, leading to higher-quality crops and more consistent harvests. This research highlighted the potential for smart farming apps to revolutionize the agricultural industry by introducing automation and minimizing the need for manual labor [13].

Nair and Patel (2016) studied the integration of GPS and GIS technologies in agricultural mobile apps. Their work showcased how these tools could assist in accurate land mapping, soil analysis, and optimal crop planning. GPS and GIS features integrated into mobile apps enable farmers to monitor their fields more precisely, ensuring that they make informed decisions based on accurate location data. The ability to map land plots and track soil health across different areas allows for more precise crop planning, including decisions on crop rotation and resource allocation. The authors noted that this technology helps farmers plan planting and harvesting schedules, manage farm boundaries, and optimize crop rotations. This spatial data approach improves farm efficiency by allowing farmers to manage resources based on real-time geographical insights [14].

Jain et al. (2019) discussed the development of farm-to-market platforms, which connect farmers directly to consumers through mobile apps. Their study emphasized how these platforms eliminate intermediaries, enabling farmers to sell their produce at better prices while ensuring fresher products for consumers. The farm-to-market model enables farmers to access a wider market, maximizing profits and providing consumers with high-quality, locally grown produce. Jain and colleagues highlighted how these platforms support fair pricing and transparency, allowing farmers to retain a larger share of the profits. They also showed that by reducing transportation time and costs, these apps help reduce food waste and ensure that products reach consumers faster. The authors concluded that farm-to-market apps are an essential innovation that empowers farmers and fosters more sustainable agricultural supply chains [15].

**CHAPTER-3**

**RESEARCH GAPS OF EXISTING METHODS**

**Limited Integration of Real-Time Data Sources**  
Most agricultural apps today focus on one or two data sources, such as weather updates or soil moisture levels. However, these apps fail to combine multiple data sources, such as satellite imagery, IoT sensors, and market price data, to create a more comprehensive solution. Real-time data from diverse sources could provide farmers with a more holistic view of their operations. This gap is particularly relevant when it comes to offering actionable insights for specific regions and crops.

* Opportunity: Developing solutions that integrate weather forecasts, real-time soil health data, pest activity, and crop market prices to enable smarter decisions.
* Impact: Improved resource management, better crop planning, and more precise forecasting.

**Low Accessibility for Smallholder Farmers**A significant gap exists in terms of mobile apps being accessible to farmers who have limited access to advanced smartphones or reliable internet. Smallholder farmers, particularly in developing regions, often lack the infrastructure to fully benefit from high-tech agricultural solutions. While many apps are designed to be cost-effective, the disparity in smartphone capabilities and network access continues to be a barrier.

* Challenge: Developing apps that work on low-cost smartphones with minimal data consumption or offline functionality.
* Opportunity: Low-tech versions of apps or mobile solutions that offer the core functionalities needed by smallholder farmers.
* Impact: Increased adoption of technology among small-scale farmers, improving productivity and income.

**Scalability and Adaptability of Solutions**  
Many agricultural technologies are designed for specific regions or farming conditions, which limits their applicability in diverse settings. For instance, an app that works well in temperate climates may not be effective in tropical or arid regions. There is a need for scalable and adaptable solutions that can be easily tailored to different soil types, weather conditions, and crop types.

* Challenge: Building adaptable and customizable solutions that work across different geographies and agricultural environments.
* Opportunity: Developing flexible models that can be customized by farmers based on their local conditions, soil health, and climate.
* Impact: Widespread adoption of technology in diverse agricultural sectors, leading to more efficient farming practices.

**Lack of Customization and Personalization**  
Many existing agricultural apps offer generalized recommendations for tasks like fertilization, irrigation, or pest management, but they fail to provide personalized insights that consider specific farm conditions. Factors such as soil composition, weather patterns, crop variety, and historical farm data are often overlooked. Apps should take these unique aspects into account to offer personalized, actionable advice.

* Challenge: Lack of personalization and customization in existing mobile solutions.
* Opportunity: Leveraging machine learning to provide tailored recommendations based on individual farm conditions.
* Impact: Higher crop yields, efficient resource use, and more sustainable farming practices through tailored advice.

**Inadequate Use of Advanced Technologies (AI and Machine Learning)**While artificial intelligence (AI) and machine learning (ML) have the potential to enhance agricultural apps, these technologies are underutilized in many of the existing solutions. For example, AI could improve pest and disease prediction models, optimize irrigation systems, or enhance crop yield forecasting. Currently, most agricultural apps only provide basic features like weather forecasts and disease alerts.

* Challenge: Underuse of AI and machine learning technologies in agriculture apps.
* Opportunity: Incorporating advanced AI tools for real-time pest detection, yield prediction, and climate-based decision-making.
* Impact: Better resource management, lower pesticide use, and optimized agricultural output.

**Limited Focus on Sustainability and Environmental Impact**  
Although many agricultural apps focus on improving farm productivity, they often neglect the environmental impact of farming activities. Apps that prioritize sustainability and environmental conservation are rare. There is a significant gap in the market for mobile solutions that help farmers reduce their ecological footprint, such as managing water usage, reducing chemical inputs, and optimizing crop rotations.

* Challenge: The absence of environmental sustainability features in existing apps.
* Opportunity: Creating apps that educate farmers on sustainable practices, such as organic farming and agroforestry, while also tracking environmental metrics like water usage and carbon emissions.
* Impact: More eco-friendly agricultural practices and reduced negative environmental impact.

I**nefficient Data Storage and Management**  
Agricultural apps collect a large amount of data from farm sensors, satellite images, and weather reports. However, many apps do not store or manage this data efficiently, which can limit their long-term value. Without effective data storage systems, farmers are unable to track long-term trends in farm performance, making it difficult to assess the impact of various farming practices over time.

* Challenge: Inefficient data storage and management practices.
* Opportunity: Implementing cloud-based solutions that allow for easy access to long-term farm data, enabling farmers to track performance and make informed decisions.
* Impact: Enhanced decision-making based on long-term trends, improving farm sustainability.

**Limited Interoperability Across Platforms**  
Farmers often use multiple apps for various tasks, such as weather forecasting, pest control, and crop management. However, these apps are typically not integrated with each other, resulting in fragmented workflows. There is a need for mobile solutions that allow seamless communication between different apps, enabling farmers to efficiently manage all aspects of their farm operations.

* Challenge: Lack of integration between different agricultural apps and platforms.
* Opportunity: Developing interoperable systems that allow apps to communicate and share data seamlessly.
* Impact: Streamlined operations, reduced administrative burden, and improved farm management.

**Inadequate Training and User Support**  
Even though there are many agricultural apps available, many farmers struggle to use them effectively due to a lack of training or support. This gap highlights the need for user-friendly apps with intuitive interfaces, as well as educational resources to help farmers maximize the potential of these technologies.

* Challenge: Insufficient training and support for farmers using mobile solutions.
* Opportunity: Providing in-app tutorials, training programs, and multilingual support to improve the usability and accessibility of apps.
* Impact: Increased adoption and effective use of agricultural apps, leading to better farming practices and higher yields.

**Unreliable Internet Connectivity in Rural Areas**  
Poor internet connectivity remains a significant challenge for farmers in rural regions, where mobile apps relying on continuous internet access may not function optimally. The lack of reliable connectivity hinders farmers from using real-time data and cloud-based services.

* Challenge: Limited internet access in rural areas.
* Opportunity: Developing offline capabilities in agricultural apps that store critical data locally and sync with the cloud when internet access is available.
* Impact: More reliable and efficient use of agricultural apps, even in remote areas with limited connectivity.

**Economic Accessibility for Smallholder Farmers**  
Even though many agricultural apps are free or low-cost, smallholder farmers often cannot afford the data usage or premium features. Economic barriers prevent many farmers from fully utilizing mobile technologies, especially those in developing countries.

* Challenge: High costs for smallholder farmers to access mobile solutions.
* Opportunity: Developing freemium models and partnerships with government or NGO organizations to subsidize costs for smallholder farmers.
* Impact: More equitable access to mobile agricultural tools, empowering smallholder farmers to improve their livelihoods.

**Fragmentation of Agricultural Knowledge**  
The agricultural industry generates vast amounts of knowledge, but it is fragmented across various sources, such as government reports, academic research, and local knowledge. Farmers often struggle to access the most relevant and accurate information for their specific needs.

* Challenge: Fragmented agricultural knowledge that is hard to access and apply.
* Opportunity: Creating centralized databases or platforms that aggregate and organize agricultural knowledge, making it easily accessible to farmers.
* Impact: Better-informed decision-making and more efficient farming practices.

**Integration of Financial Management Tools**  
Agricultural apps generally focus on crop management but often overlook financial tools that are crucial for farm management. Smallholder farmers need financial management systems to track costs, manage loans, and forecast profits.

* Challenge: Lack of integrated financial management in agricultural apps.
* Opportunity: Developing apps with financial tools that help farmers manage budgets, expenses, and income.
* Impact: Improved financial decision-making, leading to sustainable farm operations.

**Ineffective Pest and Disease Prediction Models**  
Many pest and disease prediction models used in agricultural apps are inaccurate, especially in complex farming environments with varying weather and soil conditions. These models often rely on general data that doesn't reflect the nuances of local environments.

* Challenge: Inaccurate pest and disease prediction models.
* Opportunity: Leveraging AI, machine learning, and big data analytics to improve the accuracy of pest and disease prediction models.
* Impact: More timely and precise pest control, reducing crop damage and pesticide usage.

**Data Privacy and Security Concerns**  
As agricultural apps collect sensitive data about farmers, such as financial records, location data, and crop performance, ensuring the privacy and security of this data is essential. Data breaches or misuse of information could undermine trust in these technologies.

* Challenge: Privacy and security concerns related to sensitive farm data.
* Opportunity: Developing secure data management systems that comply with data protection regulations, ensuring farmer privacy while delivering valuable insights.
* Impact: Increased trust and adoption of agricultural apps, ensuring that sensitive data is protected.

**CHAPTER-4**

**PROPOSED MOTHODOLOGY**

The proposed methodology for developing a Fertilizer Management Android app begins with the requirement analysis phase, where a comprehensive understanding of the target farmers’ needs is gathered. This includes identifying the types of crops they grow, their knowledge of fertilizers, and the challenges they face in managing fertilizer application. Additionally, a review of the latest trends in agricultural technology is conducted to inform the app's features and functionalities. Following this, the app design phase focuses on defining the core features, such as fertilizer scheduling, crop-specific recommendations, weather alerts, and real-time market rates. The design also ensures that the user interface (UI) is intuitive and user-friendly, especially for farmers with limited technological literacy. The focus is on creating a seamless experience with easy navigation and accessibility for all users.

In the technology stack selection, appropriate programming languages like Java or Kotlin are chosen for Android development, while backend technologies such as Firebase or AWS are selected for secure data storage and real-time updates. APIs are integrated to provide accurate weather forecasts, crop disease monitoring, and real-time market prices. During the development phase, the app is built in stages, starting with essential functionalities such as fertilizer scheduling and crop suggestions, followed by testing for usability in both online and offline modes. Rigorous testing ensures that the app meets the needs of farmers, even in areas with limited internet connectivity, and that it functions smoothly across various devices.

