

**A Web-based farming assistant app to help the farmers in their daily activities
and aid in better decision making.**

Final Year Project COMP1682

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Submission date: **01th April 2021**

Word count: **23562 (not counting appendices)**

Abstract

The world's population is growing, as well as the demand for food. Many developed countries are trying to find alternative ways to grow food and fulfill the increasing demand for food supply. Developed countries are now adopting AI and IoT technologies to increase their farming capabilities (Rudolph, 2019). But the underdeveloped or poor countries with an unstable financial situation are deprived of the advantage of AI and IoT in the agriculture industry, due to the expense and lack of technological advancement.

This motivated me to develop an e-Agriculture system that will be focused on improving agriculture and rural development by providing better information and communication system (Chauhan, 2015). The web-based system is aimed to help farmers increase their crop yield and decrease the production cost by helping them make better decisions and help them maintain or manage their daily farming activities.

To develop this project proper research, planning, analysis, and testing will be done to ensure the best outcome. To create the system and manage the development process a development framework will be followed as a guideline/rule to ensure effectiveness and work efficiency. Hopefully, the output web application from this project will be very helpful for the farmers.

Acknowledgments

Alhamdulillah, I was able to complete the project successfully within the deadline. I am grateful to Almighty ALLAH and would like to express my gratitude to Him. I would like to especially thank my loving course coordinator Mr. MUSTAFIZUR RAHMAN for continuing the online class during the COVID-19 pandemic situation. Without his inevitable contribution, academic support, and guidance, it would be impossible for me to complete the project on time. I would also like to express my gratitude to my project supervisor Md. MINHAJ HOSEN for guiding and motivating me to finish the project.

I would also like to give thanks to my family, friends, and relatives for supporting me morally over the past year.

Important links related to the project:

Tile	URLs
Project Demonstration video link.	https://drive.google.com/drive/folders/1ngedrxliXMbF1kvtQGVIFTtVdAPB7_jy?usp=sharing
Project source code GitHub link.	https://github.com/nahidnfr123/SmartAgroProjectSubmission.git
Link to important diagrams and images related to the project.	https://drive.google.com/drive/folders/1pExluVpdRTOOnWeco1_y3Vslh6P4DW_2Y?usp=sharing

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1. Introduction

1.1. Background

Agriculture has been the backbone for many developing countries like Bangladesh, India, Sri Lanka, etc. As the world's population is growing, more and more food is consumed and is required to grow more. Running a profitable farm today is harder than ever. A high amount of time energy and labor is spent, although about 30% of the crops grown are wasted. Farmers are entrepreneurs who are consistently challenged by complex situations like weather conditions, disease, pests, bugs (insects), competitive market, knowledge gap, etc. Farmers around the world face loss due to these situations. Moreover due to the lack of communication farmers need to buy products (seeds, fertilizer, pesticides, etc.) through the mediator (agents) which increases the production cost, and when it comes to selling products they do not get the expected profit.

Developed countries like America, Israel, etc. use modern technologies such as machinery, robots, drones, AI technology, BIG data, etc. to maximize their yield. It is not an easy process to implement such technologies in a country like Bangladesh. Therefore alternative ways to improve agriculture and the farmer's life need to be found.

The proposed system is dedicated to the farmers, they can use the system for free to manage their farms efficiently and keep track of their yield. Farmers will be able to sell their cultivated products to consumers and retailers. Farmers will be able to communicate with buyers and agriculture officers using the system.

1.2. Aims

The main aim of this research is to develop a web-based farming assistant app that will be able to help the farmers manage and keep track of their daily farming activities and will aid in better decision making. The system will also make the communication and the agro marketing process more transparent.

1.3. Objectives

The objectives for this project is given below:

- ❖ **Objective 1:** Extensive research/investigation on similar products to exploit the weakness or gaps in the existing solutions.
- ❖ **Objective 2:** Analyze the system requirement specification for managing the farming.
- ❖ **Objective 3:** Research the usability and design specification of the product.
- ❖ **Objective 4:** Develop a useable product/solution.
- ❖ **Objective 5:** Test and evaluate the developed solution.
- ❖ **Objective 6:** Generate the project research report.

1.4. Project Scope

The scope of this project is to identify the current issues in the agriculture sector in developing countries and find out the possible solution and finally develop the solution.

The final product from this project will ensure a common platform for farmers, retailers, and consumers to buy and sell products. It will enhance the communication process

in the agricultural sector and open doors to potential modern agricultural knowledge for rural farmers.

1.5. Nature of Challenges

Due to the current COVID19, pandemic situation requirement gathering for the proposed project will be a challenging task. Interviews, surveys, and questionnaires session needs to be held with the end-users, arranging this session will be difficult due to lockdowns all over the country. Farmers in the Asian region are mostly illiterate. They do not have the proper knowledge to use and interact with the system. Training and motivating the farmers to use and adapt to the new system might be a challenging task. Pilot programs need to be executed to educate the farmers to use the new system. Reaching the farmers on their field will also be difficult. As this is a solo project, all the research and development work needs to be done by a single person. Completing and delivering the project within the fixed time limit might also be challenging.

2. Literature Review

2.1. Approach to literature searching

To carry out this research, it is essential to ensure that all the information is collected from a relevant, authentic source and is cited by other academics (Rowley & Slack, 2004). This research focuses on the agriculture industry and the issues it is currently facing, based on academic journals, articles, and research papers. The literature review is a summary of established research works on a particular topic. The literature review is done to demonstrate a solid understand of the research topic and to find the problem areas and gaps in previous researches (Rowley & Slack, 2004).

2.2. Discussion on the problem domain

Agriculture is the oldest occupation, more than half of the globe's population is directly or indirectly dependent on the livelihood of agriculture (Committee, 1985). Pests, disease, nutritional deficiency, climate change, and other factors all lead to losses for farmers around the world (Jadhav, et al., 2020). They rely on the local knowledge obtained from other farmers or experts like extension workers from the agriculture department (Chandak, 2020) (Bank, 2008). Staffs from the agriculture department are not available all the time they also fail to reach everyone and this is a lengthy and complicated process (Chandak, 2020).

2.2.1. Identifying the problem

Bangladesh is one of the most densely populated countries in the world where the demand for food is increasing every day (Hossain, et al., 2019). Being one of the climate hot spots, Bangladesh's agriculture and food production are facing numerous challenges. The agricultural land is decreasing due to various reasons such as industrialization, urbanization, rural housing, river and soil erosion (Rahman, 2017). Inefficient farm management, fragmented market, and supply chain, poor market access, less engagement of women in economic activities are causing poverty and poor nutrition. While the challenges put pressure on food for all, the economic growth and knowledge development on dietary diversity is triggering a rapid change in the market system on the choice of safe and healthy food (Rahman, 2017).

2.2.2. Use of harmful chemicals

In the early days farming was organic when chemical fertilizers and pesticides were not available. After the industrial revolution, modern farmers started using harmful chemical fertilizers and pesticides to improve their crop production and yield. Farmers are interested in the profit they make and are unaware of human and environmental health. Extensive/uncontrolled use of these chemical products leads to the soil, air, and water pollution (Prashar & Shah, 2016). Experiments have shown that long-term use of chemicals and pesticides alters the structure and functional properties of soil microbial communities while also causing a nutrient imbalance in agricultural soil (Prashar & Shah, 2016).

2.2.3. Climate change

According to some research, agriculture and aquaculture is highly dependent on nature and are affected by climate change. Climate change would almost certainly have an effect on food security on a global, regional, and local level. Food supply, access to food, and food quality may all be affected by climate change (EPA, 2017). In developing countries, agriculture and crop yield are highly dependent on rainfall due to poor water irrigation systems. Most of the total agricultural products are grown in this season. According to the Bangladesh Bureau of Statistics (BBS, 2015), climate changes can have serious consequences in an agriculture dependent nation like Bangladesh, where over 55 percent of the overall population is dependent on the livelihood of agriculture and accounts for 17.22 percent of the total GDP (Hossain, et al., 2019). Around 45 percent of the labor employment in Bangladesh is in the agriculture sector (Bank, 2016).

2.2.4. Agricultural marketing

A survey conducted by Dr. Michael Gold, Dr. Corinne Valdiivia, and Dr. Laura McCann (2007) found that the main problem of farmers is they do not get the actual value for the products they produce (Valdivia , et al., 2007). Agricultural marketing deals with the marketing of agricultural product outcomes. And the movement flows from farmers, primary trades, wholesalers, importers, exporters, and retailers. Farmers have limited access to market information, have a low literacy rate, and have multiple distribution channels that drain both farmer's and consumers' pockets. Farmers' government support is still in its infancy, and most

small farmers depend on leeches who charge exorbitant interest rates. Vultures prey on the profit that farmers are expected to get (Abishek & M. Bharathwaj, 2016). Farmers are forced to sell their products at a very low price, to the middle man, the money lenders, or the landlords. Due to the involvement of mediators, the product's price becomes higher than it should be, which makes consumers suffer (Abishek & M. Bharathwaj, 2016).

Because of the involvement of many ventures, the products go through different stages before reaching the consumer. The products are stored for months which causes food to rot and waste. Harmful preservatives and formalin are used to make the products look fresh for a long time. Sometimes ventures also create syndicates to stores products and create artificial food shortages to raise the product price and gain more profit (Levi, et al., 2020). Ineffective market surveillance to discourage syndication causes an artificial shortage of food and raises prices (CRI, 2014).

2.2.5. Knowledge and information gap:

Till today most of the farmers in rural areas depend on the local or indigenous knowledge of agriculture. Indigenous or local knowledge means, skills, and/or experiences obtained through tradition and practice that has been passed down over generations (Obidike, 2011). Farmers in rural areas lack access to relevant modern farming knowledge and information that would help them obtain higher yields. They are not only left in the dark but are also forced to seek formal jobs in urban areas as their only means of survival (Obidike, 2011).

2.2.6. Agricultural loan:

As reported by the Green Revolution that the latest technological breakthrough has resulted in major improvements in production and increased the degree of the composition of costs associated with the manufacturing process (Alauddin & Biswas, 2014). New technologies are capital intensive, farmers in rural areas and small farmers are poor, they cannot easily have access to these modern technologies (Alauddin & Biswas, 2014). Only 25 percent of Bangladesh's 2 core 60 lac farmers accept agriculture (Krishi) and Polli loans. Because of their lack of awareness about the loan application process and the non-cooperative nature of bank staff, a substantial majority of the remaining 75 percent of the farmers do not apply for loans. Among the loan seekers, about 75 percent have to face loss instead of profit due to the high-interest rate (Onlinekrishi, 2021). There are various government agricultural debt waiver and relief programs. But these government programs usually fail to reach small farmers in rural areas.

2.2.7. Machinery and drone use

The introduction of machinery and drones in agriculture may be threatening for some countries as fewer people will be required to work in the field. Therefore workers may need to find other jobs which are very difficult in a country like Bangladesh, where even educated people struggles to find a job. Moreover, the use of machinery and drone will increase mechanical and e-waste.

2.2.8. Planting material

Selecting the correct type of quality planting material is one of the most important aspects for obtaining a good quality product and a higher yield (Hotegni, et al., 2015). Rural farmers are not able to find good quality planting materials due to the knowledge and communication gap. Sometimes farmers are cheated by seed sellers as they sell wrong or low-quality seeds, which leads to losses in production and yield (Bertin, et al., 2012). A recent report in Bangladesh shows that farmers in a district have been cheated by seed sellers as they have provided fake onion seeds to farmers. After the onion plants have grown farmers realized that they will not get their expected yield.

Due to these problems, the contribution of the agriculture sector in the total GDP of Bangladesh is decreasing day by day.

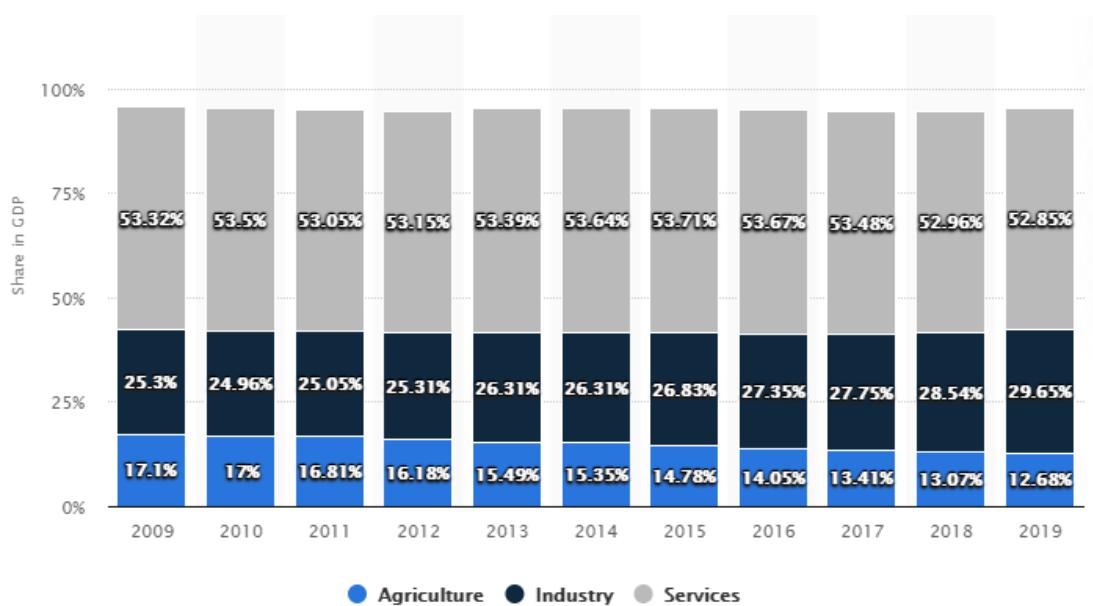


Figure 1: Bangladesh's Gross Domestic Product (GDP) Share of Economic Sectors from 2009 to 2019 (Statista, 2020).