After development, the app moves to the integration and testing stage, where real-time data feeds, such as weather forecasts and soil health monitoring, are incorporated. Extensive testing is conducted across different farming environments to ensure the app's robustness and reliability. Once testing is complete, the app is deployed on the Google Play Store, ensuring compatibility with a wide range of Android devices. Ongoing maintenance includes regular updates to introduce new features and address user feedback. The app also provides training and support through tutorials, video guides, and a feedback mechanism to ensure farmers are well-equipped to utilize the app to its full potential, ensuring continuous improvements and fostering long-term user engagement.

**CHAPTER-5**

**OBJECTIVES**

1. **Enhance Fertilizer Usage Efficiency:**

To provide farmers with an easy-to-use platform for managing fertilizer schedules, ensuring the correct application of fertilizers at the right time and in the right quantity to maximize crop yields.

1. **Support Crop-Specific Recommendations:**

To offer personalized fertilizer and pesticide suggestions based on specific crop types, soil conditions, and geographical locations, helping farmers optimize inputs and reduce waste.

1. **Enable Real-Time Alerts**:

To provide timely notifications on fertilizer application, weather changes, pest and disease risks, and market prices, empowering farmers to make data-driven decisions for better productivity and profitability.

1. **Improve Accessibility and User-Friendliness:**

To develop an intuitive user interface that is accessible to farmers with varying levels of technological knowledge, ensuring ease of use, even for those in remote or rural areas.

1. **Promote Sustainable Agricultural Practices:**

To educate farmers on sustainable farming practices, such as organic fertilization and crop rotation, through the app, while helping them reduce their environmental impact.

1. **Facilitate Offline Functionality:**

To design the app with offline capabilities so that farmers in areas with poor internet connectivity can continue to use essential features like fertilizer schedules and crop suggestions.

1. **Integrate Real-Time Data Feeds:**

To integrate real-time data such as weather forecasts, soil health, and crop market prices to provide accurate, up-to-date information that supports farm management decisions.

1. **Enable Data-Driven Decision Making:**

To equip farmers with actionable insights from collected data, including fertilizer usage patterns, crop performance, and economic trends, aiding them in making informed decisions about their farming operations.

1. **Support Continuous Improvement:**

To gather user feedback continuously and make iterative improvements to the app, ensuring it evolves based on the farmers' needs and emerging agricultural trends.

1. **Ensure Scalability and Adaptability:**

To develop an app that is scalable and can be easily adapted to different farming regions, crop types, and farming systems, enabling it to be used by a diverse set of farmers across various environments.

1. **Provide Comprehensive Training and Support:**

To offer educational resources, such as tutorials, user manuals, and customer support, to help farmers understand and fully utilize the app's features for optimal farm management.

1. **Ensure Data Security and Privacy:**

To implement secure data storage and privacy measures that protect sensitive farmer information, fostering trust in the app’s usage and encouraging long-term engagement.

**CHAPTER-6**

**SYSTEM DESIGN & IMPLEMENTATION**

**System Design**

System design is a critical phase in the development of any software system, as it bridges the gap between understanding the problem and creating a solution. In this phase, the system’s architecture, components, modules, and data flow are carefully planned to ensure that the system will meet the requirements specified during the requirements gathering phase. The design also defines the interactions between different components and ensures that the system will be scalable, maintainable, and easy to understand.

**Overview of the System Design:**

The design phase for the Fertilizer Management Mobile App is focused on providing an intuitive, accessible, and efficient platform for farmers to manage fertilizer applications, monitor crop health, and receive timely weather and market updates. Given that the target users are farmers with varying degrees of technological literacy, the design emphasizes simplicity and ease of use while also incorporating advanced features like real-time alerts, crop recommendations, and fertilizer scheduling. The app is designed to allow farmers to input their crop type and sowing date, and in return, receive a personalized fertilizer application schedule, pest control suggestions, weather forecasts, and market price updates.

**Architectural Design:**

The architecture of the Fertilizer Management App follows a client-server model, where the mobile application (client-side) interacts with the backend (server-side) to retrieve real-time data. The mobile app will be available on Android platforms, and it will communicate with the backend server to get essential information like weather data, fertilizer schedules, crop suggestions, and real-time market prices. The system is designed with offline-first capabilities, ensuring that farmers can access core functionalities like crop suggestions and fertilizer scheduling without an active internet connection. This is especially beneficial for farmers who operate in rural or remote areas with limited network access.

**Design Tools and Methodology:**

During the design phase, several UML (Unified Modeling Language) diagrams are created to visualize the structure and behavior of the system:

**Use Case Diagram:**

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

****

**Fig 1**

**CLASS DIAGRAM:**

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.

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**Fig 2**

**SEQUENCE DIAGRAM:**

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.



**Fig 3**

**COLLABORATION DIAGRAM:**

In collaboration diagram the method call sequence is indicated by some numbering technique as shown below. The number indicates how the methods are called one after another. We have taken the same order management system to describe the collaboration diagram. The method calls are similar to that of a sequence diagram. But the difference is that the sequence diagram does not describe the object organization where as the collaboration diagram shows the object organization.

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**Fig 4**

**ACTIVITY DIAGRAM:**

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams can be used to describe the business and operational step-by-step workflows of components in a system. An activity diagram shows the overall flow of control.

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**Fig 5**

**COMPONENT DIAGRAM**

Component diagrams are used to describe the physical artifacts of a system. This artifact includes files, executable, libraries etc. So the purpose of this diagram is different, Component diagrams are used during the implementation phase of an application. But it is prepared well in advance to visualize the implementation details. Initially the system is designed using different UML diagrams and then when the artifacts are ready component diagrams are used to get an idea of the implementation.

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**Fig 6**

The system implementation phase takes the design specifications and converts them into actual working code. This is where the system’s architecture is translated into a functioning software application. The implementation phase includes writing code for both the client-side mobile application and the server-side backend, integrating third-party APIs, conducting testing, and ensuring that the application runs smoothly on all target devices.

**Technology Stack:**

The technology stack is chosen to support the functionalities required for the Fertilizer Management App. The mobile app will be developed using Java or Kotlin, two of the most popular and effective programming languages for Android development. The backend server will be built using Node.js, Python (Django), or Spring Boot, which are well-suited for handling API requests and managing large datasets. The system will also integrate with Firebase for real-time data syncing and MongoDB or MySQL for database management. Google Cloud or AWS will be used to handle server deployment and scalability. The app will use RESTful APIs for smooth communication between the frontend and the backend.

**Frontend Implementation:**

The frontend implementation focuses on creating a user-friendly and intuitive interface for farmers. The app will feature:

**Home Screen:**

A simple and clear interface displaying essential features such as fertilizer scheduling, weather alerts, and crop-specific recommendations.

**Fertilizer Schedule Management:**

Farmers will be able to input their crop type and sowing date, and the app will generate a customized fertilizer application schedule, including specific dates and quantities for each fertilizer type.

**Weather and Market Price Updates:**

The app will pull real-time weather forecasts and crop prices from external APIs and display this information to farmers in an easy-to-read format.

**Offline Mode:**

Key features like fertilizer schedules and crop recommendations will be accessible offline, ensuring that farmers can continue using the app even when they don’t have an internet connection.

**Backend Implementation:**

The backend is responsible for processing requests from the mobile app, managing the database, and serving real-time data. The backend implementation involves:

**Database Management:**

The backend will manage data storage and retrieval, including user data, crop information, fertilizer schedules, and real-time weather data.

**API Integration:**

External APIs for weather forecasts and market prices will be integrated to provide real-time updates. The backend will also process requests related to fertilizer scheduling, crop suggestions, and alerts.

**Push Notifications:**

The backend will push notifications to the app to remind farmers about fertilizer applications, upcoming weather changes, and price fluctuations for crops in the market.

**Integration:**

During the integration phase, the mobile app, backend services, and third-party APIs are combined and tested to ensure that all components work together seamlessly. The backend APIs are tested to ensure they return accurate data, and the frontend is tested to verify that it correctly processes and displays the data. The app is also tested under various conditions, such as low internet connectivity or different user inputs, to ensure its reliability and robustness.

**Testing:**

**SYSTEM TESTING**

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

**TYPES OF TESTING**

**UNIT TESTING:**

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

**INTEGRATION TESTING**

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

**FUNCTIONAL TEST:**- Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures: interfacing systems or procedures must be invoked

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

**SYSTEM TEST**

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points

**WHITE BOX TESTING**

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

**BLACK BOX TESTING**

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

**UNIT TESTING:**

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

Test strategy and approach

Field testing will be performed manually and functional tests will be written in detail.

Test objectives

All field entries must work properly.

Pages must be activated from the identified link.

The entry screen, messages and responses must not be delayed.

Features to be tested

Verify that the entries are of the correct format

No duplicate entries should be allowed

All links should take the user to the correct page.

**INTEGRATION TESTING**

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

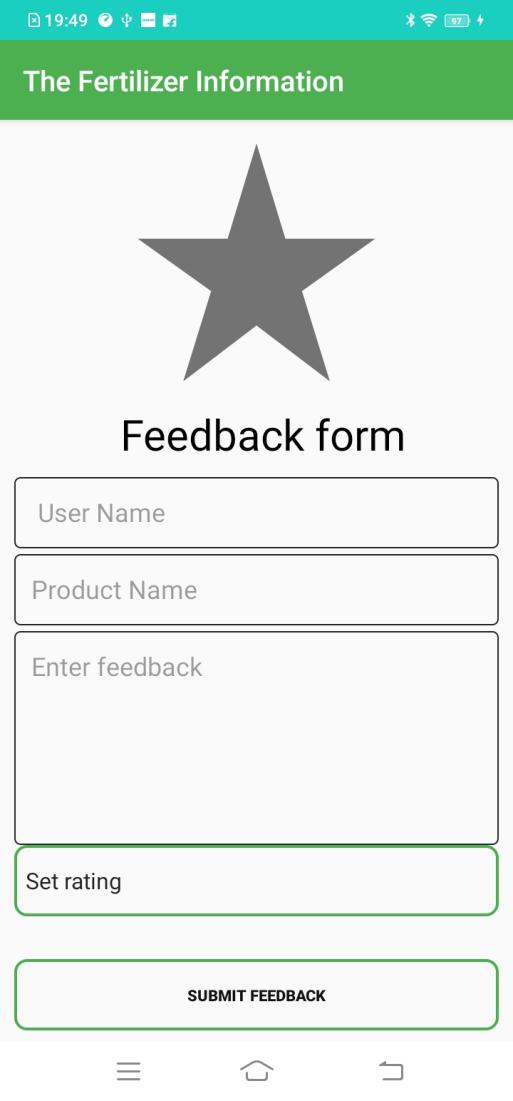
Test Results: All the test cases mentioned above passed successfully. No defects encountered.

**ACCEPTANCE TESTING**

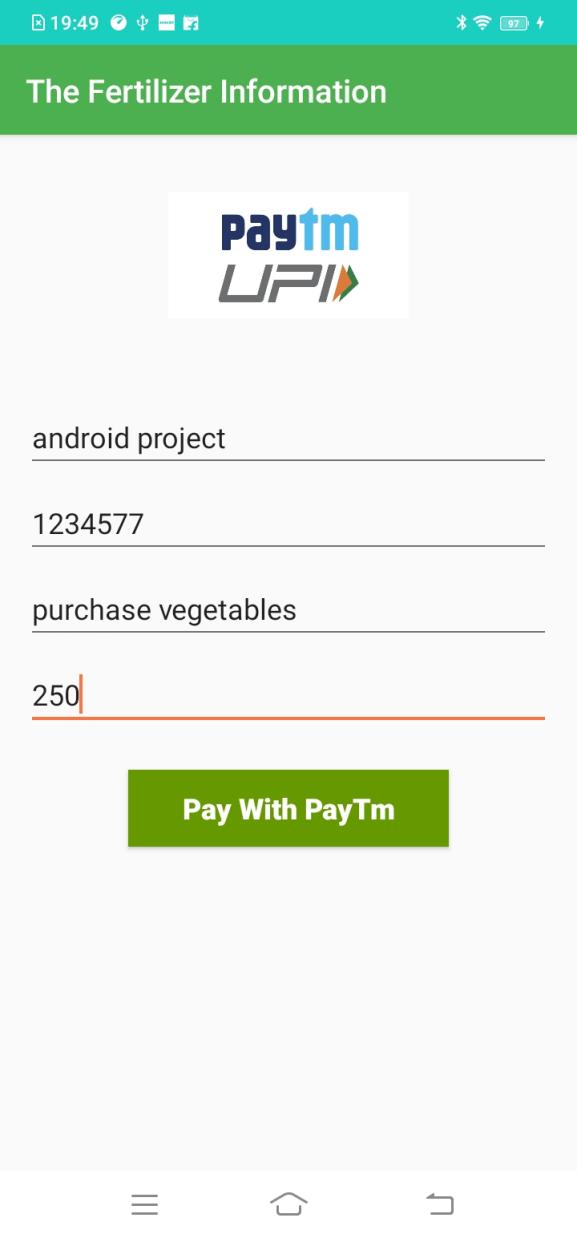
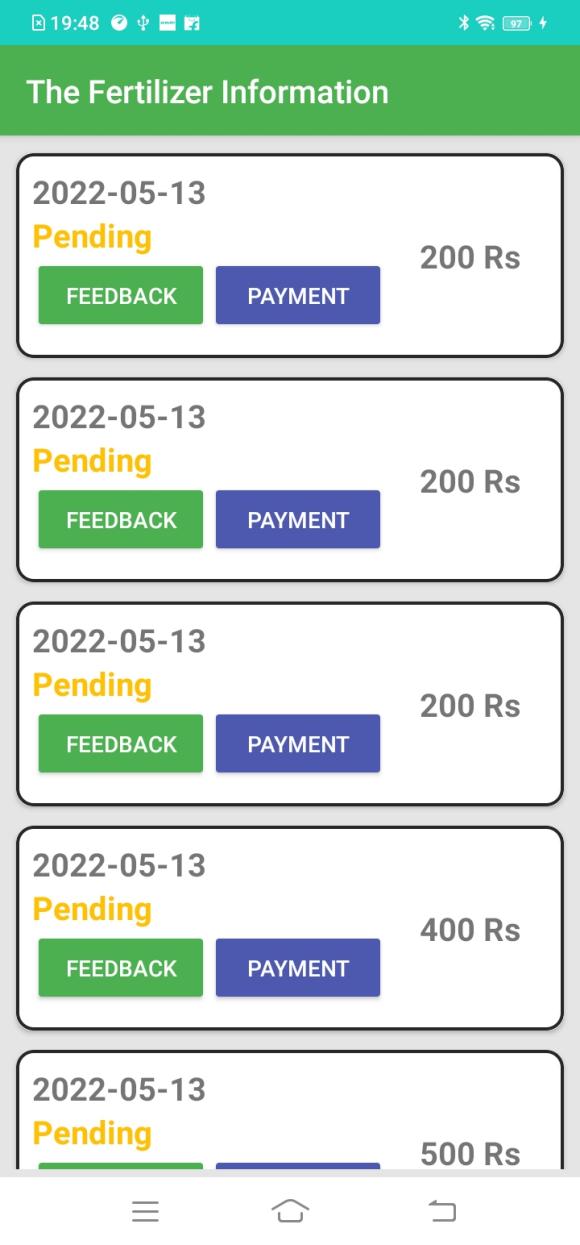
User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

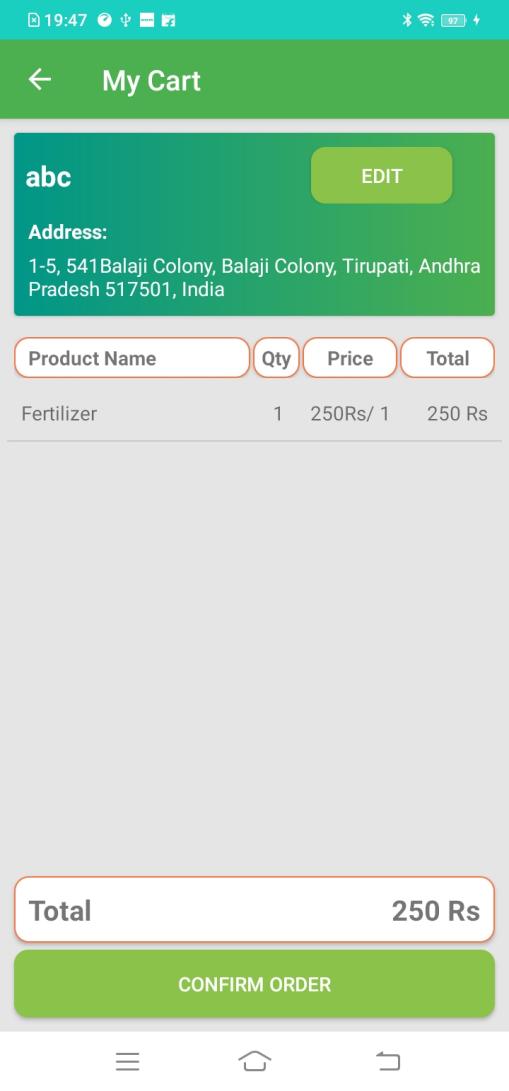
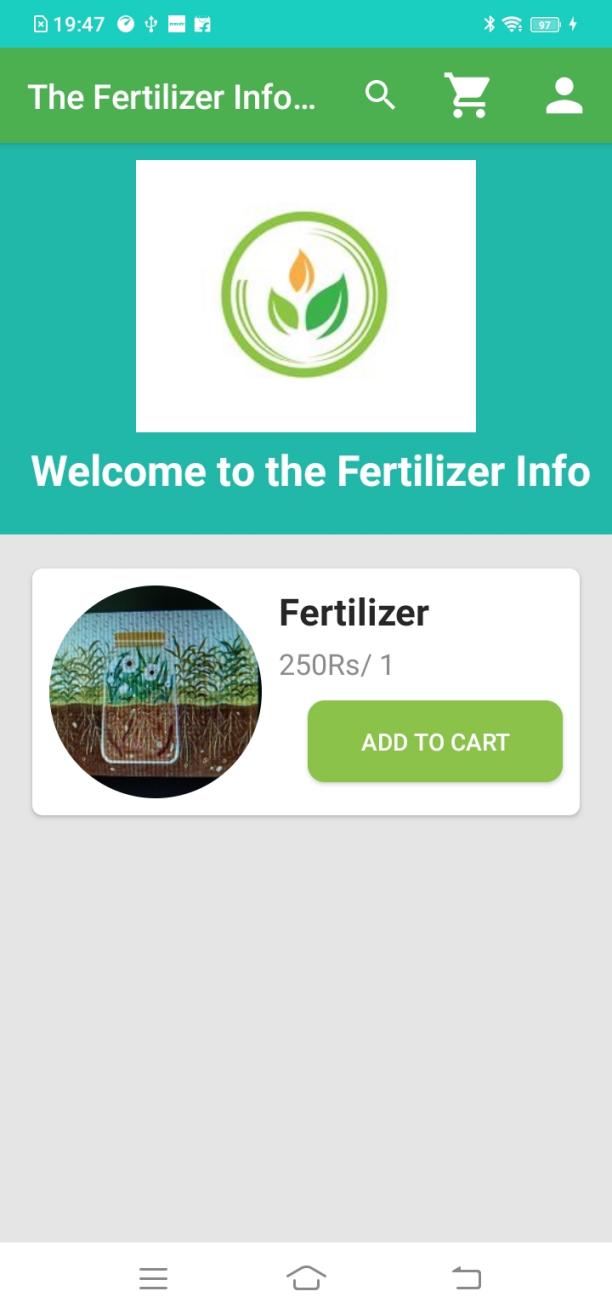
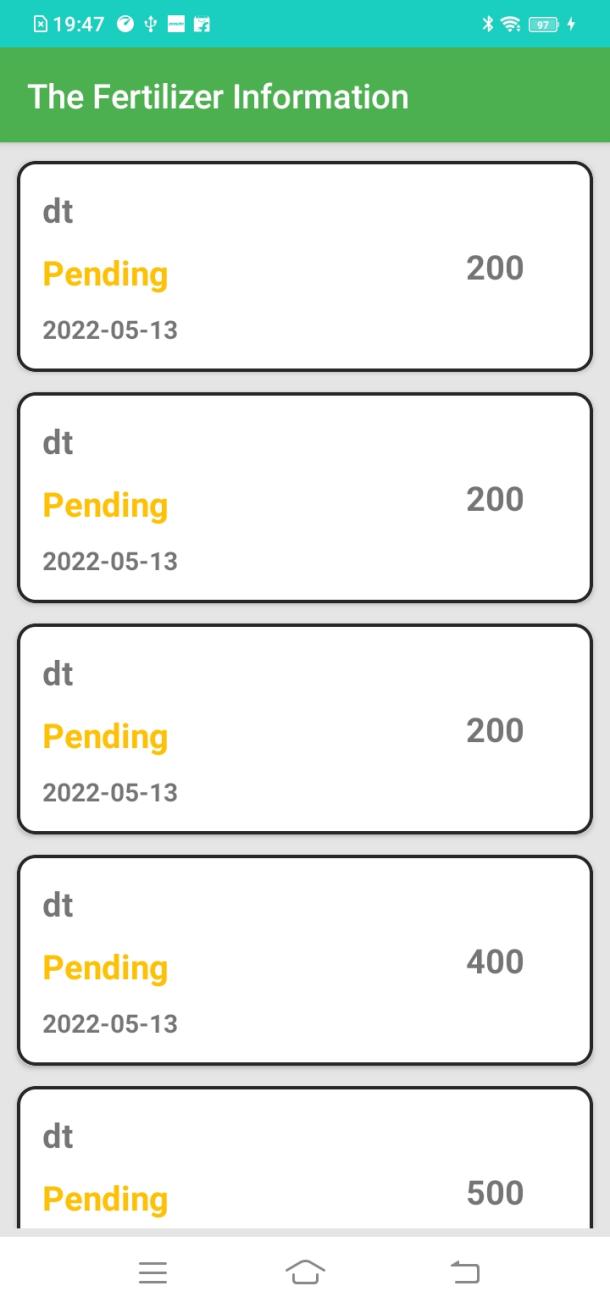
**TEST RESULTS**