2.3. Discussion on problem solutions

In this section solutions to the above-discussed problems will be outlined based on the published journals, research papers, and articles.

2.3.1. Eliminate the information gap using ICT

Information and communication technology (ICT) can be simply described as a set of technologies that aid in the storage, processing, distribution, and communication of data, information, or both (A, 2017). As a result, it involves technologies such as hardware and software peripherals that are connected to the internet to perform communication and information processing (A, 2017).

E-Agriculture is one such idea that is making a significant contribution to the improvement of the agricultural process. ICT's main function in agriculture is to facilitate broad access to information, which will aid knowledge sharing and decision-making. (A, 2017). Modern information technology can boost agricultural production by moving knowledge and information from rural areas to agricultural practitioners (Dey, et al., 2008).

According to Lio and Liu (2006), there is a close connection between farmer productivity and the use of ICT. They believe that using ICT's will help farmers increase their negotiation power (Lio & Liu, 2006). With access to information, small-scale farmers can compete more effectively with large operators. They can also gain Information about crop selection, produce products for niche markets, and market the products directly to customers. Small farmers are at the generosity

of the international market force if they lack access to information and communication skills (Dey, et al., 2008).

The growing use of cell phones by farmers has inspired the creation of a mobile-based solution to bridge the information gap. Farmers needed both relevant authentic information about crops, diseases, pests, insects, land planning, harvesting and growing methods, and dynamic information like present crop production and market prices. Agriculture divisions, agrochemical firms, consumers, and various government agencies all need this situational data to assure food security through efficient supply chain planning while reducing waste. To inspire farmers to act on this information, they have used empowerment theory to establish empowerment-oriented agriculture practices and collated transaction data to produce situational information. As a result, the original mobile-based Information system has developed into a Digital Knowledge Ecosystem which can forecast existing production conditions in almost real-time, allowing government agencies to dynamically adapt the incentives given to farmers for growing various kinds of crops to achieve sustainable agriculture production through crop diversification. (Ginige , et al., 2016).

The main idea is to create an Agricultural Knowledge Center (AKC) specifically designed for farmers where they will be able to gain authentic knowledge about modern farming techniques, cope up with or reduce the impact of climate change or natural disasters, pests, and disease control, etc. Farmers should be able to get access to AKC using their internet connectable devices for example a mobile phone, computer, etc. (Dayu, 2012).

2.3.2. Online Agricultural marketing system

The main problem of the agro-business system is the middleman (Michael, et al., 2020). Middleman provides a link between farmer and buyer, they know the market working condition and have access to agro market information (Michael, et al., 2020). To reduce the information gap of farmers a system can be developed which would allow farmers to access current market information and allow them to easily connect and communicate with retailers and consumers so that they can buy and sell their goods at a profitable price. To ensure that farmers earn a fair price by developing new techniques and using the online market. The application should act as a forum for agricultural products to be transported directly from farms to consumers or retailers. This smartphone and web application should allow farmers and customers or retailers to buy and sell farm products at the best possible price without the intervention of a middleman (Abishek & M. Bharathwaj, 2016).

2.3.3. Digitalize agricultural loan application process

Farmers in rural are small and economically unfeasible. Most farmers seek loans from landowners or local money lenders at very high interest (Abishek & M. Bharathwaj, 2016). Government agencies banks and NGOs should step forward to provide loans to farms. Proper knowledge about the availability of loans and the loan-seeking process should be provided to farmers. The application process for a loan should be digitalized by using UDC or mobile applications. The loan-seeking process should be transparent, farmers should be made aware of the availability

of loans and allow them to apply, track and visualize their progress of loan application (Onlinekrishi, 2021).

2.3.4. Mitigating Climate change impacts

Climate change is threatening agriculture in South Asia. As a result, to sustain agricultural production, minimize vulnerability, and increase the agricultural system's resistance to climate change, adaptation majors are needed. To mitigate the effects of climate change, many adaptation practices in the production process have been proposed and tested (Aryal, et al., 2019). Weather forecasts assist in scientifically improving agricultural productivity, reducing risks and losses, and the crop and water use quality (Cabrera, et al., 2007) (Hansen, 2011). Using accurate/optimum weather predictions, crop losses can be reduced by doing some crop management ahead of time and choosing agriculture crops that are best suited to the predicted climatic conditions (Kenkel & Norris, 1995). The adoption and use of technological advances such as irrigation, mechanization, fertilizers, rainwater harvesting technology, pesticides/ insecticides, meteorological knowledge, and new crop varieties resistant to adverse climatic conditions as a solution for climate change are the most promising and explored means to mitigate climate change (Chuku & Okoye, 2019). The key reason for the low absorption of technical options as climate change mitigation strategies has been attributed to a lack of financial support for farmers and inadequate institutional support (Kumar, et al., 2017).

2.3.5. Pests and disease control

Every year, delayed identification of crop disease has a major effect on global crop production. Pests and diseases are some of the most important aspects to consider in agriculture (Jadhav, et al., 2020). Farmers in rural areas are unaware of new pests and diseases. In this case, a system (mobile application) could be developed, by which farmers will be able to take pictures of the affected plant or leaf and upload them to the server. The server will detect the disease and suggest the farmers to take necessary precautions (Jadhav, et al., 2020). If in any case the system fails to detect the problem farmers will be able to connect to agriculture offices in a video call and seek for a solution.

2.3.6. Planting materials / Seed bank:

Due to the reorganization of the effect of quality planting material on the livelihood of agriculture, natural seed, and seedling programs have emerged. However, these programs' limited capacity, slow expansion of the private sector, the existence of subsistence farmers' demand forced them to search out alternative models (Bertin, et al., 2012). The scientist has developed genetically modified seeds which can resist viruses and diseases and have the capability of producing higher yield (Rostoks, et al., 2019). These advanced planting materials are not available to rural farmers. An online system should be developed where farmers will be able to choose the variety of seeds or any other planting material they need and place their order. In this way, all the farmers will be able to buy products at a common price.

2.4. Recommended approach

After reading, analyzing, and understanding academic journals, articles, and researches some recommended approach is given below:

- An e-commerce market platform could be developed dedicated to the farmers where farmers will be able to sell their products at a proper price.
- Farmers lack proper knowledge and information. A knowledge center could be developed where farmers will be able to gain knowledge of modern farming from watching videos or reading articles.
- An accurate weather update system should be developed for farmers so that farmers can harvest their crops at the right time.
- The communication gap is a major problem in rural areas. A system could be developed that enabled farmers to communicate with retail and agricultural officers easily.

2.5. Conclusion

After analyzing and reviewing literature from many other established sources such as journals, articles, and research papers, etc., it was found that the development of sustainable agriculture is essential for survival. The research identified the vulnerable spot and problems in the agricultural sector. Research also confirmed that there is a lot of room for growth and development in this sector, which can lead to lots of opportunities.

3. Product research

To enhance the possibilities in modern agriculture many systems are available on the market, similar to the expected output product of this project. In this section, an in-depth critical analysis of some existing systems was done. The detailed explanations, review, and comparison of the chosen systems are given in the following parts. Both local and international solutions will be considered for the critical analysis.

The selected solutions are critically analyzed and weighted based on the following criteria:

- User Interface (Human-computer interaction, HCI).
- Usability.
- Security.
- Accessibility.
- Features and services.

3.1. Review/Comparison

Through critical analysis, the gaps in some of the leading existing solutions will be found. The problem and gaps in the existing solutions can be fixed in the solution that will be developed. Some of the best solutions were completely paid so those were not considered in critical analysis. Three of the non-paid or trial versions of leading solutions are discussed below:

- **Fosholi:** Fosholi is a Bangladeshi (local) website started in 2018 aimed to develop the agricultural sector by providing agricultural knowledge with the help of ICT. It also enables farmers to buy quality seeds, fertilizer, and pesticides using the system. **Website URL:** <https://fosholi.com>.

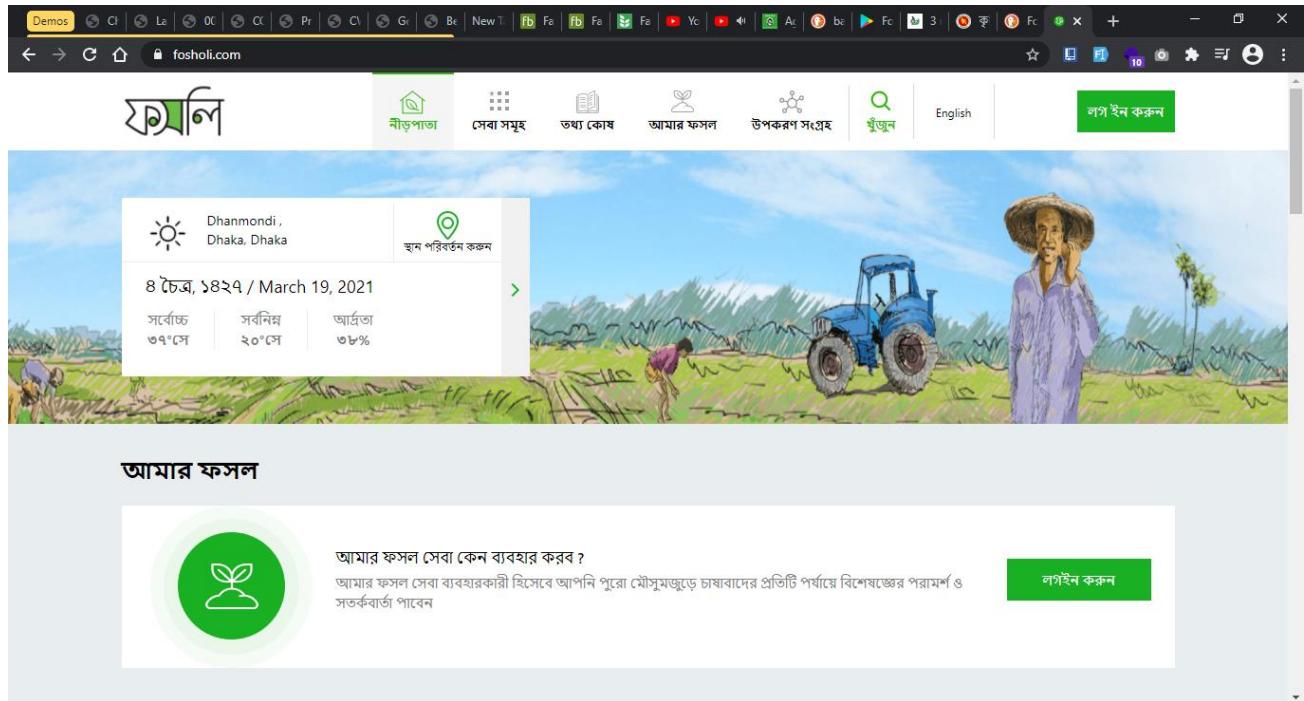


Figure 2: Fosholi.com.

- **Farmlogs:** Farmlogs is a farm management solution started in 2011 aimed to help farmers grow by allowing them access to more data and technology.

Website URL: <https://farmlogs.com>.

The screenshot shows the FarmLogs website. At the top, there's a navigation bar with links for PRODUCTS, DOWNLOAD, COMPANY, BLOG, SUPPORT, LOG IN, and SIGN UP. Below the navigation is a large image of a hand holding a smartphone displaying a circular field map. To the left of the phone, text reads "Powerful software for running a modern farm" and "Plan, manage, monitor, and market from any device." A blue "TRY IT FOR FREE" button is at the bottom of this section. To the right of the phone, there's a screenshot of the FarmLogs software interface showing a "Fields" dashboard with various data points and graphs.

Figure 3: Farmlogs.com.

- **Farmbrite:** Farmbrite is a web-based software used to manage and organize agro-business, established in 2013. **Website:** <https://www.farmbrite.com>.

The screenshot shows the Farmbrite website. The header includes a "Try it Free" button and a "Login" button. The main headline reads "COMPLETE FARM SOFTWARE" and "Everything you need to run a more efficient and productive farm." Below the headline, a subtext states "Farmbrite gives you all the planning, management, tracking, sales and reporting tools you need to run a thriving farm or livestock business." A "GET STARTED" button is prominently displayed. At the bottom, a call-to-action says "The complete software platform for your whole Ag business!" and "Maximize results from seed-to-sale, regardless of what you grow or raise".

Figure 4: Farmbrite.com.

3.1.1.Best features

The best features of the three chosen solutions are outlined below:

Fosholi:

- **Agro knowledge:** Articles on agriculture is available and categorized in sections.
- **Communication:** Farmers can communicate with staff from the agricultural department.
- **Accessibility:** Both the mobile app and web version of the software are available.
- **Climate update:** Real-time weather update is shown to users. Prediction on the effect of weather change on crops is also shown.
- **Online market:** Farmers can buy planting materials, fertilizers, and machinery using the system.
- **Map:** Agricultural map is available which shows different agriculture information on the map (For example, flood, soil condition, pests, and disease risk areas, etc.).
- **Report:** Field reports by the government are provided.
- Very simple login and registration process, using only mobile number.

Farmlogs:

- **Track records:** Keep logs, records, and reviews of all fields in one place.