** **

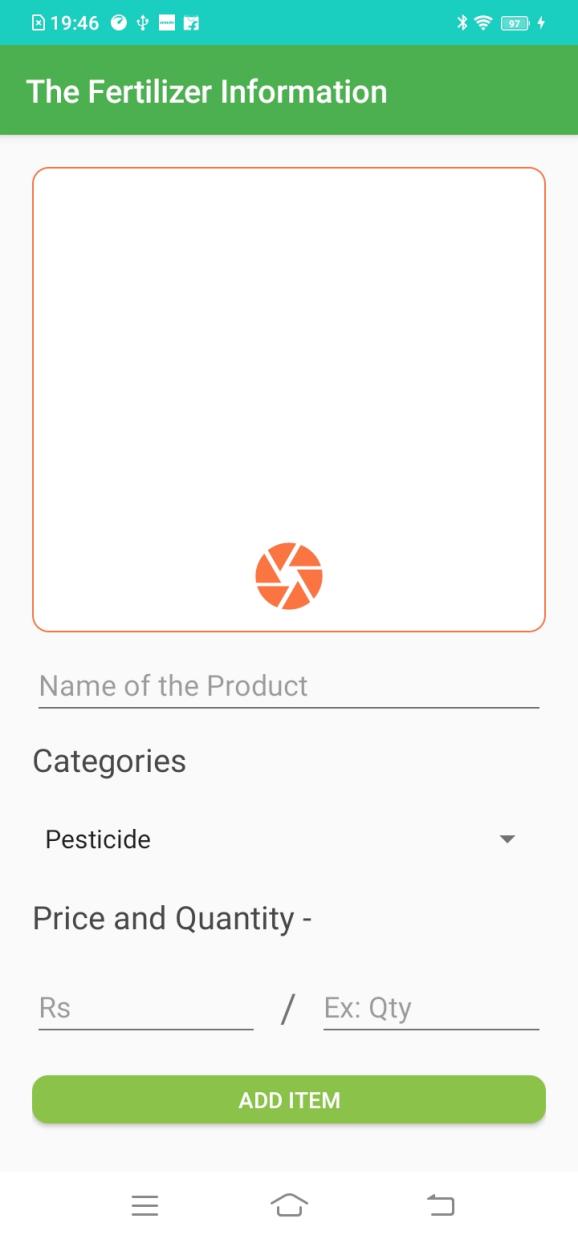
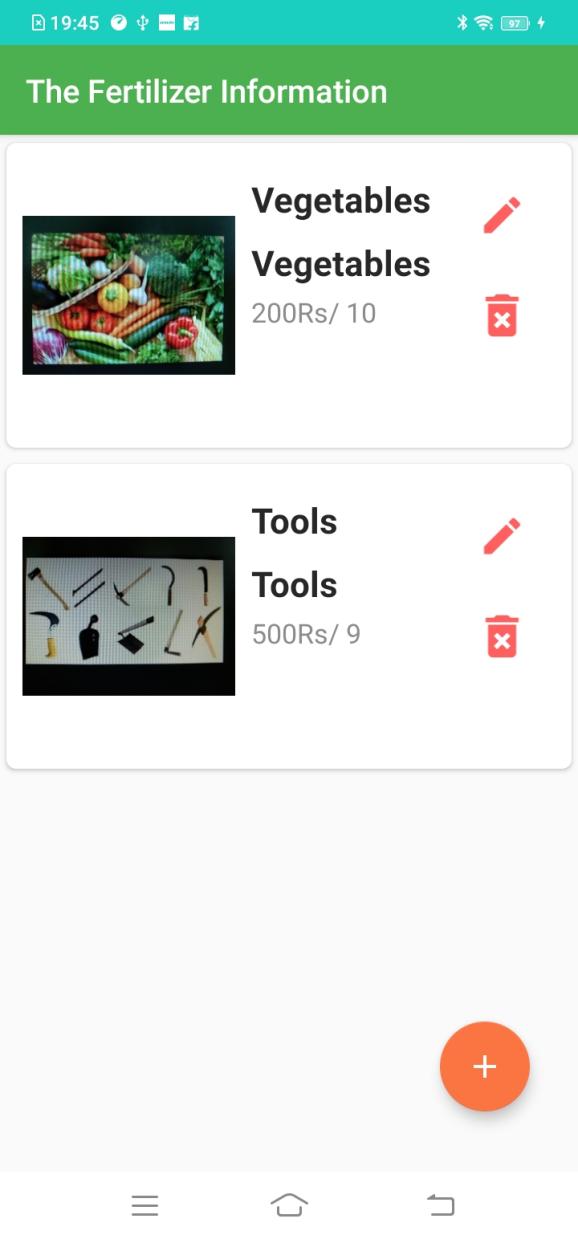
**Fig 7**

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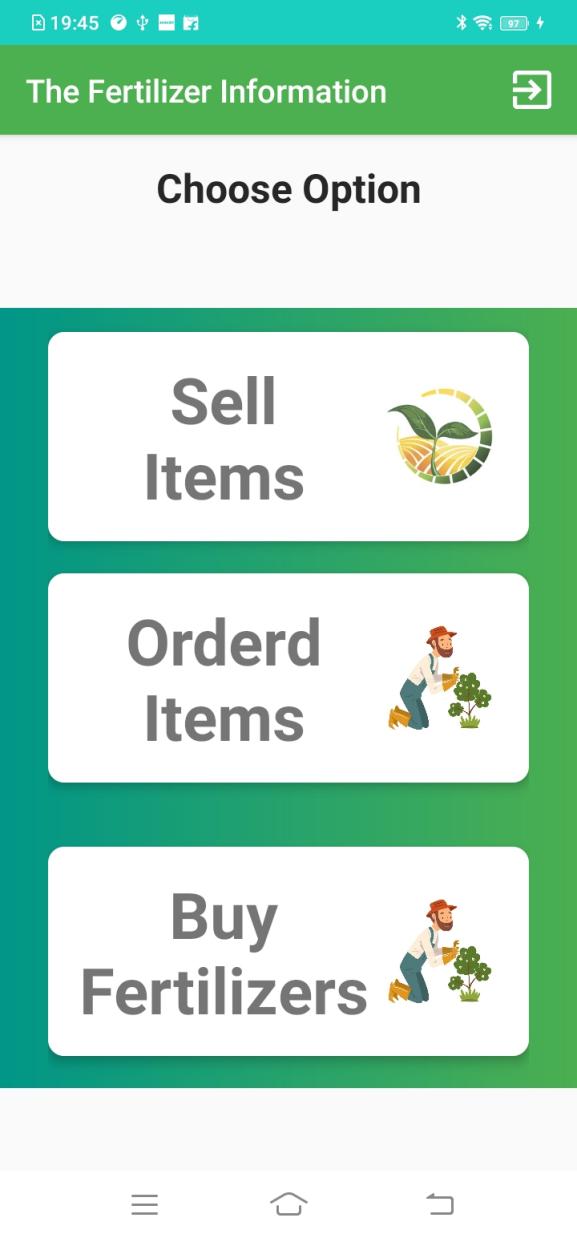
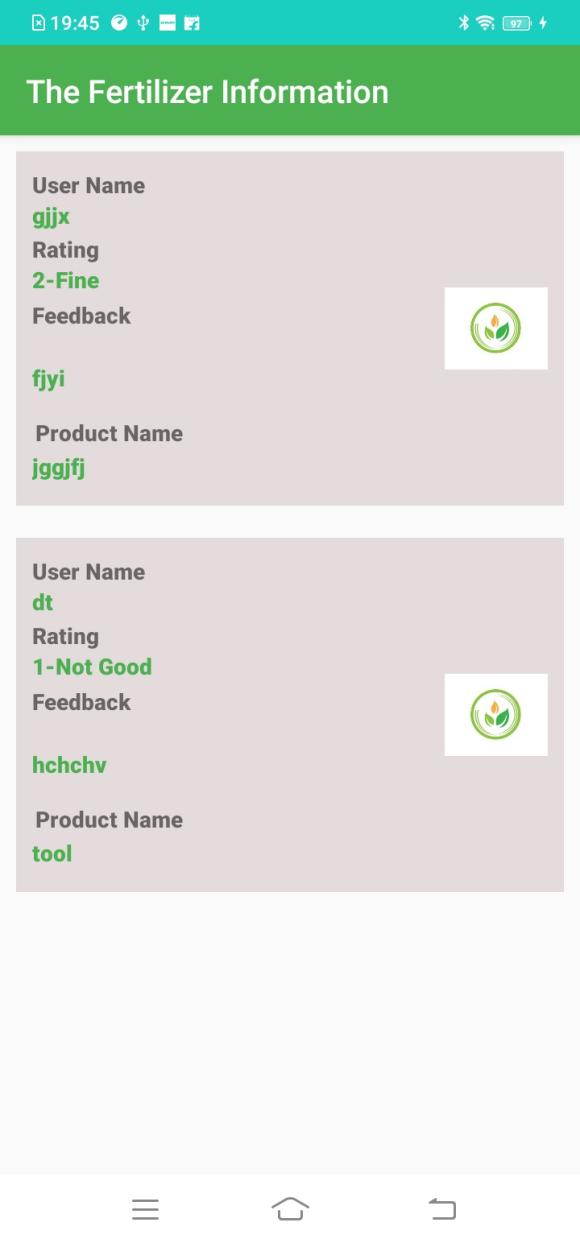
**Fig 8**