- **Accessibility:** Both the mobile app and web version of the software are available.
- **GPS field mapping:** Farmers can mark their fields on the map and have a clear aerial view of their field. The system automatically pulls in the last 8 years of field data (rainfall, average crop yield, etc.) once a field is marked on the map.
- **Agricultural knowledge:** Pesticide database and service records are available.
- **Real-time price update:** Search local price using ZIP code and ability to view current future price benchmarked against daily price fluctuations.
- **Reports:** The system can generate reports from user data.
- **Climate change:** Ability to track current and previous rainfalls.

Farmbrite:

- **Task and schedule:** Using the system farmers can assign tasks, collaborate with teams, automate reminders and notification, and track tasks.
- **Crop planning:** Crop planning, monitoring, and harvesting are all made easier.
- **Equipment and resource:** Enhanced resource management and monitoring.
- **Livestock management:** Grazing, monitoring, and reporting of livestock are all made easier.

- **Accounting and financials:** Farm financial reporting is streamlined.
- **Online e-Commerce store:** Market and sell your products on the internet. Order and sales monitoring can be made easier.
- **Report and analytics:** The system generates reports from farmer's data to aid in better decision making.
- Accessible from computer and mobile device.

3.1.2. Limitations

The limitations of the three chosen solutions are outlined below:

Fosholi:

- Farmers are not able to sell their products using the system.
- Generate report facilities not available.
- Farmers are no able to track, log, record, store or manage their farming data.
- Pests, insects, or disease detection system is not available.
- Farmers are not able to manage their land.

Farmlogs:

- The ability to connect to officers from the agriculture department is not present.
- App operates only in one language. Farmers may not be able to understand the English language.

- Pests, insects or disease detection system is not available.
- Apply for loan option is not available.
- No option for farmers to sell their products.

Farmbrite:

- The app operates only in one language. Farmers may not be able to understand the English language.
- Pests, insects, or disease detection system is not implemented on the system.
- There is no option to connect or contact the local agricultural officer.
- There is no option to apply for a loan.

Conclusion:

Among the discussed software solution Farmlogs and Farmbrite solve most of the problems. But these software solutions are paid versions. I could just use and test the system for a free trial version with limited features. Yet those solutions may need to include more potential features to make the system more robust. Farmers in the rural areas are poor and illiterate, they are not willing to invest money in software. Moreover, the local systems lack features, and the international systems are developed in one language and need to be paid in dollars. Therefore it is discouraging for rural farmers to use these systems.

3.2. Weighted scoring Model

The weighted scoring model is a framework to prioritize a system that can help to determine which features and activities to prioritize on the product development roadmap. Using this framework initiatives/actions are rated on a cost-vs-benefits basis using a collection of standard parameters, and then graded based on their final scores. The table below shows the weight scoring model of the system discussed in the previous section. Each system is rated from 1 to 100 against each criterion and the total score is calculated.

Criteria	Weight	Requirement source		
		Fosholi	Farmlogs	Farmbrite
Ease of use (Usability)	30%	80	65	75
Pricing	10%	100	50	0
Support	10%	100	100	100
Features and services	30%	30	70	70
Accessibility	20%	100	100	100
Weighted Score	100%	70	73	73.5

3.3. Recommended approach

After analyzing the problem domain and critically analyzing some existing solutions the problems and gaps in these solutions have been found. Although change is not possible overnight rather a new system needs to be developed and farmers should be

trained to learn and adapt to the new system. The recommended approaches are mentioned below:

- The system will be accessible in different languages so that it is easier for farmers to use the system in their native tongue.
- Farmers should be able to gain knowledge and information from the agricultural knowledge center present in the system.
- Knowledge about modern and improved farming methods will be available in text and video format.
- Farmers will be able to get the latest news on agriculture and climate change.
- Farmers will be able to see the current market price of the crops they cultivate. In case of a price rise, farmers will be notified through SMS.
- Farmers will be able to directly communicate with the retailer through text-based chat or video call.
- The system should contain an e-commerce platform that allows farmers to sell products directly to retailers or consumers.
- If farmers or retailers use our systems (companies') delivery service then both of them must pay a service charge.
- The online payment system should be available for a faster and reliable transaction.
- Farmers should be able to order seeds and other planting materials using the system.
- The system should allow farmers to access loan-related information and apply for a loan using the system.

- Farmers should be able to track and view their loan application progress.
- If farmers can spot pests or diseases in their plant then they will be able to upload photos of the infected part to the server. The server will be able to automatically detect the disease and suggest precautions. If it fails farmers will be able to communicate with the agricultural officer through a video call.
- The system must be able to accessible, secure, usable, and maintainable.
- Farmers will be able to create events and will get notified before any events.

The literature review and product research allowed extensive research as well as an in-depth review and analysis on the topic of agriculture development in rural areas. The problem domain was clearly defined and possible solutions were found, laying the groundwork for the project to begin.

4. Legal, social, ethical, and professional issues and consideration

While working on a project it is vital to consider some legal, ethical, social, and professional issues. To do the project professionally, we must consider the consequence that the project would face when in the development process and when it is being used by real-world consumers and the general public. To work professionally a professional should decide what actions are appropriate and inappropriate through:

- Code of conduct, code of practice, and standards.
- Computer law.
- Ethical decision-making.

4.1. Discrimination

Discrimination refers to the act of unethical or bias distinction made between a human being/person regardless of color, sex, age, religion, nationality, ethnicity, gender, or any other category. The developed solution should not support discrimination or discriminate. While developing the solution no language, images, symbols or other materials should be used that could offend any community or person. When analyzing and developing gender, age, culture, and other problems should be considered. Discrimination can be reduced by fairness testing, it is a testing-based approach for determining software discrimination with an emphasis on discriminatory behavior's causality (Galhotra, et al., 2017).

4.2. Security and data protection

Security and data protection refers to the confidentiality, integrity, accessibility, and availability of data (GAJJAR, 2013). In the development of the project, lots of data needs to be collected from different stakeholders. It is necessary to ensure the security and privacy of these collected data and information essential for the management of the project. By its nature, the developed web application will store user's data for its functions and work as intended. The end-user must be provided with adequate access so that they are mindful of what information and data are being collected, processed, used, stored, and how it is being secured. Data transparency, liability, security, privacy, accessibility, and accuracy needs to be maintained at all times. Users should be notified clearly that their data will not be used for any purpose that they have not agreed to. When implementing this web solution it is required to ensure the security of end-user data. The system should ensure that no data private or confidential can be compromised without the user's consent. To ensure security in project management the rules and guidelines provided by ISO 27001 will be followed (Tripwire, 2019).

4.3. Software licensing

To develop this project many open source software, frameworks and libraries were used. Most of these use the Massachusetts Institute of Technology or MIT license. It is a restrictive free license. While developing the solution it is necessary to give credit to the software or framework developer depending on the license agreement. Any

unlicensed or illegal software will not be used in this project. The list of used software, framework, and libraries is provided in the appendix section.

4.4. Legal impact

Legal issues refer to the laws created due to ethical issues. Laws can vary from country to country. According to the bdlaws website, which is a Bangladesh government website, there are no laws related to project management in Bangladesh (Admin, 2019). Therefore British and European laws related to the subject will be followed and the website will not violate or break any of the laws provided by the authority. As the website will store and display user's data it must comply with the data protection and privacy act of 1998 and the GDPR regulations. Major legal issues are privacy, patents, copyrights, trademarks unauthorized assess, etc. Copyright is legal ownership applying to intellectual property like music, films, software, code, etc. (GAJJAR, 2013). Any copyright materials should not be used in the developed system. Unauthorized access to user's data and into the system should be restricted. It must be ensured there is nothing unethical or illegal on the website.

4.5. Social impact

Social issues may have positive or negative impacts, it depends on individuals. Social issues may impact many sectors like education, culture, health, gender, age, etc. Social issues may arise if people lose their job due to the implementation of this website. There may be a gap between people who cannot access electronic

technology in general and the internet and EC in particular. While implementing the project it is necessary to investigate the social issues.

4.6. Environmental impact

The environmental effect of this project will be addressed during its development phases. Environment impact includes impact on the resource, energy, and human health. The end product from this project will indirectly lead to less resource usage. Most rural farmers do not use smartphones. To use the system farmers may need to get a smartphone, this may increase the resource usage. But the system will help farmers predict weather conditions accurately and provide knowledge about organic, greenhouse, and vertical farming. This will reduce the use of harmful chemical pesticides, fertilizer, and water loss. The data will be stored in a cloud-based backend server that would allow greater performance, resulting in a lower energy footprint. The physical and mental health of farmers and consumers may improve as this solution will allow farmers to gain more profit from the crops they produce and consumers will be able to buy the product at a low price.

5. Development method and tools

5.1. The necessity of development methodology

Development methodology defines a set of rules, techniques, and guidelines that must be followed to complete a project successfully and meet business needs.

Development methodologies are used so that the development teams can effectively collaborate, cooperate, and manage their teams and the development process. It enables teams to divide a large problem into smaller tasks for easier control, sharper focus, supports planning and control, provides progress visibility, provides structure, and leads to better product and documentation. There are various types of development methodologies available that can be used base on the type, size, and nature of the project. The importance of choosing a development methodology is to have the optimal structure/discipline for delivering a reliable product for business and to avoid wasting time, resources, and demoralizing developers, among other things. Some of the popular and most used development methodologies are mentioned below:

- Waterfall.
- Agile Development (AD).
- Dynamic System Development Methodology (DSDM).
- Rapid application development (RAD).
- Structured System Analysis and Design Method (SSADM).

5.2. Comparisons among different methodology

In this section, different methodologies will be discussed and their pros and cons will be outlined. This will help to choose an appropriate methodology to follow for the development of this project.

Waterfall: Waterfall is a traditional Software Development Life Cycle (SDLC) model. Which is one of the first most widely used methodologies. In waterfall, methodology requirements are collected from the stakeholders at the start of the project, and then sequential steps are followed, each step must be completed before entering the next step. These steps include Requirements Analysis, System Design, Implementation, Testing, Deployment, and Maintenance (Petersen, et al., 2009).

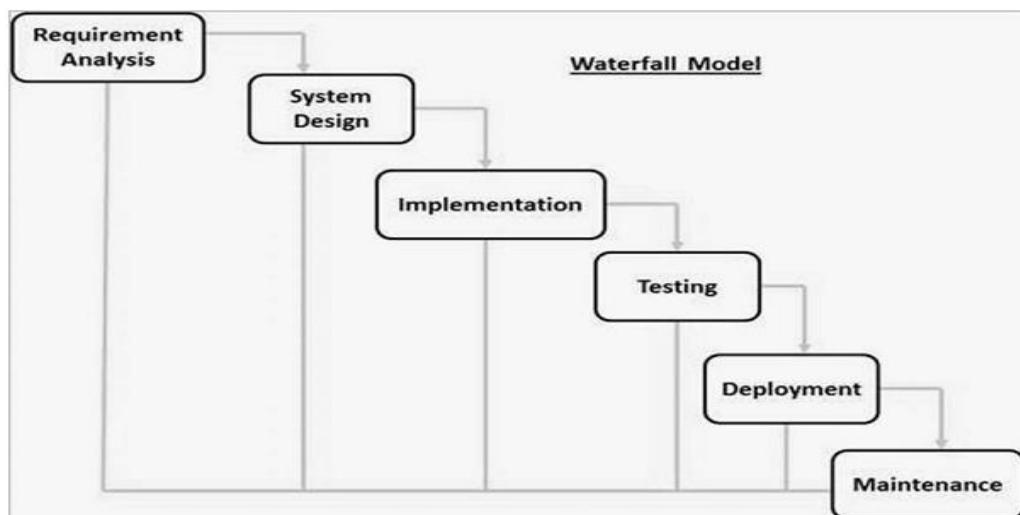


Figure 5: Waterfall model lifecycle.

✓ **Pros:**

- Straightforward and easy to comprehend, manage and implement.
- Accurately estimation of project cost, time, and resources can be made.

- Appropriate for small to mid-sized projects with clear and unambiguous requirements.
- Plan and schedule with clear milestones.

✓ **Cons:**

- No workable solution is produced until the end of the project.
- Lack of flexibility as a change in requirement is not possible.
- The solution might not fulfill its intentions. Because customers are not sure and accurate about all the product's needs and requirements at the start of the project.
- End-users are not involved in the development process, therefore no feedbacks are requested from the end-user.
- Not applicable for a complex or object-oriented project (OOP).

Agile development (AD): Agile is one of the most widely used software development methodologies. In agile development, the product is broken down into smaller chunks and is developed in iterations. The requirements are first collected and then prioritized. The prioritized requirements are divided into time frames also known as time box to produce a working functionality in each requirement. At the end of the whole development process, the solution will contain all the features (Vu, 2020).

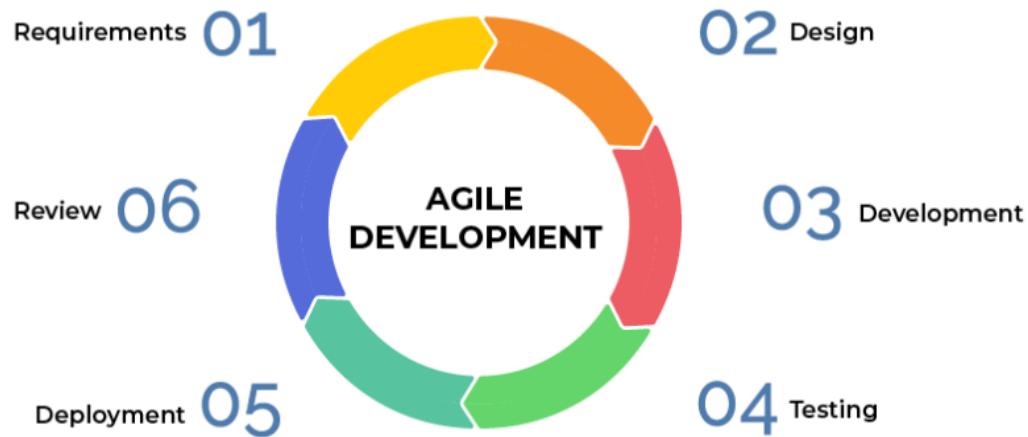


Figure 6: Agile development methodology lifecycle.

✓ **Pros:**

- Flexible and can adapt to change in requirements.
- Effective communication between stakeholders.
- Product to market is faster.
- The risk of developing a wrong solution is reduced due to iterative testing and feedbacks.
- Bugs are identified before they cause bigger problems.

✓ **Cons:**

- Difficult to measure cost and time because requirements may change.
- High-risk probability if customers are not sure about the requirements.
- User involvement throughout the whole project.

Dynamic System Development Methodology (DSDM): DSDM is an agile project development methodology for developing business solutions. DSME was created in 1994. It helps enterprise solutions to be implemented efficiently while ensuring a high degree of consistency under time and expense constraints. It uses the MoSCoW prioritization rule to prioritize the requirements and follows an iterative development process for ensuring the right product is being developed. DSDM focuses more on people than tools (Stapleton, 1999). Using DSDM it is possible to create a potentially usable product before the end of the development process. There are eight principles of DSDM, which are:

- Focus on business needs.
- Deliver on time.
- Collaborate.
- Never compromise quality.
- Build incrementally from a firm foundation.
- Develop iteratively.
- Communicate continuously and clearly.
- Demonstrate control.

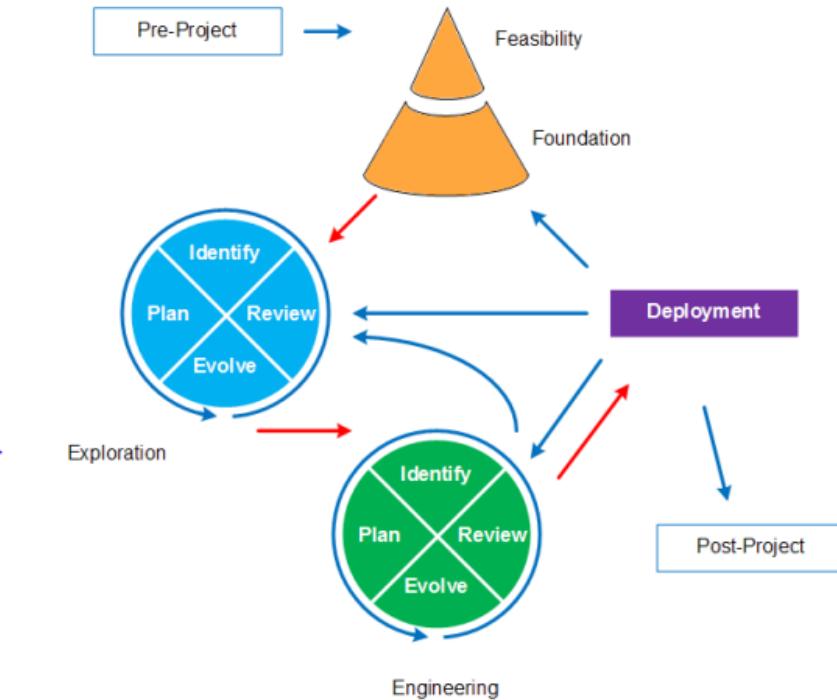


Figure 7: DSDM lifecycle.

✓ **Pros:**

- Can adapt to change in requirements.
- Encourages greater involvement of the end-user.
- It encourages the involvement of all the stakeholders in the development process.
- The risk of developing a wrong solution is reduced.
- A basic functional system is delivered fast, followed by the addition of more features at frequent intervals.

✓ **Cons:**

- Expensive to implement.
- Not applicable for a small-sized project.

- High priority features are more focused and low priority features are sometimes left behind.
- More user involvement may hamper the workflow.

Rapid application development (RAD): RAD is a software development approach that prioritizes prototyping over extensive planning. Prototypes are models designed to mimic the design and functionality of the end product. To make the development process faster the prototypes and functional modules are developed in conjunction. Because comprehensive planning is done ahead of time, it is easier to integrate improvements into the development process. RAD also follows an iterative and incremental development lifecycle and have small teams with different domains and skill level working on the project.

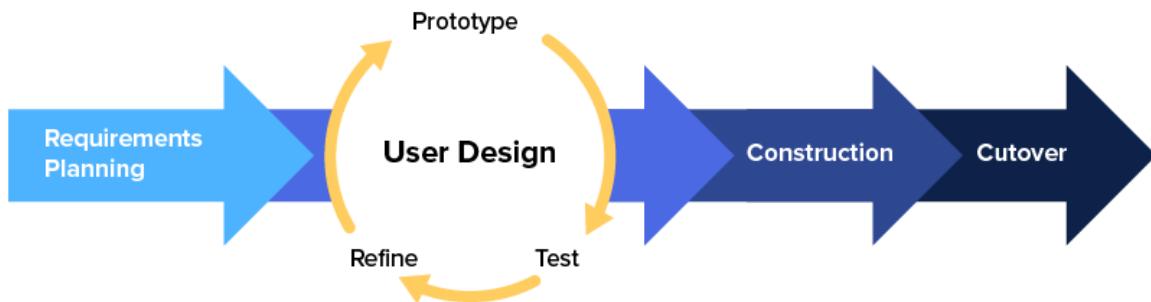


Figure 8: Rapid application development (RAD) lifecycle.

✓ **Pros:**

- With the use of RAD tools, iteration time can be shorter, which leads to a faster development process.

- Adaptation to change in requirements is possible.
- It is possible to track progress.
- Code reuse is encouraged, therefore less hand coding is required, less room for errors in code, and short testing time.
- Development time is reduced, due to quick iterations.
- Encourages end-user involvement for reviews and feedback.

✓ **Cons:**

- A professional or highly skilled development team is required.
- Higher management complexity.
- User involvement is required throughout the project lifecycle.

Structured System Analysis and Design Method (SSADM): SSADM is a methodology to analyze the design and develop a new system. It is based on the waterfall model and follows waterfall methodology from the feasibility study to the design stage in the development process. SSADM allows end-user involvement in the requirement analysis stage. Unlike the waterfall model, in SSADM end users can give feedback and assure that the requirements are met after each stage is completed. SSADM breaks the project into small tasks or features.

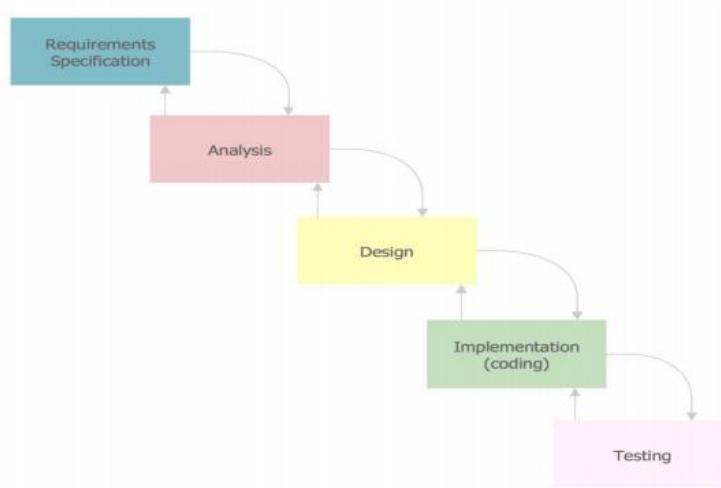


Figure 9: SSADM life cycle.

✓ **Pros:**

- Product delivery on time.
- Users are involved in the process.
- Issues or bugs can be identified earlier in the development process.
- Minimize risk, low possibility of developing a wrong solution as regular feedbacks are taken from the end-user.

✓ **Cons:**

- Focuses more on analyzing which may consume more time and money.
- It is not for the novice; experienced team members are required to too properly perform their tasks.
- It is not an iterative development process.

5.3. Recommended methodology with justification

All the methodologies discussed above are for development teams. There is no methodology available for solo developers or academic projects. Therefore it is preferable to develop a custom methodology by combining the best practices from the best methodologies, to adapt to the solo development environment of this project. Agile development process DSDM and SSADM are combined to create a new methodology for this project. The methodology is named Dynamic System Analysis Design and Development Method (DSADDM). This is an iterative development process that will allow the end-user involvement in certain phases of the development process. The following figure shows the lifecycle of the proposed software development model.

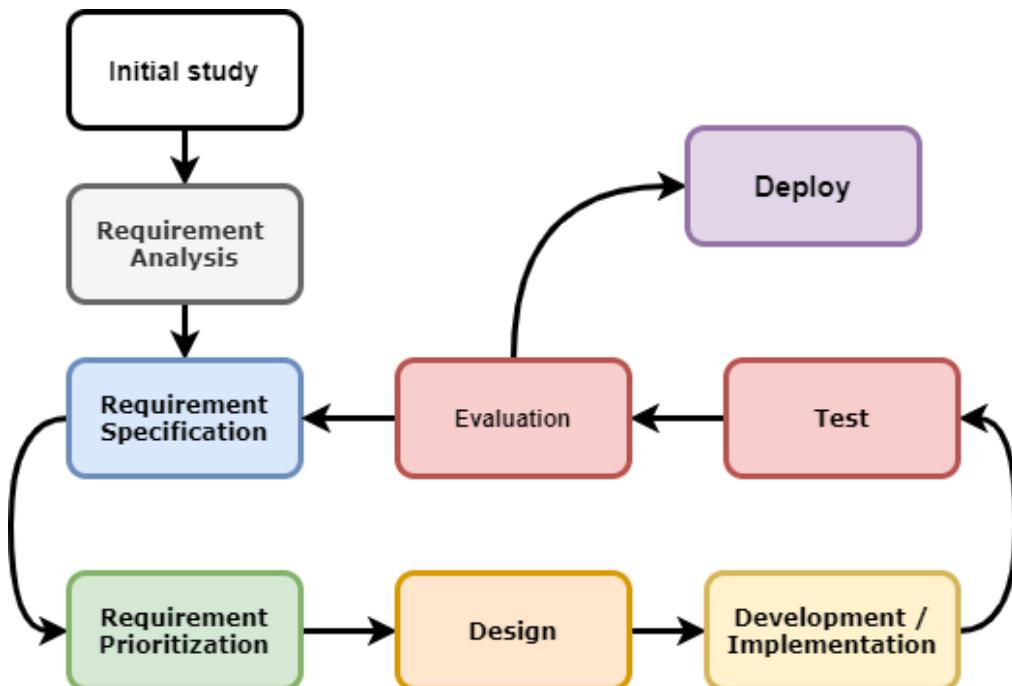


Figure 10: DSADDM Lifecycle.

DSADDM life cycle: A structural breakdown of the chosen methodology is given below:

- **Initial study:** This is the starting phase of the project where an in-depth analysis of existing solutions, feasibility study, literature review, user research, etc. is conducted.
- **Requirement analysis:** In this phase, the system requirements are collected using different requirement gathering techniques, for example, interviews, questionnaires, surveys, user stories, brainstorming, etc.
- **Requirement specification:** In this phase, the collected requirements are turned into data/diagrams, like activity diagram, use case diagram, sequence diagram, DFDs, ERDs, etc. These diagrams will outline the system functionalities and how the actual system should work.
- **Requirement prioritization:** In this phase requirements are prioritized using the MoSCoW prioritization rule. The must-have requirements will be developed first followed by the should-haves and could haves.
- **Design:** Both logical and physical designees are developed in this phase. During the logical design, possible solutions are brainstormed and hypothesized. In the physical design, the hypothesis is turned into an actual requirement. The design includes Low fidelity design (Sketch), Prototype, etc.
- **Implement:** The actual system is developed and coding is done in this phase.
- **Test:** Quality assurance testing is done in this phase. Testing includes test plan, test case development, test execution. Tests are done to identify errors and bugs in the system and to verify if all the functionalities are working properly.

- **Product Evaluation:** In this phase, customer reviews are taken to make sure that the requirements are correctly met. If the requirements are ‘not’ met then the iteration will again continue.
- **Deploy:** If the customer review is positive then the successfully implemented features are deployed in this phase. One by one each feature will be incrementally added, which will eventually turn into the final product at the end of the project.

Justification for choosing this approach:

Software development methodologies are meant for business solutions to be developed. Where a team or a group of team works together by following some rules and guidelines during the development process. So that, they can manage their team and the workflow efficiently. All these guidelines may not be applicable when a single person is working on a project. As in academic projects the documentation and analysis part is more focused which includes different diagrams and models, features of SSADM should be helpful in this case. Using the features of the DSDM model the whole project can be broken down into smaller tasks. These tasks will be developed in increments in different time boxes. Requirements might change along the development process, SSADM does not allow requirement changes. In this case, DSDM can be followed to iterative develop the project.

All the methodologies have their pros and cons. So the best features of both DSDM and SSADM are combined to make think work more efficiently.

5.4. Requirement gathering techniques/tools with justifications

Requirements gathering is an important aspect of every enterprise, big or small. It is key to understanding and satisfying the needs of end-users. Identifying and documenting the project's required specifications from clients, users, and other stakeholders are part of the requirement gathering process. This knowledge can be applied to the development of software, products, services, etc. (Athuraliya, 2021). There are various tools and techniques available for requirement gathering, some of them are discussed below:

5.4.1. Techniques for requirement gathering:

Interviews: Interview plays an important role in information gathering. This method involves a direct conversation with the stakeholders that use questions and answers to gather information. Interview questions are of two types, closed-ended and open-ended. Closed-ended questions require short and specific answers whereas open-ended questions require elaborate answers (Hartenstein, 2002). Interviews are considered to be a simple and efficient way for analysts and stakeholders to share data and finding requirements or needs. However, this method can be costly and time-consuming (Hartenstein, 2002).