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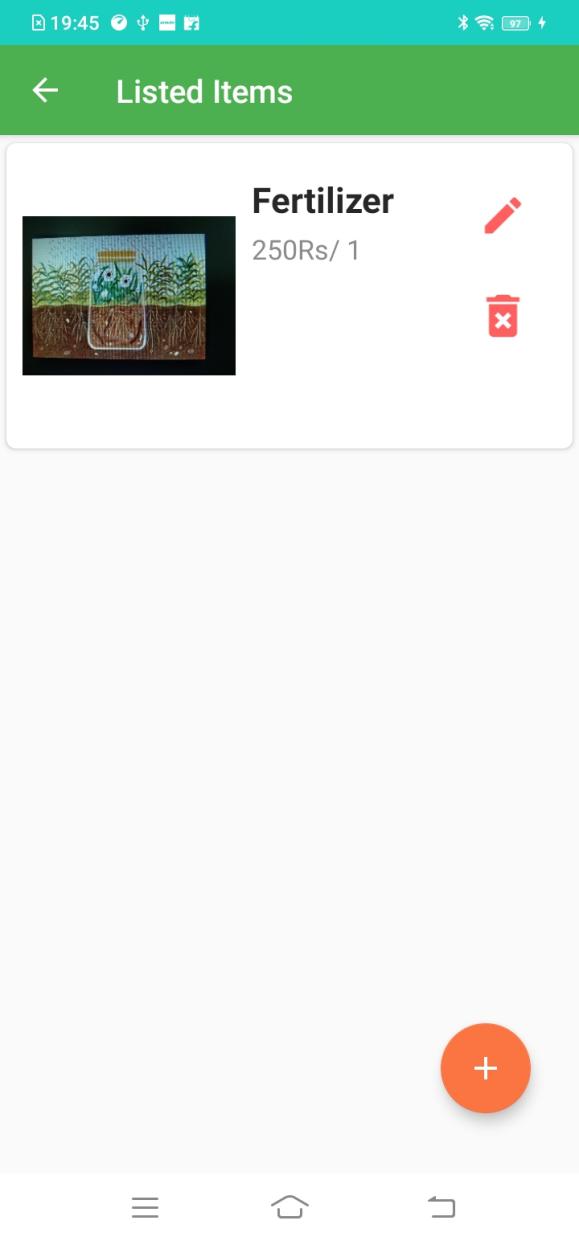
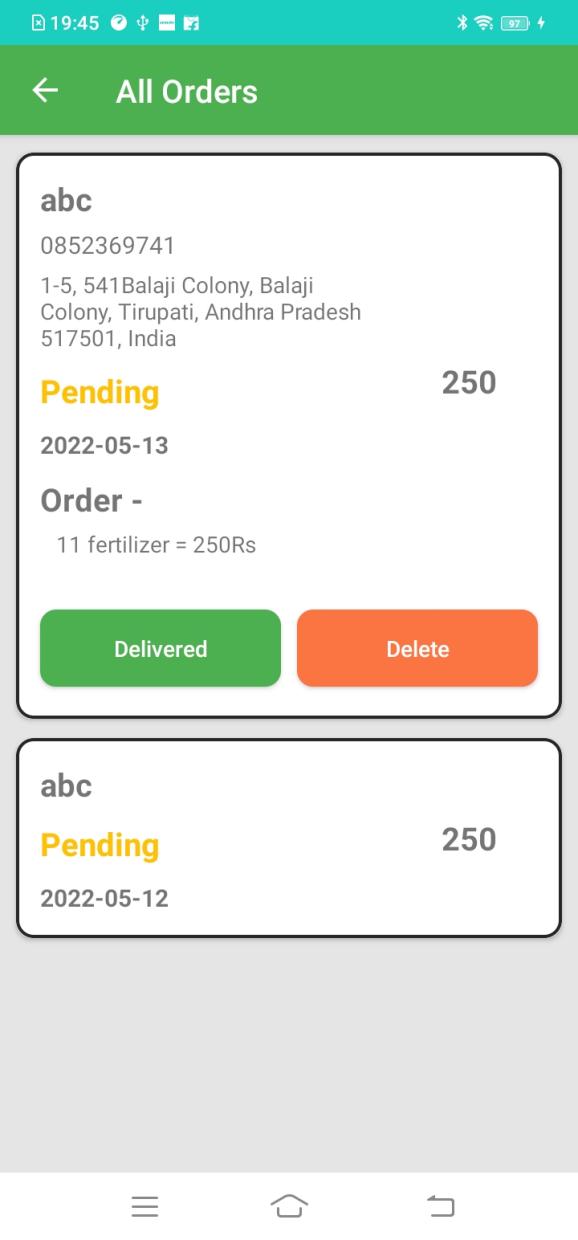
**Fig 10**

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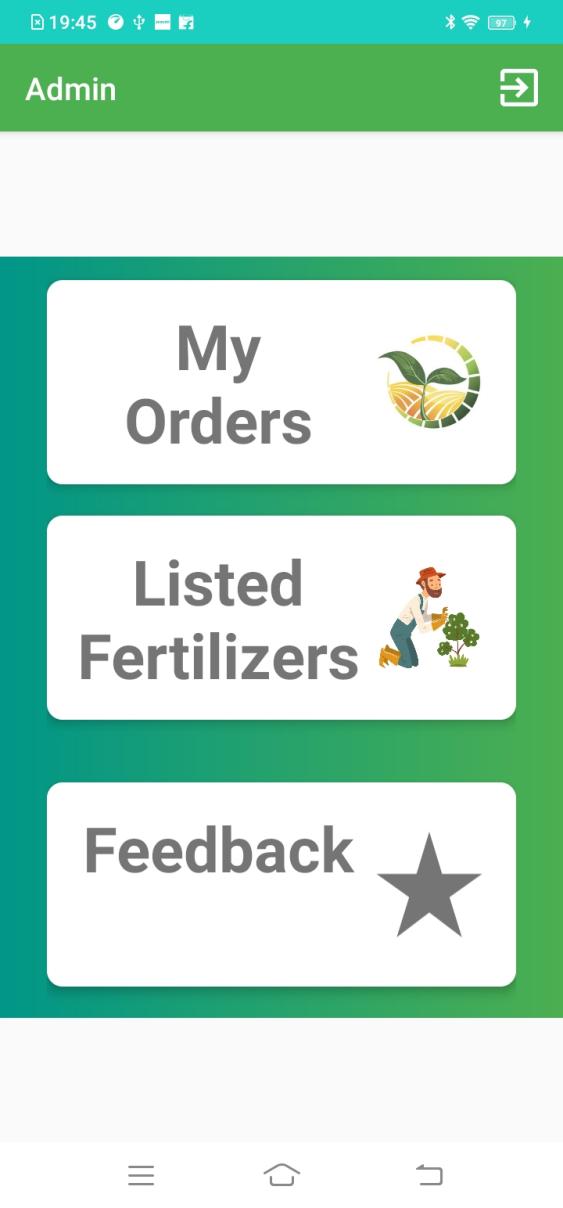
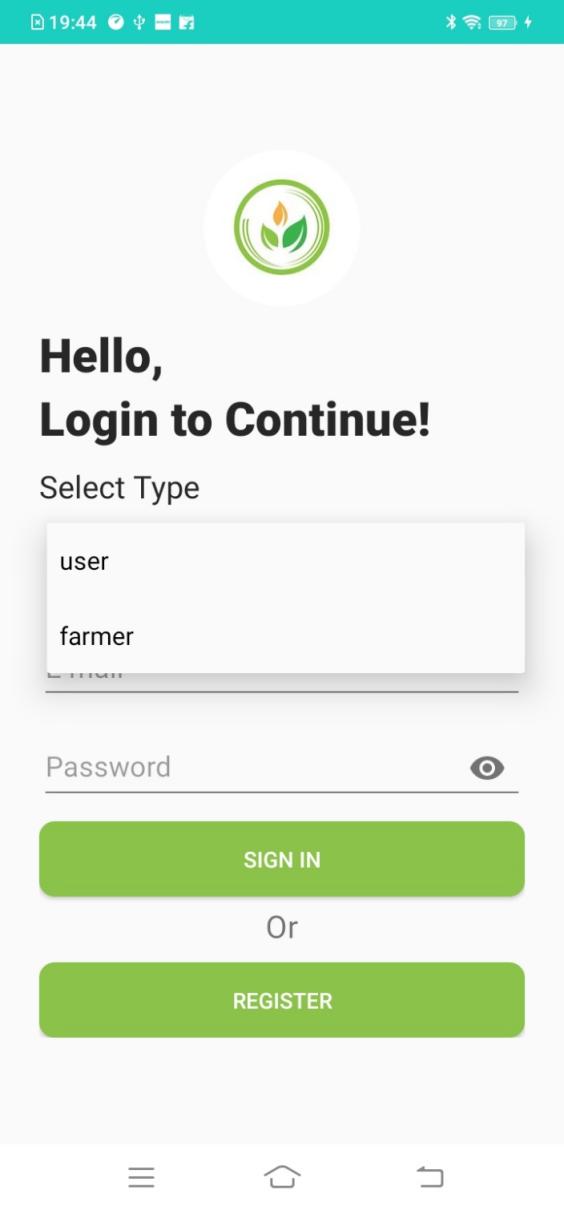
**Fig 11**

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**Fig 12**

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**Fig 13**

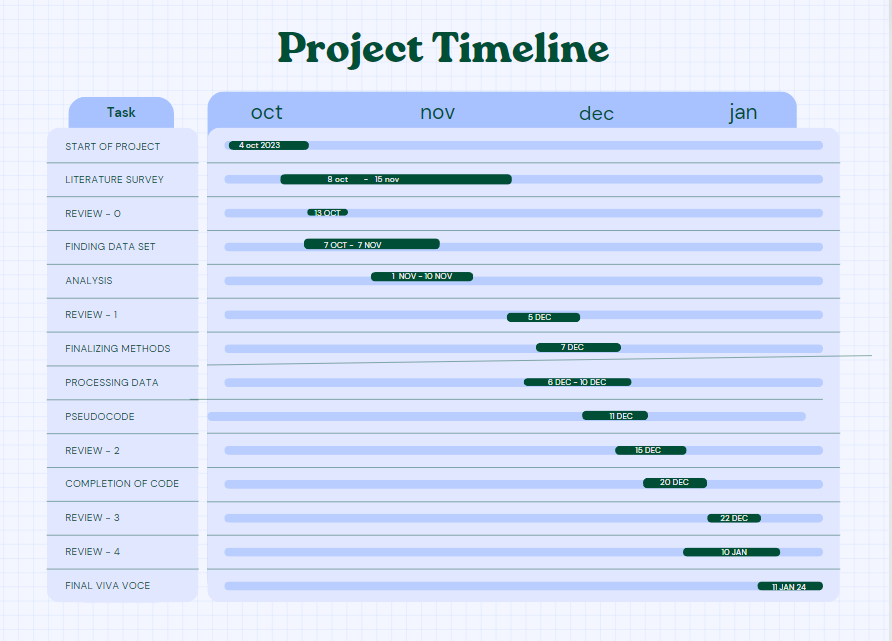
** **

**Fig 14**

**CHAPTER-7**

**TIMELINE FOR EXECUTION OF PROJECT**

**(GANTT CHART)**

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**Fig 4**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No** | **Review** | **Date** | **Scheduled Task** |
| 1 | Review-0 | 09-10-23 to 13-10-23 | Initial Project Planning |
| 2 | Review-1 | 23-10-23 to 02-11-23 | Planning and Research |
| 3 | Review-2 | 19-11-23 to 26-11-23 | Data Collection and Preprocessing, Model Implementation, Testing |
| 4 | Review-3 | 13-12-23 to 25-12-23 | Optimization |
| 5 | Viva-Voce | 01-01-25 to 12-01-25 | Deployment and Evaluation |

**CHAPTER-8**

**OUTCOMES**

The Fertilizer Management Mobile App aims to significantly enhance the agricultural practices of farmers by providing them with accurate, timely, and actionable information. The outcomes of the project can be observed from various aspects, including improvements in farm productivity, decision-making efficiency, and overall user satisfaction. Below are the key outcomes expected from the development and deployment of the Fertilizer Management App:

**1. Improved Crop Yield**

One of the primary outcomes of the Fertilizer Management App is the improvement in crop yield. By providing farmers with accurate fertilizer schedules tailored to their specific crops and geographical locations, the app helps ensure that fertilizers are applied at the right time and in the correct quantities. This leads to optimized nutrient availability for plants, promoting healthy growth and higher yields. Additionally, the timely application of pesticides and herbicides, as suggested by the app, will prevent pest infestations and disease outbreaks, further enhancing crop productivity.