Questionnaires/Survey: Interviews are unquestionably beneficial, but they can be time-consuming and expensive to conduct especially when a larger group of stakeholders are involved. Surveys or questionnaires are a set of questions where respondents are asked to rate arguments from strongly agree to strongly disagree, open and closed questions, and checkboxes. Surveys can be both online and offline, which saves time and cost. In doing this project online survey was

prioritized over interviews to gather information, due to the COVID 19 pandemic satiation conducting the interviews was not extensively possible.

Brainstorming: Brainstorming is a method to gather ideas, possibilities, and solutions. Brainstorming can be done in groups or individually. It provides an open space to come up with unconventional solutions which might not be accepted in formal situations.

User story: User story mapping is a method for identifying and understanding the end-users requirement. It assists development teams in prioritizing projects depending on what would lead to a better user experience. The user story outlines how an end-user interacts with the system.

Focus groups: Bringing together groups of end-users is a great way to get insights that can help the project succeed. The groups can act as representatives of end-user and can be seen in two ways. To begin, they must volunteer information about their requirements, needs, desires, and challenges, and then they must check, verify, and optimize work that has already been done.

Observation: Observing the existing solutions or workflow in real life can be a very effective way to gather information. Active and passive observation are the two methods of observation. Passive observation is observing how things work and is useful with a prototype. Active observation is the most effective way it involves watching how things work and asking questions at the same time.

5.4.2. Tools for requirements gathering:

Use Case Diagrams: Use case diagram aids in representing the interaction of users with the system.

Activity diagram: The activity diagram shows a graphical representation of the workflow and stepwise actions and activities performed in a system. The UML activity diagrams are intended to show computational and organizational activities.

Sequence Diagrams: A sequence diagram depicts how objects communicate over time. It offers a top-to-bottom view, with messages being exchanged between the various objects. Objects within a system may be actors, processes, or sub-packs.

Wireframes/Prototype: At the end of requirement gathering, prototyping the deliverables is a great way to get feedback from the end-user. When a problem is not well-understood building and evaluating prototyping can help define the problem.

Class diagram: Class diagram represents a system's static structure. It illustrates how class, object, attributes, and functions are related.

Rich picture: Rich picture is a part of software development methodology used to learn about a complicated or unclear problem by drawing accurate representations of them.

5.5. Technical tools with justifications

Technical tools refer to the tools which will be used to develop this project. The tools involved in doing this project are given below.

Trello board: Trello is a project management and collaboration tool. Trello board is free to use software, it will be used to record the initial requirements and manage the task for this project. It is better than using Microsoft excel or spreadsheets.

Draw.io: draw.io is a tool for creating diagrams for example use-case, activity, sequence diagram, etc. Draw.io is a free diagramming tool developed by Microsoft. This report contains many important diagrams for example use case diagram, activity diagram, methodology diagram, class diagram, etc. All these diagrams will be drawn using this tool.

Adobe XD: Adobe XD is a free popular prototyping tool. The prototype of this project will be developed by using adobe xd.

IDE: For coding, the system an IDE or a text editor is required. There are several IDEs and text editors available for writing code. PHP Storm and Web Storm by jet-brains are used as a preferred IDE to code. PHP Storm and Web Storm are advanced IDEs with advanced features developed for professional developers. Generally, software's provided by jet-brains is paid but they also have a student license plan, which students can use for free.

These technical tools are chosen for the development of this project because I have experience of development using these tools. I think that I can complete the proposed project successfully by using these tools.

6. Planning

It is generally acknowledged that inadequate project planning is one of the most important causes of project failure. Over the years, different techniques and methods for project management have been developed (Hartman & Ashrafi, 2004). But still, projects fail due to improper planning or lack of planning. This part of the report is focused on the project plan. The project plan, Test plan, Risk management plan, Change management plan, and Quality management plan will be discussed in this section.

6.1. Project plan

6.1.1. Management plan/Work breakdown structure (WBS)

A WBS is a deliverable-oriented hierarchical decomposition of the work to be executed by a team or individual to accomplish the project objectives and create the required deliverable (Shelly A. Brotherton, et al., 2008). In WBS, larger tasks are broken down into manageable chunks of tasks. Using a work breakdown framework helps the project team to describe the task logically, without being confused by the schedule, which would be defined later in the planning stage. To perform the WBS some steps needs to be followed:

- Determine the functional deliverables.
- The functional deliverables are divided into tasks, sub-tasks, and further into work packages.
- The work package is a list of tasks or “to-dos” to produce a specific or particular unit of work.

The work break down (WBS) structure for this project is given below:

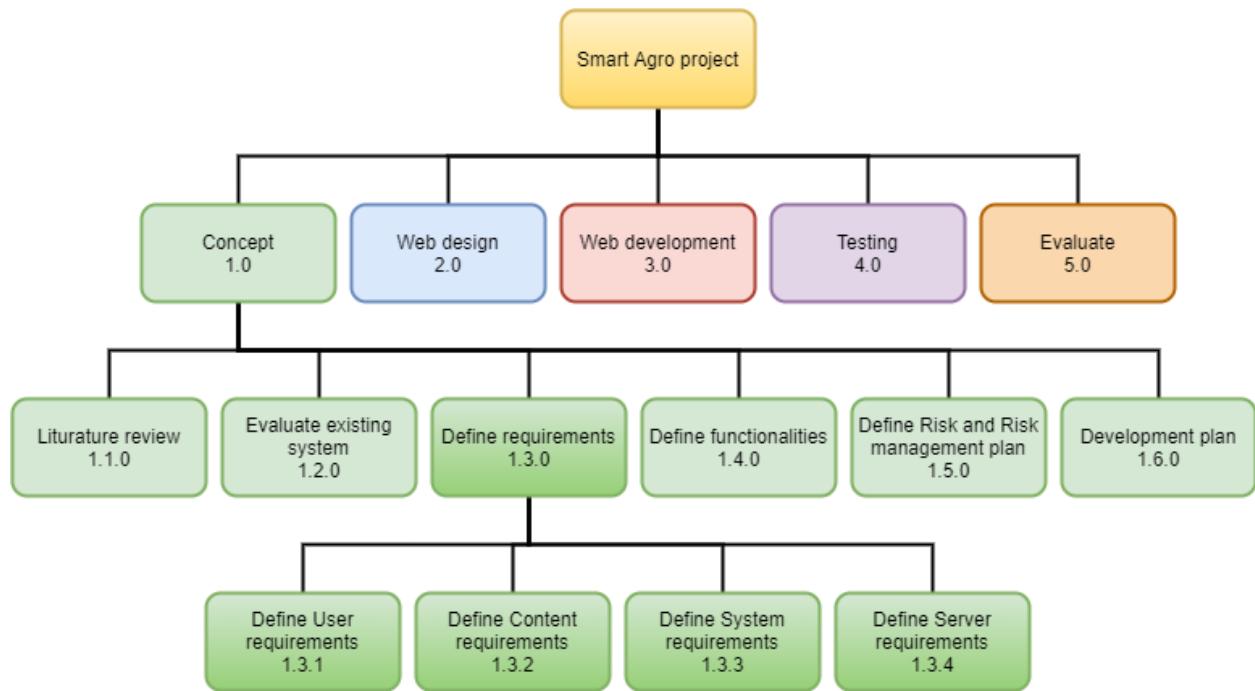


Figure 11: Work Breakdown Structure (WBS).

6.1.2. Resource allocation

Resource allocation means the process of allocating resources to support a team's goal. Labor, equipment, technology, time, financial resource, etc. are all examples of resources. Resource allocation is required to meet business objectives. Normally resource in a project includes human resource, budget, equipment's, tools, time, etc. The human resource is roles involved in the development process of the project. These roles are end-user, analyst, developer, designer, and tester. As this is an academic solo project, all the roles will be performed by an individual. The figure below shows the resource allocation:

		Task Mode	Task Name	Duration	Resource Names
1			SmartAgro	90 days	User,Analyst,Developer,Tester
2			Pre-Project	13 days	Analyst
3			Proposal	1 day	Analyst
4			Literature Review	6 days	Analyst
5			Product Research	5 days	Analyst
6			Methodology	2 days	Analyst
7			Analysis	7 days	Analyst,User,Developer
8			Requirement Analysis	3 days	User,Analyst,Developer
9			Define scope and boundaries	2 days	Analyst,Developer
10			Feasibility Study	1 day	Analyst,Developer
11			Use Case	1 day	Analyst,User,Developer
12			Design	14 days	Developer
13			Data Design	2 days	Developer
14			Architecture Design	4 days	Developer
15			Interface Design	5 days	Developer
16			Procedural design	3 days	Developer
17			Development	30 days	Developer,User,Analyst,Tester
18			Database Implementation	1 day	Developer
19			Develop System Modules	22 days	Developer
20			Integrate System Modules	3 days	Developer
21			Perform Initial Testing	2 days	Developer,Tester,User,Analyst
22			Review	2 days	Developer,User,Analyst,Tester
23			Testing	7 days	Tester
24			Test strategy and Test plan	1 day	Tester
25			Test design	1 day	Tester
26			Test execution	4 days	Tester
27			Generate test report	1 day	Tester

Figure 12: Resource Allocation.

6.1.3. Timebox

A timebox is a time management technique that includes, a pre-allocating fixed amount of time to complete an activity and then doing it within the time frame. Agile frameworks use the time box technique to manage projects. The DSADDM methodology is used to conduct this project, which is an agile-based methodology. The project requirements will be prioritized using the MoSCoW prioritization rule and will be divided into time boxes, with each time box lasting at least one week and up to four weeks.

The time box estimation table template is given below.

Time box	Task	Date	Deliverables
1			
2			
3			

6.1.4. Activity network

The activity network defines the steps or activities that need to be performed sequentially to complete a project. The figure below represents the activity network diagram for the proposed system.

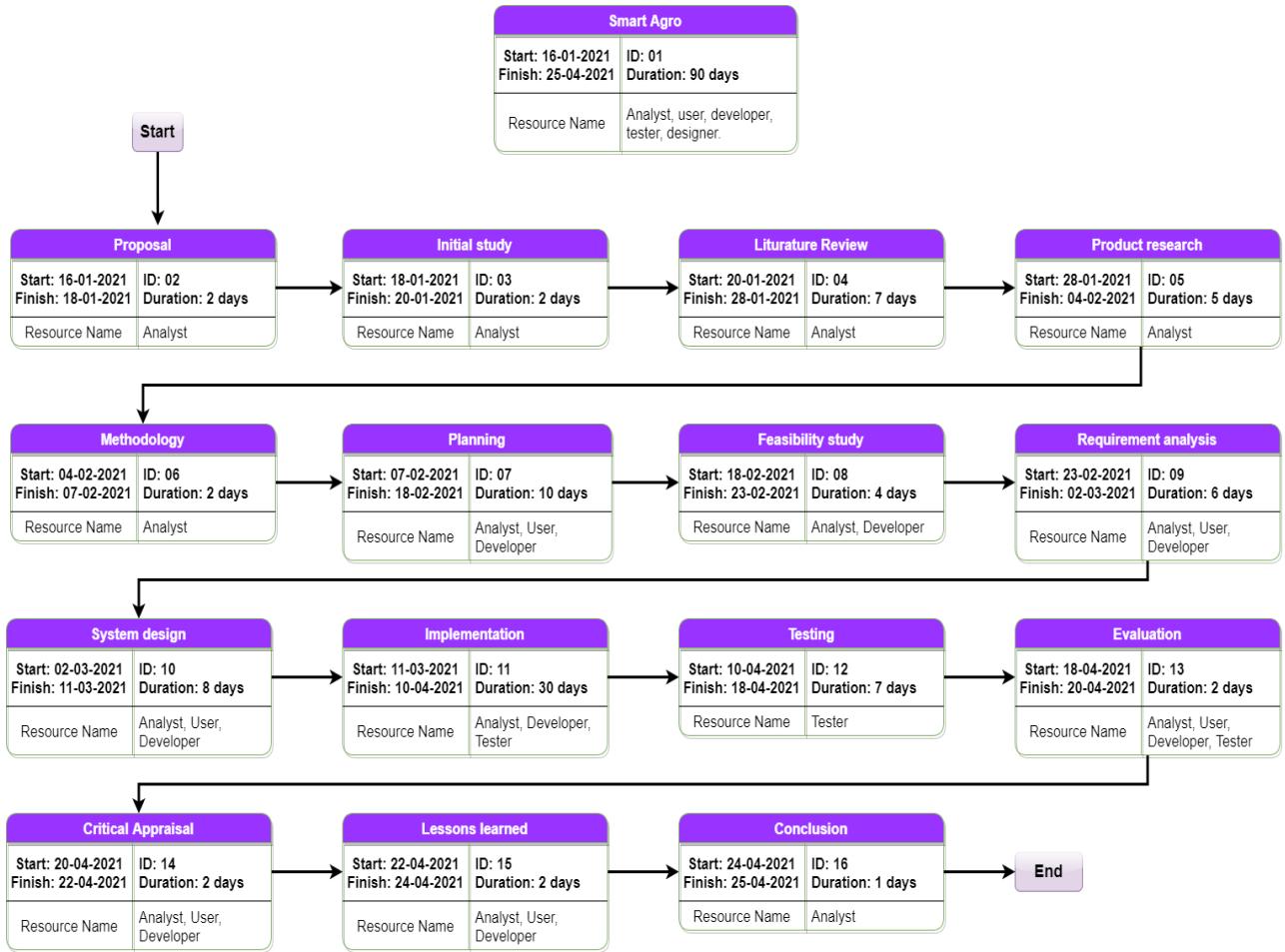


Figure 13: Activity Network.

6.1.5.Critical path

The activity network is defined in the previous section. Now the critical path in those activities needs to be identified. Critical paths are selected based on importance, difficulty, time limit, and priority. In this project, there are four critical paths identified, those are Planning, Implementation, System Design, and Requirement Analysis. The figure below shows the critical paths marked in orange color.

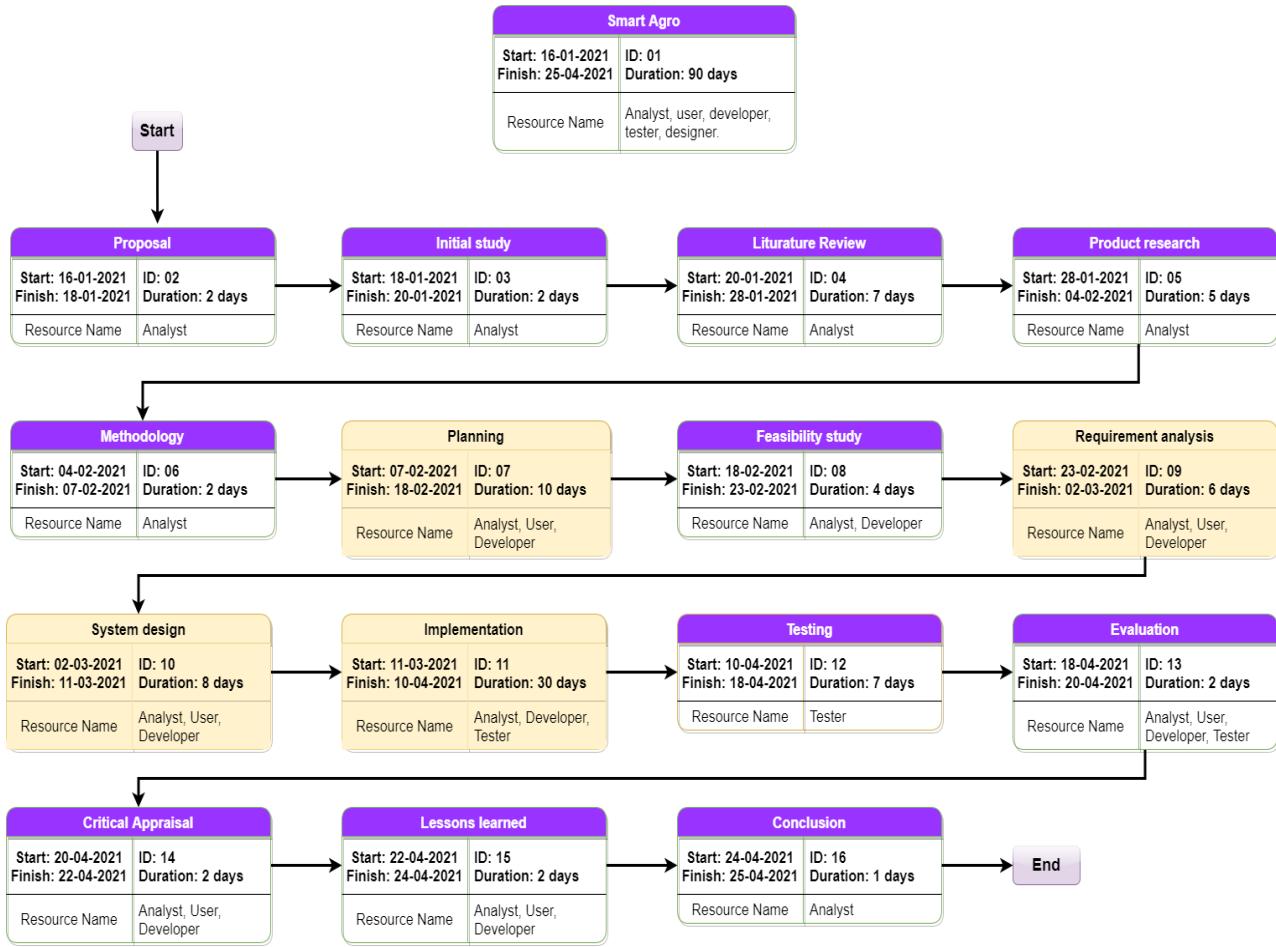


Figure 14: Critical Path (highlighted in orange color).

6.1.6. Gantt chart

Gant Chart is used to illustrate the starting and ending point (date) of project tasks or activities. This project will be done in approximately 90 working days starting from **16-01-2021** to **25-04-2021**. The figure below illustrates the Gantt chart for this project.

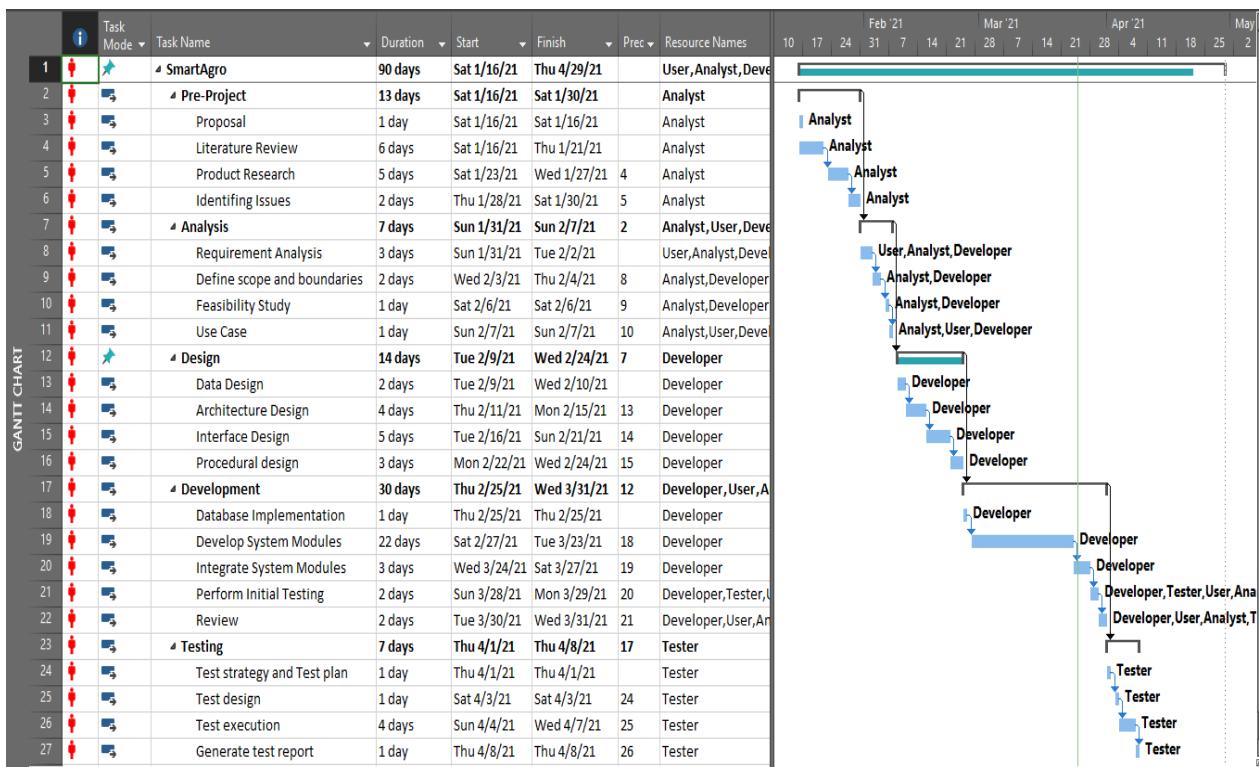


Figure 15: Gantt chart.



Figure 16: Gantt chart

6.2. Test plan

Testing is an integral part of the project. It ensures that the developed features are working as intended to fulfill a business or end-users requirements. The main goal of testing is to find the bugs and errors in the system and ensure the accuracy and acceptance of the system.

6.2.1. Required Tests

Various types of testing can be done in a system. Only the required tests will be done in this project. There are two types of testing functional and non-functional.

The required tests are listed below:

- Unit testing.
- Integration testing.
- System testing.
- Acceptance testing.
- Security testing.
- Usability test.
- Reliability test.
- Performance test.

6.2.2. Testing environment/Testing against time boxes

6.2.2.1. Testing against time boxes

The project will be done iteratively. Each time box is an iteration where a feature/task will be completed. Each iteration will produce a potentially deliverable product. The product needs to be tested before it is deployed/added to the system. The intended functionality of the developed task will be tested to ensure acceptance, accuracy, and quality of the product. The time box testing template is given below:

User Name	Role			
Time box ID				
Time box objects				
Test Type	Test Steps	Expected Result	Actual Result	Comment
Unit Test				
Integration Test				
Module Test				
Usability Test				
Reliability Test				
Security Test				
Performance Test				
Acceptance Test				

6.2.2.2. Test environment

The system environment to perform the tests are given below.

- Internet connection cellular or using ISP.
- Minimum 3 desktop and or laptop computers running different operating systems.
- Mobile or tablet device at least 2.
- Web Browser (Chrome, Firefox).
- Database.
- User Data at least 10.

6.2.3. What needs to be tested?

- **Test case:** A test case is used to check whether or not the developed functionality or feature is working properly. The system is tested for errors or bugs as well as if the system's requirements are met. The test plan of the project is given below.

Test Case ID:	Test Type:	Tester:	
Test Title			
Test Case Description			
Execution steps			
Test Browser:	Test device OS:		
SL.	Actions	Expected Result	Actual result
1			
2			

- **User acceptance test plan:**

The user acceptance test is done by the end-users to verify that the system requirements have been met and agreed upon. In this test, users use the system to verify how it performs under different situations by interacting and giving data input to the system. This testing is similar to black-box testing where the output is checked based on the given input to the system. The user acceptance test case template is provided below:

User Name:	Role		
Test Case ID:	Test Type:		
Test Title			
Test Case Description			
Execution steps			
Test Browser:	Test device OS:		
SL.	Actions	Expected Result	Actual result
1			
2			

6.3. Risk management plan

Risks are an inevitable part of every project and managing risk also the most important part (Scavetta, 2019). Risks are identified, recorded, tracked, and planned. Any risks are expected to become issues. A risk management plan will assist in mitigating challenges before they become issues (Scavetta, 2019). A risk management plan is required for this project to identify the possible risks that may occur before or during the project's lifecycle and create a plan to reduce the impact or mitigate the risk. There are four main steps to execute a risk management plan (Risk Identification, Risk Assessment, Risk Precaution, and Risk Monitor).



Assess (Green section):

Once risks are identified, we determine the likelihood and consequence of each risk. This will include knowledge of the factors critical to success and the threats and opportunities related to the achievement of objectives. This allows CPA, in conjunction with management, to develop an understanding of the nature of the risk and its potential to affect the business's goals and objectives.

Evaluate (Blue section):

The identified risks are ranked by determining the risk magnitude, which is the combination of likelihood and consequence. Generally, if the magnitude or severity of the risk under consideration is high, the risk response needs to be strong (mitigate, transfer or avoid). Captive Planning works closely with management to determine if certain risks should be retained by the business, transferred to the commercial market, or underwritten in a captive.

Figure 17: Risk management process lifecycle (www.captiveplanning.com, 2021).

6.3.1. Risk identification

Some of the possible risks that may arise during the execution of this project are identified and discussed below.

Methodology risk:

- **Methodology Implementation:** The DSADMM methodology has been newly created to suit the purpose of this project. Although this methodology was created after extensive research. It is not a tested methodology, therefore there is a chance of project failure if not executed properly.
- **Time management and time box:** The project deliverables are dependent on the time box, which has been created with assumptions. If in any case

there is a failure in delivering the deliverables of the time boxes there might be a late delivery of the entire project.

Technical Risk:

- **Data loss:** Data may be lost due to a hard drive crash, ransomware or virus attack, or accidental deletion.
- **Device risk:** The working device may be damaged due to lightning, short circuit, fire, computer viruses, etc.
- **Security risk:** The working device may be affected by computer viruses, malware, or hackers.

Internal Risk:

- **Health issues:** Currently there is a COVID 19 pandemic outbreak throughout the world. There is a risk of getting infected while interviewing or researching on this project. Other health issues may also occur. Which may eventually affect projects time management.
- **Stress:** There may be a chance of getting stressed out because of environmental or mental situations. As an academic individual, there is also study pressure. These may lead to stress and can impact the overall project outcome.

External Risk:

- **Working environment:** The working environment is also an important factor when doing the project. Working environment includes proper workspace, power supply, internet connection, etc.

6.3.2.Risk assessment

Once risks are identified risk assessment is done to determine the impact, likelihood, severity, and frequency of a risk occurring. The risks are identified and now the impact, likelihood, and frequency of the risks will be assessed. The risk assessment table for this project is given below:

Risk	Risk Specification	Likelihood	Impact	Severity	Frequency (Yearly)
Methodology	Methodology	Low	High	High	0-1
	Implementation				
	Time management and time box	Medium	High	High	2-3
Technology	Data loss	High	High	Very High	2-3
	Device risk	Low	Medium	Medium	1-2
	Security risk	Medium	High	High	4-5
Internal	Health issue	High	Medium	High	2-4
	Stress	Medium	Medium	High	4-8
External	Working environment	Low	Medium	Medium	2-3
	Electricity	Medium	Low	Low	18-25

6.3.3. Risk action plan

After identifying, assessing, and analyzing the risk an action plan is created to mitigate the risk. The table below shows the action plan for the project.