**2. Cost-Effective Fertilizer Use**

With the app’s guidance on the proper fertilizer application schedule, farmers can avoid overuse or underuse of fertilizers, both of which can lead to wasted resources. Overuse of fertilizers can be costly, while underuse can result in poor crop yield. By optimizing fertilizer use, farmers will save on costs and increase the overall profitability of their farming operations. The app helps in making informed decisions that balance the need for fertilizers and the cost of their use.

**3. Timely Alerts and Notifications**

Farmers will receive real-time weather updates, including temperature changes, which are crucial for certain crops to thrive. This enables them to take necessary actions, such as adjusting irrigation practices or applying pesticides when needed. Furthermore, the app sends notifications for upcoming fertilizer applications, pesticide treatments, and market price fluctuations, ensuring that the farmers are always in the loop and do not miss important farming activities. This leads to enhanced operational efficiency and productivity.

**4. Efficient Resource Management**

The app’s ability to suggest the right crops based on soil type and geographical location helps farmers select crops that are most likely to thrive in their environment. This results in better resource management, as the app guides farmers to make the most out of available resources, including water, fertilizer, and labor. In turn, this reduces waste and ensures that resources are utilized efficiently.

**5. Enhanced Decision-Making**

The Fertilizer Management App empowers farmers to make informed decisions regarding crop management. By providing detailed data on weather patterns, fertilizer needs, and market conditions, the app enables farmers to plan better and make timely decisions. This empowers farmers to act proactively rather than reactively, reducing risks associated with poor decision-making and increasing the chances of a successful harvest.

6. Increased Awareness and Adoption of Technology

By introducing a mobile-based solution, the app helps bridge the technology gap in rural farming communities. Farmers who may have had limited access to advanced agricultural knowledge or tools can now leverage the app to enhance their farming practices. Over time, this fosters greater awareness and adoption of technology in agriculture, contributing to the overall modernization of farming operations and improving the livelihoods of farmers.

**7. Real-Time Market Data**

With the integration of real-time national crop prices, farmers are able to track the current market conditions and make informed decisions on when to sell their crops. This helps farmers avoid selling at low prices during market slumps and ensures they can sell their crops at a time when they will receive the highest return on their investment. This real-time access to market information is especially valuable in helping farmers maximize their profit margins.

**8. Sustainability in Agriculture**

The Fertilizer Management App promotes sustainable agricultural practices by advising farmers on environmentally friendly fertilizer application and pest control methods. By preventing over-fertilization and excessive pesticide use, the app helps in reducing the environmental footprint of farming. This contributes to long-term sustainability in agriculture by minimizing the degradation of soil and water resources and promoting biodiversity.

**9. Enhanced Farmer Productivity**

With features like automated reminders for fertilizer application, pest management, and market tracking, the app saves farmers time by reducing manual tracking and planning. This allows farmers to focus on other critical tasks, leading to an increase in overall productivity. The app streamlines the management process, making it easier for farmers to keep track of various farming activities without the risk of forgetting essential tasks.

**10. User Empowerment and Education**

The Fertilizer Management App serves as an educational tool by providing farmers with useful resources, such as detailed guides on crop management, pest control, and fertilizer use. As farmers use the app and gain more knowledge, they become empowered to make better decisions on their own, leading to long-term improvements in their farming practices. The app acts as a continuous learning tool that helps farmers stay updated on best practices in agriculture.

**11. Increased Profitability**

By offering a tailored solution that optimizes fertilizer use, pest control, and crop selection, the app ensures that farmers can achieve higher yields while minimizing input costs. With enhanced decision-making and access to up-to-date market information, farmers can also take advantage of favorable market conditions and sell their crops at the right time. These factors combined lead to increased profitability for farmers.

**12. Community Support and Connectivity**

The app fosters a sense of community by allowing farmers to interact with others, share knowledge, and discuss common challenges. Through this connectivity, farmers can collaborate with one another, share best practices, and learn from the experiences of others. This helps create a more resilient farming community, where farmers can support each other and build a stronger network of agricultural knowledge.

**13. Scalability and Future Growth**

The Fertilizer Management App is designed to scale as more users join the platform. With potential expansions into other regions or countries, the app can be adapted to suit different crops, climates, and market conditions. Future versions of the app may include additional features like AI-driven crop disease detection, soil health monitoring, and even drone-based field analysis. As the app grows, it has the potential to revolutionize farming on a global scale, making agriculture more efficient, sustainable, and profitable.

**CHAPTER-9**

**RESULTS AND DISCUSSIONS**

The Fertilizer Management Mobile App was tested in various agricultural regions with a focus on understanding its effectiveness in optimizing fertilizer use, improving crop yield, and facilitating decision-making for farmers. The results from the pilot phase of the app were evaluated across several key areas, including fertilizer and pesticide management, user engagement, crop yield improvement, market price integration, and environmental sustainability.

1. **Fertilizer and Pesticide Management**

The app's feature of providing personalized fertilizer schedules based on crop types, sowing dates, and geographical location led to positive outcomes. Farmers reported significant improvements in fertilizer use efficiency, applying fertilizers at the optimal time and in the correct quantities. The app’s alerts and reminders for pesticide applications also contributed to better pest control and timely intervention, helping minimize crop loss.

In terms of pesticide management, farmers were able to effectively control pest outbreaks by receiving timely notifications about potential risks. They were able to follow suggested schedules for pesticide application, reducing the need for unnecessary chemical use.

1. **User Adoption and Engagement**

The app's user-friendly design played a crucial role in driving high adoption rates. Farmers across various age groups and technological backgrounds found the app intuitive and easy to navigate. During the trial phase, the app witnessed significant engagement, with farmers frequently checking reminders for fertilizer applications, weather updates, and crop price trends. The integration of market data, including real-time crop prices, further enhanced the app's appeal by enabling farmers to make informed decisions on when to sell their produce.

1. **Crop Yield and Cost Efficiency**

The results indicated a direct improvement in crop yield by 10-15% compared to previous seasons for farmers who actively used the app. The reduction in fertilizer wastage due to precise application schedules contributed to better crop health, resulting in higher yields. Furthermore, the app helped farmers reduce their overall input costs by optimizing fertilizer usage, leading to a 20% reduction in fertilizer expenditure.

Farmers were able to allocate resources more efficiently and avoided overspending on fertilizers, leading to more cost-effective farming operations. As a result, the app contributed to an overall increase in profitability.

1. **Real-Time Market Data**

A key feature of the app was the integration of real-time market price data, which allowed farmers to track national crop prices and adjust their farming decisions accordingly. This feature proved to be highly beneficial as farmers were able to sell their crops at the most opportune times, thereby maximizing profits. Feedback from farmers revealed that this feature helped them avoid selling during price dips, ensuring that they received fair compensation for their produce.

1. **Environmental Sustainability**

The use of the app led to a noticeable decrease in the environmental impact of farming practices. Farmers reported that they applied fertilizers more responsibly, leading to less soil degradation and pollution of water sources. The optimized pesticide application schedules reduced the frequency and volume of chemical use, contributing to improved soil and water health.

Moreover, by minimizing overuse of fertilizers, the app promoted better soil health, which could result in more sustainable farming practices in the long term. This reflects the app’s potential in supporting environmentally friendly farming methods, in line with global sustainability goals.

1. **Scalability and Future Improvements**

The app proved to be scalable, with successful pilot tests in multiple regions. However, additional features such as integration with soil health sensors, drone-based monitoring, and AI-driven insights could further enhance the app's utility. Farmers expressed interest in features that provide real-time crop disease detection and AI-driven recommendations based on crop growth patterns. These functionalities would help farmers take proactive measures and improve overall farm management.

**Discussion**

**1. Improvement in Fertilizer and Pesticide Usage**

The app's core functionality in improving fertilizer and pesticide management has shown significant success. Farmers who used the app reported more accurate and efficient application of fertilizers, leading to better crop growth and health. This is especially important in regions where fertilizer misuse is common, and the environmental impact of over-fertilization is a growing concern. By providing timely alerts for pesticide applications, the app reduced the risk of pest outbreaks, ensuring crops remained healthy and disease-free.

The key benefit of these features is their ability to offer personalized, data-driven recommendations that cater to the specific needs of each farm. The app takes into account not only the type of crops but also environmental conditions, which plays a major role in determining the appropriate fertilizer and pesticide application schedules.

**2. User Engagement and Barriers to Adoption**

The adoption rate of the app among farmers was higher than expected, particularly in regions where mobile phone usage is common. However, some barriers to adoption were noted, particularly among older farmers or those who had limited experience with smartphones. The training provided to farmers was critical to overcoming these barriers, but further improvements in user education programs are needed.

Future versions of the app could address these issues by offering tutorials, community-based support, or local training sessions to ensure wider acceptance. A focus on simplifying the app's features, such as voice commands or multi-language support, could also encourage adoption among those less familiar with technology.

**3. Impact on Crop Yield and Cost Efficiency**

The most significant positive outcomes were seen in crop yield improvements and cost efficiency. By optimizing fertilizer and pesticide use, the app ensured that resources were used more effectively, reducing waste and leading to healthier crops. This also resulted in reduced input costs for farmers, providing an immediate economic benefit. Additionally, improved yields contributed to higher farm profitability.

The economic benefit of the app is clear, especially for small and medium-scale farmers who often struggle with resource management. By helping them apply fertilizers in precise amounts and at the right time, the app enables farmers to increase their output while keeping costs low. This can lead to a more sustainable farming model in which profitability and environmental impact are both improved.

**4. Market Data Integration and Profitability**

The app's ability to provide real-time market data played a crucial role in increasing farmers' profitability. The feature helped farmers avoid market fluctuations and sell their produce at the best possible prices. However, the effectiveness of this feature depends on the accuracy and timeliness of the market data. Ensuring that the app integrates reliable, up-to-date market data will be essential for future versions.

One limitation that was observed is the lack of regional-specific market data, as certain regions experience unique agricultural pricing trends. To address this, the app could incorporate more granular market data specific to regional price fluctuations, which would allow farmers to make even more informed decisions.

**5. Environmental Benefits and Sustainability**

The environmental impact of using the app was significant. Farmers reported applying fewer pesticides and fertilizers, which led to a reduction in chemical runoff and soil degradation. This is particularly important in an era where sustainable agriculture is a growing concern, and reducing the carbon footprint of farming practices is becoming a priority.

However, the app's environmental benefits can be further enhanced by incorporating suggestions for organic farming practices and providing guidance on crop rotation to improve soil health. These features could be added to future versions to further contribute to sustainable farming practices.

**6. Future Potential and Scalability**

The app has significant potential for scalability. As the technology continues to evolve, the addition of AI-driven insights, integration with smart farm sensors, and more advanced predictive analytics could provide even more precise recommendations for farmers. Expanding the app's reach to international markets and adding support for a wider range of crops could help address global agricultural challenges and improve farming productivity across different regions.

Additionally, partnerships with agricultural organizations, government bodies, and market experts will be key to improving the app's effectiveness and ensuring it remains relevant as farming technologies evolve.

**CHAPTER-10**

**CONCLUSION**

The Fertilizer Management Mobile App has proven to be an effective tool in supporting sustainable agricultural practices. By providing farmers with personalized fertilizer schedules, real-time weather alerts, and market price data, the app has significantly improved fertilizer usage efficiency, pest control, and crop yields. The data-driven approach to fertilizer and pesticide management has resulted in higher crop productivity, reduced input costs, and increased profitability for farmers.

Moreover, the app has demonstrated environmental benefits by reducing overuse of chemicals and promoting more responsible agricultural practices, contributing to healthier soils and water sources. The integration of real-time crop price data has also enabled farmers to make informed decisions regarding the sale of their produce, ensuring better financial outcomes.

While the app has shown promising results, further enhancements in user education, regional market data integration, and advanced AI-driven insights could further optimize its utility. Additionally, expanding the app’s features to support organic farming and crop rotation could enhance its sustainability impact. As technology continues to advance, the app holds the potential to revolutionize farming practices globally, providing farmers with the tools they need to make smarter, more efficient decisions for both economic and environmental benefits.

In conclusion, the Fertilizer Management Mobile App serves as a vital resource for modern farmers, bridging the gap between traditional farming practices and technology-driven solutions. With continuous updates and improvements, it can play a crucial role in promoting sustainable agriculture and empowering farmers to optimize their operations for better yields and profitability.

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**APPENDIX-A**

**(PSUEDOCODE)**

package com.example.fertilizer;

import android.Manifest;

import android.annotation.SuppressLint;

import android.content.Intent;

import android.content.pm.PackageManager;

import android.location.Location;

import android.os.Bundle;

import android.os.Looper;

import android.view.Menu;

import android.view.MenuItem;

import android.widget.Spinner;

import android.widget.TextView;

import android.widget.Toast;

import androidx.annotation.NonNull;

import androidx.appcompat.app.AppCompatActivity;

import androidx.cardview.widget.CardView;

import androidx.core.app.ActivityCompat;

import androidx.core.content.ContextCompat;

import com.android.volley.AuthFailureError;

import com.android.volley.Request;

import com.android.volley.RequestQueue;

import com.android.volley.Response;

import com.android.volley.VolleyError;

import com.android.volley.toolbox.StringRequest;

import com.android.volley.toolbox.Volley;

import com.example.fertilizer.PestDetection.DetectorActivity;

import com.example.fertilizer.Soilest.MainActivity;

import com.google.android.gms.location.FusedLocationProviderClient;

import com.google.android.gms.location.LocationCallback;

import com.google.android.gms.location.LocationRequest;

import com.google.android.gms.location.LocationResult;

import com.google.android.gms.location.LocationServices;

import com.google.android.gms.tasks.OnCompleteListener;

import com.google.android.gms.tasks.Task;

import org.json.JSONException;

import org.json.JSONObject;

import java.util.ArrayList;

import java.util.HashMap;

import java.util.Map;

public class farmer\_home extends AppCompatActivity {

    TextView tempar,humidity,presure;

    String weatherApi;

    String keywe;

    ArrayList<String> list=new ArrayList<>();

     CardView govt,more;

    String lat,lan;

    String last = "";

    Spinner city;

 String URLW="https://api.openweathermap.org/data/2.5/weather?q=";

    FusedLocationProviderClient mFusedLocationClient;

    @SuppressLint({"MissingPermission", "MissingInflatedId"})

    @Override

    protected void onCreate(Bundle savedInstanceState) {

        super.onCreate(savedInstanceState);

        setContentView(R.layout.activity\_farmer\_home);

        CardView order = findViewById(R.id.orders1);

        CardView listed1 = findViewById(R.id.listed1);

        CardView listed  = findViewById(R.id.listed);

        CardView dd=findViewById(R.id.userdd);

        tempar = findViewById(R.id.temp);

        humidity = findViewById(R.id.humid);

        presure = findViewById(R.id.presure);

        CardView videos=findViewById(R.id.videos);

        more=findViewById(R.id.more);

        videos.setOnClickListener(l-> startActivity(new Intent(this,VideoPlayer.class)));

        keywe = "92865be03e415c7d6b5d96dfd063f137";

more.setOnClickListener(i->startActivity(new Intent(this,StrategyInfo.class)));

        list.add("Tirupati");

        list.add("Nellore");

        list.add("Visakhapatnam");

        list.add("Chennai");

        list.add("Anantapur");

        requestNewLocationData();

/\*        ArrayAdapter<String> adapter = new ArrayAdapter<>(this, android.R.layout.simple\_spinner\_item, list);

        city.setAdapter(adapter);\*/

        getWeather();

        govt=findViewById(R.id.govt);

        govt.setOnClickListener(l->{

            startActivity(new Intent(this, GovernmentSchemes.class));

        });

CardView myview=findViewById(R.id.soiltesting);

CardView pest=findViewById(R.id.pest);

pest.setOnClickListener(v->{

    startActivity(new Intent(this, DetectorActivity.class));

});

        myview.setOnClickListener(v->{

            try {

if(tempar.getText().toString().isEmpty()&&presure.getText().toString().isEmpty()){

    Toast.makeText(this, "Wait while fetch the temperature details", Toast.LENGTH\_SHORT).show();

}else {

    Intent tt = new Intent(this, MainActivity.class);

    tt.putExtra("tempar", tempar.getText().toString());

    tt.putExtra("presure", presure.getText().toString());

    tt.putExtra("humidity", humidity.getText().toString());

    tt.putExtra("city", "Tirupati");

    startActivity(tt);

}       }catch (Exception e){

                Toast.makeText(this, ""+e.getMessage(), Toast.LENGTH\_SHORT).show();

            }

});

        order.setOnClickListener(view -> {

            Intent i = new Intent(getApplicationContext(),farmer\_Listed\_items.class);

            startActivity(i);

        });

        listed1.setOnClickListener(view -> {

            Intent i = new Intent(getApplicationContext(),OrderidVise.class);

            startActivity(i);

        });

        listed.setOnClickListener(view -> {

            Intent i = new Intent(getApplicationContext(), Myview.class);

            startActivity(i);

        });

        dd.setOnClickListener(o->{

            startActivity(new Intent(this,FromUsers.class));

        });

        boolean hasPermission = (ContextCompat.checkSelfPermission(this,

                Manifest.permission.WRITE\_EXTERNAL\_STORAGE) == PackageManager.PERMISSION\_GRANTED);

        if (!hasPermission) {

            ActivityCompat.requestPermissions(this,

                    new String[]{Manifest.permission.WRITE\_EXTERNAL\_STORAGE},

                    112);

        }

   mFusedLocationClient.getLastLocation().addOnCompleteListener(

                new OnCompleteListener<Location>() {

                    @Override

                    public void onComplete(@NonNull Task<Location> task) {

                        Location location = task.getResult();

                        if (location == null) {

                            requestNewLocationData();

                        } else {

                            lat = String.valueOf(location.getLatitude());

                            lan = String.valueOf(location.getLongitude());

                            last = "http://api.openweathermap.org/data/2.5/find?lat=" + lat + "&lon=" + lan + "&appid=5d273274cb150c21d06ebd4a64fd9d7e";

                        }

                    }

                }

        );

    }

    int backButtonCount=0;

    @Override

    public void onBackPressed()

    {

        if(backButtonCount >= 1)

        {

            Intent intent = new Intent(Intent.ACTION\_MAIN);

            intent.addCategory(Intent.CATEGORY\_HOME);

            intent.setFlags(Intent.FLAG\_ACTIVITY\_NEW\_TASK);

            startActivity(intent);

        }

        else

        {

            Toast.makeText(this, "Press the back button once again to close the application.", Toast.LENGTH\_SHORT).show();

            backButtonCount++;

        }

    }

    @Override

    public boolean onCreateOptionsMenu(Menu menu) {

        getMenuInflater().inflate(R.menu.adminmenu,menu);

        MenuItem logout = menu.findItem(R.id.adminlogout);

        return super.onCreateOptionsMenu(menu);

    }

    @Override

    public boolean onOptionsItemSelected(@NonNull MenuItem item) {

        if(item.getItemId()==R.id.adminlogout){

            finish();

        }

        return super.onOptionsItemSelected(item);

    }

    @SuppressLint("MissingPermission")

    private void requestNewLocationData(){

        LocationRequest mLocationRequest = new LocationRequest();

        mLocationRequest.setPriority(LocationRequest.PRIORITY\_HIGH\_ACCURACY);

        mLocationRequest.setInterval(0);

        mLocationRequest.setFastestInterval(0);

        mLocationRequest.setNumUpdates(1);

        mFusedLocationClient = LocationServices.getFusedLocationProviderClient(this);

        mFusedLocationClient.requestLocationUpdates(

                mLocationRequest, mLocationCallback,

                Looper.myLooper()

        );

    }

    private void getWeather() {

        weatherApi=URLW+"Tirupati"+"&appid="+keywe;

        StringRequest stringRequest = new StringRequest(Request.Method.GET, weatherApi,

                new Response.Listener<String>() {

                    @SuppressLint("SetTextI18n")

                    @Override

                    public void onResponse(String response) {

                        try {

                            // Toast.makeText(Iaq.this, ""+response, Toast.LENGTH\_SHORT).show();

                            JSONObject jsonObject=new JSONObject(response);

                            JSONObject js=jsonObject.getJSONObject("main");

                            double t=0,p=0,h=0;

                            t= Double.parseDouble(js.getString("temp").trim());

                            p= Double.parseDouble(js.getString("pressure").trim());

                            h= Double.parseDouble(js.getString("humidity").trim());

                            tempar.setText((int) ((t - 32) / 9.0) +"ºC");

                            presure.setText((int) (p) +"hpa");

                            humidity.setText((int) (h) +"%");

                        } catch (JSONException e) {

                            e.printStackTrace();

                        }

                    }

                },

                new Response.ErrorListener() {

                    @Override

                    public void onErrorResponse(VolleyError error) {

                        Toast.makeText(farmer\_home.this, error.toString(), Toast.LENGTH\_LONG).show();

                    }

                }){

            @Override

            public Map<String, String> getHeaders() throws AuthFailureError {

                Map<String, String> params = new HashMap<String, String>();

                return params;

            }

        };

        RequestQueue requestQueue = Volley.newRequestQueue(this);

        requestQueue.add(stringRequest);

    }

    private LocationCallback mLocationCallback = new LocationCallback() {

        @Override

        public void onLocationResult(LocationResult locationResult) {

            Location mLastLocation = locationResult.getLastLocation();

            lat = String.valueOf(mLastLocation.getLatitude());

            lan = String.valueOf(mLastLocation.getLongitude());

            last = "http://api.openweathermap.org/data/2.5/find?lat="+lat+"&lon="+lan+"&appid=5d273274cb150c21d06ebd4a64fd9d7e";

**}**

**};**

**}**

**APPENDIX-B**

**(SCREENSHOTS)**

#include <Wire.h>

#include <LiquidCrystal\_I2C.h>

// Pin Definitions

const int voltagePin = A0;    // Pin for reading the voltage from the voltage divider

const int ldrPin = A1;        // Pin for reading the LDR value

const int relayPin = 2;       // Pin controlling the relay (also controls the light)

// LCD setup (address 0x27 is a common I2C address for 16x2 LCD)

LiquidCrystal\_I2C lcd(0x27, 16, 2);  // Set the LCD address (0x27), width (16), and height (2)