Risk	Risk Specification	Severity	Action Plan
Methodology	Methodology	High	Need to consult with the supervisor about implementing the methodology.
	Implementation		
Technology	Time management and time box	High	Close observation of the first two-time box is required. Further time boxes will be done accordingly.
	Data loss	Very High	Creating regular backups using Google drive or GitHub.
	Device risk	Medium	Ensure the availability of a backup device to work on.
Internal	Security risk	High	Use of antivirus programs and firewalls for enhanced security and privacy.
	Health issue	High	Regular health checkups and vaccination.
External	Stress	High	Ensure off days between working days.
	Working environment	Medium	Ensure high-speed internet and proper place to work on.

	Electricity	Low	Ensure a backup power supply in case of power/electricity cut off.
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6.4. Change management plan

Change management is the process and practices by which an organization defines and applies changes in its internal and external processes. Change management plan is defined at the project outset. Using a change management plan can make the difference between a successful and a fail project. Changes may occur during a project's lifecycle. This project is being developed using a custom-built methodology DSADDM, which is based on an agile development methodology DSDM. Like DSDM DSADDM allows adapting to changes in an efficient way. The required changes will be identified and are added to the changelog. The requirement specification is updated based on the changelog and the requirement list is prioritized. Finally, the changes are implemented in further iteration if budget and time allow it.

6.4.1. Factors that might cause changes

The factors that might cause changes in an academic project are mentioned below:

- **Requirements:** End-users requirements might change as the features are reviewed and evaluated after each iteration.
- **Resource:** There may be a requirement for change in the resource.
- **Technology:** Technology like Programming language or framework might change based on the systems requirements.

- **Timebox:** Timebox may change after observing the first two time boxes
- **Bugs or errors:** Bugs and errors in the system may cause a shift in the time box if solving those errors consumes more time.

6.4.2.Considering business value / priority

During the development process, different changes may be expected but all the changes will not be allowed. Changes that might impact or enhance overall business values, performance, and benefit the business prospects will get a higher priority.

6.4.3.Change workshop

DSADDM allows end-users interaction with the development team during the project lifecycle. Change workshop will be held to bring all the stakeholders to meet and analyze, understand the purpose, goal, scope, deliverables, and benefit of the requested change. Here changes are measured against the project baseline. A changelog is created to collect and track all the changes.

6.4.4.Change that is allowed

After a change is requested it will be analyzed by the project manager. All the changes may not apply to the system. Changes should be compared against the

project baseline, which comprises of project's expense, quality, scope, and time.

The allowed changes are outlined below:

- Any relevant changes that can be implemented within the budget and time limit.
- Changes that may improve the business process and enhance business value.
- Changes that will improve the overall user experience of the system.
- Change in technology in the middle of implementation is not acceptable because then the project will need to be started from the beginning.

6.4.5. Key decision-takers of change

Normally the Project Manager plays the key role as a change manager, who takes all the decisions. And the Project Sponsor serves as a change evaluator and change decision-maker (James, 2020). But as this is an academic solo project all the potential roles are performed by an individual. Therefore all the key decisions are taken by the individual.

6.5. Quality management plan

According to the ISO 8402 standard quality is a set of characteristics and features that meets definite needs (Paquin, et al., 2000). A Quality management plan is a well-defined collection of documentation and information that can be used to successfully monitor quality during a software development process, from initiation to

implementation. The primary aim of a quality management plan is to ensure that project deliverables are of good quality and satisfy system requirements.

6.5.1.Rules applied to maintain quality

The rules applied to maintain the quality of this project is given below:

- **Software Quality planning:** At the beginning of the project a shared understanding of what quality means for this project and an acceptable level of quality is defined (Luchen, 2020). All stakeholders agree upon the set criteria and an acceptable level of quality for this project. These acceptance criteria are recorded for further use throughout the development life cycle.
- **Software Quality assurance:** The developed solution will be tested against the defined acceptance criteria to measure that the intended level of quality is met. An effective test environment needs to be created to carry out the tests properly. The standards defined by ISO 9000 and CMMI models will be followed during the development process.
- **Software Quality control:** Software quality control is the process of maintaining software quality. Different types of reviews and testing will be done iteratively during the project lifecycle to ensure the quality of the developing solution.

Review	Testing
Requirement review	Unit testing
Code review	Integration testing
Design review	Module testing
Deployment review	System testing
Test review	Acceptance testing

6.5.2.Quality plan and measuring meter

A quality metrics definition will be created at the beginning of the project to which all the stakeholders will agree. These metrics will give a clear idea of what quality standards are set for this product/solution. Based on the defined metrics the quality of a solution can be measured (Elizalde, 2015). To measure the quality some questions need to be answered, those questions are listed below.

Measuring proposed solution quality:

- Will the solution meet the development team's UX definition of quality as well as users' definition of quality?

Measuring implementation quality:

- Have the development team developed according to the defined requirements and the design specification?

Measuring stability and performance quality:

- Is the product performs as expected based on the defined metrics (load time, response, no. of sessions, etc.)?
- Are there any severe bugs in the system?
- Is the product stable and does not crash?
- Did the new features make any breaking changes to existing functionality?

By answering these questions the quality of the developed solution can be measured.

7. Feasibility study

A feasibility study is a process to determine the feasibility and sustainability of a system. Feasibility studies help to identify whether the project is worth the investment or not. There are various feasibility studies like technical, financial, operational, legal, etc. to identify the feasibility of a system. Some of these studies are conducted for this project.

7.1. Technical feasibility

This evaluation focuses on the technical resources available to the organization. The technical feasibility study helps organizations determine whether the required technical resources are available and the technical team is capable of converting ideas into functional systems with the use of the available resource. Technical feasibility involves the evaluation of hardware, software, and other technical requirements of the proposed system (simplilearn, 2019).

In this project, all the roles will be performed by an individual, therefore the requirements for an individual to conduct the project are identified. The technical resources required for this project is given below:

✓ **Hardware resource:**

- **Model:** HP 15-ay013TX
- **Type:** 64 Bit
- **Processor:** Intel(R) Core(TM) i3-6100U CPU @ 2.30 GHz.
- **Memory (RAM):** 8.00 GB.
- **Hard Disk:** minimum 120 GB SSD + minimum 500 GB HDD.

- **Graphics:** Intel (R) HD Graphics 620 + AMD Radeon (TM) R5 M330 2GB.
 - **Display:** 15.6 inch LCD (1366x768).
 - **Peripheral devices:** keyboard, Mouse.
- ✓ **Software resource:**
- **Office:** MS Office 2019.
 - **Operating system:** Ubuntu, Windows 10 Pro.
 - **Browser:** Chrome, Firefox, Microsoft Edge.
 - **Database:** Xampp.
 - **Design/Diagram:** Adobe XD, Draw.io.
 - **Code editor:** PHP Storm, VS Code.
 - **Version control:** Git.
 - **Backup:** Google drive, MEGA Cloud.

✓ **Programming knowledge:**

- **Frontend:** HTML, CSS, SCSS, Bootstrap, JavaScript, VueJs.
- **Backend:** PHP, Laravel.
- **Database:** MySQL.
- **Package manager:** NPM, Composer.

The hardware, software, and programming knowledge resources are given above. All the mention hardware and software resources are available. And the developer also has a good grasp of the programming knowledge mentioned. Therefore this project is technically feasible.

7.2. Operational feasibility

This evaluation involves conducting a study to analyze and determine how well the proposed system can fulfill the requirements and needs of the project. After developing the “**Smart Agro**” system the operational feasibility of the system will be tested. The operational feasibility study will examine how well the “**Smart Agro**” system solves problems and takes advantage of the opportunities identified during scope definition and how it satisfied the requirements identified in the requirement analysis phase of system development (simplilearn, 2019). The operation feasibility study also identifies the advantages of the new system against the old system.

Key questions to answer to identify the systems operational feasibility.

- How end-user feel about the new system?
- How will the working environment for the end user change?
- Which user or manager may resist (or not use) the system?
- People tend to resist change, how to overcome the resistance?
- Can or will end-users and management adapt to change?
- Evaluate whether the system can and will work.
- Does management support the project?

7.3. Economic feasibility

This evaluation usually includes a cost/benefit analysis of the project, which aids organizations in determining the viability, cost, and benefits associated with a project before allocating financial resources. It also serves as an independent project

assessment and enhances project credibility helping decision-makers determine the positive economic benefits to the organization that the proposed project will provide (simplilearn, 2019).

7.3.1.Required hardware and software cost

The cost for hardware's and software's required for this project are given below:

Hardware cost:

No.	Hardware name	Quality	Cost (\$)
1	Laptop	1	799.99
2	Keyboard	1	36.40
3	Mouse	1	16.28
4	Wi-Fi Router	1	120.00
Total			\$ 972.67

Software cost:

No.	Software name	Cost (\$)
1	Linux Operating system: Ubuntu	Free
2	Windows Operating system: Windows 10 Pro	199.99
3	Office: MS Office 2019	149.00
4	Code Editor: PHP Storm, VS Code	Free
5	Browsers: Chrome, Firefox	Free

6	Adobe XD	Free
7	Draw.io	Free
8	Xampp	Free
9	Google Drive	Free
Total		\$ 348.99

7.3.2. Hosting cost

Domain and Hosting service will enable users to visit or access the website globally. To uniquely identify the product a unique address is required which will be provided by a domain and to make the website and its files accessible a hosting service is also required. There are various domain and hosting services available.

The chosen domain and hosting services are given below:

No.	Service name (Provider)	Package name	Yearly cost (\$)
1	Hosting (hostgator.com)	Business	87
2	Domain (hostgator.com)	.com (www.smartagro.com)	12.95
Total (per year)			\$ 99.95

7.3.3. Additional cost

The required additional costs are given below:

No.	Service name	Cost / year (\$)
1	Electricity	110.43

2	Internet	156.35
3	Utility	40
Total (per year)		\$ 306.78

7.3.4. Calculate possible earns (benefit)

The primary source of income of the “Smart Agro” system will be from selling agricultural products and delivering products from farmer’s fields to retailers or consumer’s doorsteps. Other income sources may include service charges, advertisements, and sponsors. The estimated possible earnings of five years are given in the table below:

No.	Earning Area	1 st year (\$)	2 nd year (\$)	3 rd year (\$)	4 th year (\$)	5 th year (\$)
1	Product Sales	1600	4204	5600	5800	7800
2	Services charge	400	1040	1650	1800	2500
3	Delivery charge	500	1200	1748	2685	3200
4	Advertisement	-	380	432	579	680
5	Sponsors	100	100	230	230	400
6	Others	10	40	68	85	110
Total		2610	6964	9728	11179	14690

7.3.5. Cost-benefit analysis

The cost-benefit analysis is the process of identifying the difference between the estimated cost and benefit of the business process. It provides better insight and helps to decide that the business process is worth investing in both the long and short term.

The estimated expenditure of five years is given in the table below:

No.	Cost Area	1 st year (\$)	2 nd year (\$)	3 rd year (\$)	4 th year (\$)	5 th year (\$)
1	Hardware	972.67	-	-	-	-
2	Software	348.99	-	-	-	-
3	Domain & Hosting	99.95	80.99	80.99	80.99	80.99
4	Additional cost of development	306.78	-	-	-	-
5	Employee Salary	2000	1500	2200	2500	3600
6	Office Rent	3200	3200	3200	3200	4000
7	Office utility	578.6	592.3	541.8	570.0	616.4
8	Office Internet	172.5	172.5	172.5	172.5	172.5
9	Training	160	-	56	56	110
10	Government taxes	200	200	200	200	200
11	Delivery vehicle cost	540	960	1370	1500	1800
12	Maintenance	100	108	120	134	150
Total		8679.49	6813.79	7942.29	8413.49	10729.89

Cost-benefit analysis:

The approximate revenue of five years are shown in the table below:

	1st year (\$)	2nd year (\$)	3rd year (\$)	4th year (\$)	5th year (\$)
Cost	8679	6814	7942	8413	10730
Benefit	2610	6964	9728	11179	14690
Revenue	- \$6069	\$150	\$1786	\$2766	\$3960

7.3.6. Calculate net present value (NPV).

The net present value (NPV) calculation is shown below:

First, the present value (PV) of the cash inflow of each year will be found.

Formula for finding the present value of revenue: $PV = FV / (1+r)^n$

Where, FV = future value, PV = present value, r=cost of capital, n=year number.

2nd year: $PV = 150 / (1.10)^3 = 112.7$

3rd year: $PV = 1786 / (1.10)^3 = 1341.85$

4th year: $PV = 2766 / (1.10)^4 = 2078.14$

5th year: $PV = 3960 / (1.10)^5 = 2975.2$

$$\text{NPV} = -6069 + 112.7 + 1341.85 + 2078.14 + 2975.2 = 438.89$$

By calculating the net present value (NPV) for five years a positive value of **\$438.89** is found. It suggests that the combined PV of all cash inflows exceeds the PV of cash outflow by \$438.89. This project is an acceptable one since it adds \$438.89

to the value of the company. Therefore it can be concluded that this is a good investment.

A breakdown of cost-benefit analysis is given in **Appendix B**.

7.4. Analyze the major organizational changes with the new system

7.4.1.Change in business structure

If the new system is implemented properly it should have a positive impact on the existing business structure. Currently, there are many mediators involved that play a vital role in the agricultural industry, and the flow of products from farmers to consumers depends on them. By implementing the system these mediators can be avoided this will reduce the product's price and waste and farmers can gain more benefit from the yield they produce.