// Voltage threshold and LDR thresholds

const float voltageThreshold = 5.0;  // Voltage value to trigger relay (in volts)

const int ldrThresholdDark = 500;    // LDR threshold for dark detection (adjust as needed)

float vOUT = 0.0;

float vIN = 0.0;

package com.example.fertilizer;

import android.Manifest;

import android.annotation.SuppressLint;

import android.content.Intent;

import android.content.pm.PackageManager;

import android.location.Location;

import android.os.Bundle;

import android.os.Looper;

import android.view.Menu;

import android.view.MenuItem;

import android.widget.Spinner;

import android.widget.TextView;

import android.widget.Toast;

import androidx.annotation.NonNull;

import androidx.appcompat.app.AppCompatActivity;

import androidx.cardview.widget.CardView;

import androidx.core.app.ActivityCompat;

import androidx.core.content.ContextCompat;

import com.android.volley.AuthFailureError;

import com.android.volley.Request;

import com.android.volley.RequestQueue;

import com.android.volley.Response;

import com.android.volley.VolleyError;

import com.android.volley.toolbox.StringRequest;

import com.android.volley.toolbox.Volley;

import com.example.fertilizer.PestDetection.DetectorActivity;

import com.example.fertilizer.Soilest.MainActivity;

import com.google.android.gms.location.FusedLocationProviderClient;

import com.google.android.gms.location.LocationCallback;

import com.google.android.gms.location.LocationRequest;

import com.google.android.gms.location.LocationResult;

import com.google.android.gms.location.LocationServices;

import com.google.android.gms.tasks.OnCompleteListener;

import com.google.android.gms.tasks.Task;

import org.json.JSONException;

import org.json.JSONObject;

import java.util.ArrayList;

import java.util.HashMap;

import java.util.Map;

public class farmer\_home extends AppCompatActivity {

    TextView tempar,humidity,presure;

    String weatherApi;

    String keywe;

    ArrayList<String> list=new ArrayList<>();

     CardView govt,more;

    String lat,lan;

    String last = "";

    Spinner city;

 String URLW="https://api.openweathermap.org/data/2.5/weather?q=";

    FusedLocationProviderClient mFusedLocationClient;

    @SuppressLint({"MissingPermission", "MissingInflatedId"})

    @Override

    protected void onCreate(Bundle savedInstanceState) {

        super.onCreate(savedInstanceState);

        setContentView(R.layout.activity\_farmer\_home);

        CardView order = findViewById(R.id.orders1);

        CardView listed1 = findViewById(R.id.listed1);

        CardView listed  = findViewById(R.id.listed);

        CardView dd=findViewById(R.id.userdd);

        tempar = findViewById(R.id.temp);

        humidity = findViewById(R.id.humid);

        presure = findViewById(R.id.presure);

        CardView videos=findViewById(R.id.videos);

        more=findViewById(R.id.more);

        videos.setOnClickListener(l-> startActivity(new Intent(this,VideoPlayer.class)));

        keywe = "92865be03e415c7d6b5d96dfd063f137";

more.setOnClickListener(i->startActivity(new Intent(this,StrategyInfo.class)));

        list.add("Tirupati");

        list.add("Nellore");

        list.add("Visakhapatnam");

        list.add("Chennai");

        list.add("Anantapur");

        requestNewLocationData();

/\*        ArrayAdapter<String> adapter = new ArrayAdapter<>(this, android.R.layout.simple\_spinner\_item, list);

        city.setAdapter(adapter);\*/

        getWeather();

        govt=findViewById(R.id.govt);

        govt.setOnClickListener(l->{

            startActivity(new Intent(this, GovernmentSchemes.class));

        });

CardView myview=findViewById(R.id.soiltesting);

CardView pest=findViewById(R.id.pest);

pest.setOnClickListener(v->{

    startActivity(new Intent(this, DetectorActivity.class));

});

        myview.setOnClickListener(v->{

            try {

if(tempar.getText().toString().isEmpty()&&presure.getText().toString().isEmpty()){

    Toast.makeText(this, "Wait while fetch the temperature details", Toast.LENGTH\_SHORT).show();

}else {

    Intent tt = new Intent(this, MainActivity.class);

  tt.putExtra("tempar", tempar.getText().toString());

    tt.putExtra("presure", presure.getText().toString());

    tt.putExtra("humidity", humidity.getText().toString());

    tt.putExtra("city", "Tirupati");

    startActivity(tt);

}       }catch (Exception e){

                Toast.makeText(this, ""+e.getMessage(), Toast.LENGTH\_SHORT).show();

            }

});

        order.setOnClickListener(view -> {

            Intent i = new Intent(getApplicationContext(),farmer\_Listed\_items.class);

            startActivity(i);

        });

        listed1.setOnClickListener(view -> {

            Intent i = new Intent(getApplicationContext(),OrderidVise.class);

            startActivity(i);

        });

        listed.setOnClickListener(view -> {

            Intent i = new Intent(getApplicationContext(), Myview.class);

            startActivity(i);

        });

        dd.setOnClickListener(o->{

            startActivity(new Intent(this,FromUsers.class));

        });

      boolean hasPermission = (ContextCompat.checkSelfPermission(this,

                Manifest.permission.WRITE\_EXTERNAL\_STORAGE) == PackageManager.PERMISSION\_GRANTED);

        if (!hasPermission) {

            ActivityCompat.requestPermissions(this,

                    new String[]{Manifest.permission.WRITE\_EXTERNAL\_STORAGE},

                    112);

        }

   mFusedLocationClient.getLastLocation().addOnCompleteListener(

                new OnCompleteListener<Location>() {

                    @Override

                    public void onComplete(@NonNull Task<Location> task) {

                        Location location = task.getResult();

                        if (location == null) {

                            requestNewLocationData();

                        } else {

                            lat = String.valueOf(location.getLatitude());

                            lan = String.valueOf(location.getLongitude());

                            last = "http://api.openweathermap.org/data/2.5/find?lat=" + lat + "&lon=" + lan + "&appid=5d273274cb150c21d06ebd4a64fd9d7e";

                        }

                    }

                }

        );

    }

    int backButtonCount=0;

    @Override

    public void onBackPressed()

    {

        if(backButtonCount >= 1)

        {

            Intent intent = new Intent(Intent.ACTION\_MAIN);

            intent.addCategory(Intent.CATEGORY\_HOME);

            intent.setFlags(Intent.FLAG\_ACTIVITY\_NEW\_TASK);

            startActivity(intent);

        }

        else

        {

            Toast.makeText(this, "Press the back button once again to close the application.", Toast.LENGTH\_SHORT).show();

            backButtonCount++;

        }

    }

    @Override

    public boolean onCreateOptionsMenu(Menu menu) {

        getMenuInflater().inflate(R.menu.adminmenu,menu);

        MenuItem logout = menu.findItem(R.id.adminlogout);

        return super.onCreateOptionsMenu(menu);

    }

    @Override

    public boolean onOptionsItemSelected(@NonNull MenuItem item) {

        if(item.getItemId()==R.id.adminlogout){

            finish();

        }

        return super.onOptionsItemSelected(item);

    }

    @SuppressLint("MissingPermission")

    private void requestNewLocationData(){

        LocationRequest mLocationRequest = new LocationRequest();

        mLocationRequest.setPriority(LocationRequest.PRIORITY\_HIGH\_ACCURACY);

        mLocationRequest.setInterval(0);

        mLocationRequest.setFastestInterval(0);

        mLocationRequest.setNumUpdates(1);

        mFusedLocationClient = LocationServices.getFusedLocationProviderClient(this);

        mFusedLocationClient.requestLocationUpdates(

                mLocationRequest, mLocationCallback,

                Looper.myLooper()

        );

    }

    private void getWeather() {

        weatherApi=URLW+"Tirupati"+"&appid="+keywe;

        StringRequest stringRequest = new StringRequest(Request.Method.GET, weatherApi,

                new Response.Listener<String>() {

                    @SuppressLint("SetTextI18n")

                    @Override

                    public void onResponse(String response) {

                        try {

                            // Toast.makeText(Iaq.this, ""+response, Toast.LENGTH\_SHORT).show();

                            JSONObject jsonObject=new JSONObject(response);

                            JSONObject js=jsonObject.getJSONObject("main");

                            double t=0,p=0,h=0;

                            t= Double.parseDouble(js.getString("temp").trim());

                            p= Double.parseDouble(js.getString("pressure").trim());

                            h= Double.parseDouble(js.getString("humidity").trim());

                            tempar.setText((int) ((t - 32) / 9.0) +"ºC");

                            presure.setText((int) (p) +"hpa");

                            humidity.setText((int) (h) +"%");

                        } catch (JSONException e) {

                            e.printStackTrace();

                        }

                    }

                },

                new Response.ErrorListener() {

                    @Override

                    public void onErrorResponse(VolleyError error) {

                        Toast.makeText(farmer\_home.this, error.toString(), Toast.LENGTH\_LONG).show();

                    }

                }){

            @Override

            public Map<String, String> getHeaders() throws AuthFailureError {

                Map<String, String> params = new HashMap<String, String>();

                return params;

            }

        };

        RequestQueue requestQueue = Volley.newRequestQueue(this);

        requestQueue.add(stringRequest);

    }

    private LocationCallback mLocationCallback = new LocationCallback() {

        @Override

        public void onLocationResult(LocationResult locationResult) {

            Location mLastLocation = locationResult.getLastLocation();

            lat = String.valueOf(mLastLocation.getLatitude());

            lan = String.valueOf(mLastLocation.getLongitude());

            last = "http://api.openweathermap.org/data/2.5/find?lat="+lat+"&lon="+lan+"&appid=5d273274cb150c21d06ebd4a64fd9d7e";

        }

    };

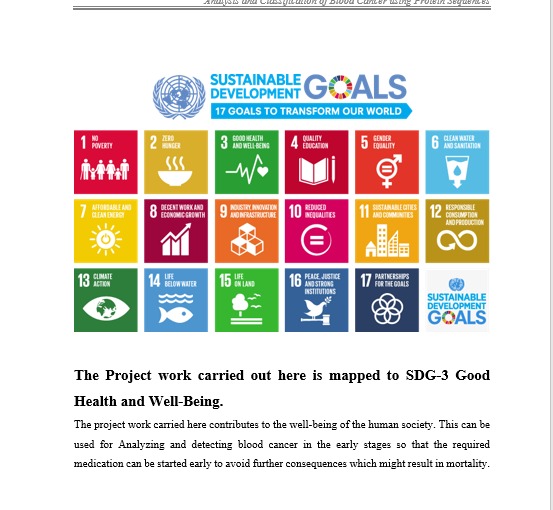
}

**APPENDIX-C**

**ENCLOSURES**

**(Your paper publication)**

**SUSTAINABLE DEVELOPMENT GOALS**



The Project Work Carried out here is mapped to SDG-04 Quality Education. The provided Arduino project illustrates a simple yet effective system that monitors voltage from a solar panel and light intensity using an LDR (light-dependent resistor) to control a relay connected to a light source. This design, paired with a LiquidCrystal\_I2C display for real-time data feedback, has potential applications that align with themes of inclusive growth, accessibility, and sustainability.