7.4.2.Change in business working procedures

The working procedure will also change because farmers will need to change their manual workflow of selling their products and keeping their field records. Farmers will be motivated to use the new system to manage their frames, sell products and gain knowledge. The farmers may no longer be required to sell products to the middlemen because the system will allow them to get more profit.

7.4.3.Change in business policy

Every small change, such as a new rule or regulation, can have a significant effect on a company. Employees and consumers do not always like new laws so implementing and accepting them can be difficult. The overall agricultural business policy might change because of the new system there will be some impact on the business stakeholders. People do not like change, therefore it will be difficult for the new system stakeholders to cope up and adapt to the changes.

7.4.4.Change in staff attitude

The output solution from this project is not for any organization, it is dedicated mainly to the farmers and general consumers. The farmer will be able to focus more on crop production rather than selling products. This will eventually increase their productivity level and yield.

8. Requirement analysis and specification

8.1. Rich picture

The rich picture helps to demonstrate complex business problems by drawing a detailed depiction of them. It is a part of soft system methodology and is typically drawn using symbols, doodles or sketch and will contain as much information as possible. To understand the existing business process regarding agriculture a detailed rich picture is drawn in the following section.

8.1.1. Diagram of rich picture

A rich picture of the existing business process is given below:

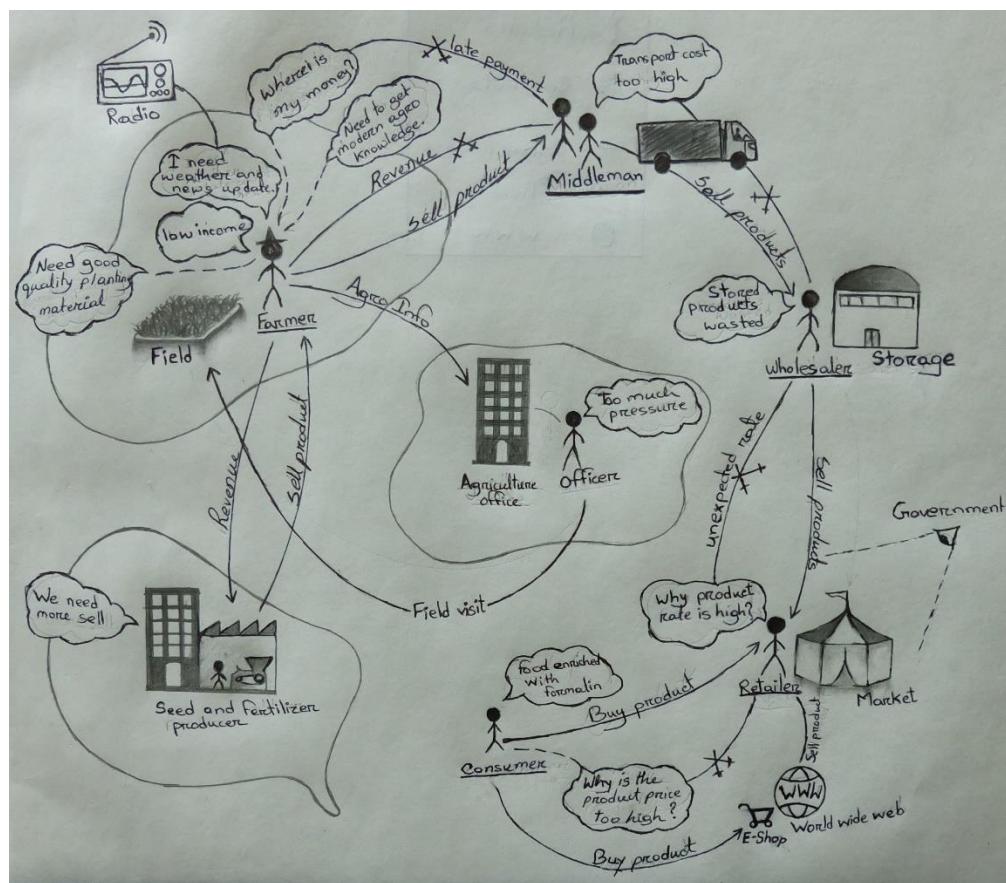


Figure 18: Rich picture of the existing agro-business system.

Rich Picture legends:

Rich picture legends	
Person icon	Actors
Arrow icon	Process
Cloud icon	Thinking
Crossed swords icon	Conflicts
Globe icon	World wide web

Figure 19: Rich picture legend.

8.1.2. Description of rich picture

The agriculture marketing process starts with the farmers and their fields. Farmers produce crops in their fields using seeds and fertilizers produced by different companies. Farmers grow their crops, cultivate their yield, and sell them to the local middlemen. The middleman does not pay the proper value of products to the farmers and sells them to the wholesaler. Wholesalers store the produce and sell it to the retailer when it's time. Due to the exchange of food from one middleman to the other, food is transported and stored for days, this causes around 20 to 25 percent of food wastage. To recover this wastage wholesalers sell products to the market or the retailers at a high price. And the consumers or general people have to buy products at a very high rate from the market. Farmers also lack modern

farming practices and information. To gain knowledge or to share problems farmers have to go to the agriculture office. Agricultural officers are not available all the time and this is also a complicated process. Agricultural officers often have to travel a long distance to reach rural farmers which is a hectic job for them. Overall the most affected group of people are the farmers and the middlemen are making all the profits.

8.1.3. Key issues

The key issues in the rich picture of the current business scenario are outlined below:

- **Food wastage:** lots of foods and vegetables are wasted during transport and storage.
- **Farmers face loss:** Farmers always get low value for products than the average market value.
- **Agro officer workload:** Agricultural officers have to travel a long distance to reach rural farmers for a field visit.
- **Agricultural knowledge:** To get agricultural knowledge or to share their problem, farmers have to reach the agriculture office.
- **High rate of products:** Products rate gates too high once it reaches the market through different middlemen. Ultimately the consumers have to buy products at a high rate.

- **Weather update and news:** Farmers have to depend on radios and TV to get the weather news.

8.1.4. Areas of conflict

Wholesaler vs retailer:

- **Unexpected product rate:** Due to loss of food during transport and storage wholesalers increases product price and retailers have to buy products at a high price.

Farmer vs middleman:

- **Late payment:** Middleman pays the farmers very late.
- **Revenue:** Middleman get all the benefit/profit that the farmers are expected to get.

Customer vs retailer:

- **Unexpected product price:** Customers have to buy products from retailers at a higher price.

Middleman vs delivery:

- **High delivery cost:** The cost of delivering products to the wholesalers is high.

8.2. Organizational structure (BPMN)

Business Process Model and Notation or BPMN allows business to understand their internal business process in a graphical notation. To implement a new system it is essential to have a clear understanding of existing business processes and the persons involved in those processes.

BPMN diagram of the existing system is given below: Negotiate

- Agricultural marketing process from farmers to consumers.

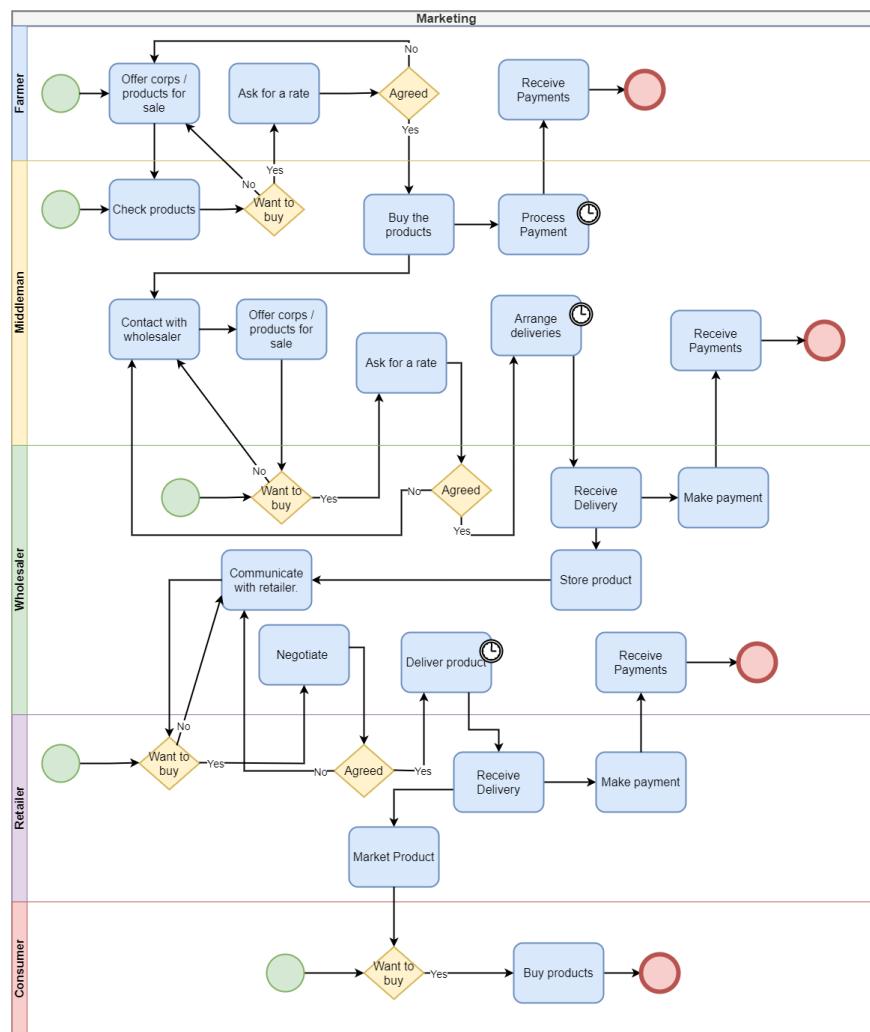


Figure 20: Agriculture marketing process.

- Process of communicating with agriculture officer.

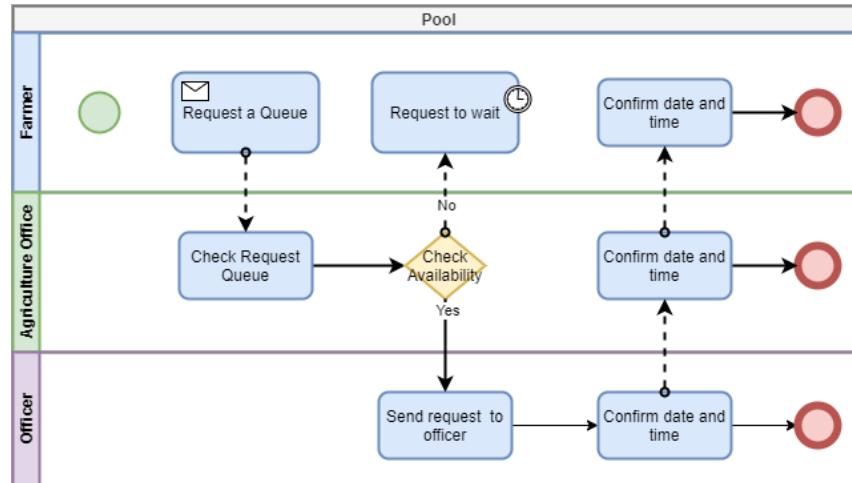


Figure 21: Process of communicating with agriculture officer.

- Seeds and fertilizer buying process.

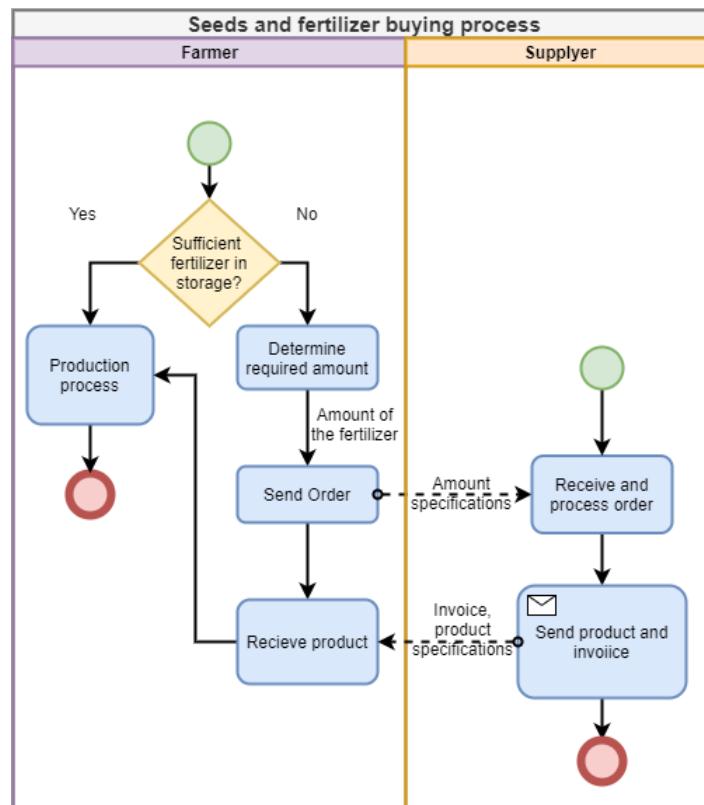


Figure 22: Seeds and fertilizer buying process.

8.3. Project stakeholders

All the project stakeholders are listed below:

Development team: The team that will develop the system. In this project, it is an individual who will play all the necessary roles in a development team.

Farmer: Farmers are the primary target user of the system, who produce crops for their living.

Retailer: People who want to buy products from the farmers and sell them to the local market.

General people/Consumer: General people who are the customer and want to buy products using the system.

Agriculture officer: Servers the farmer, share knowledge and solves their problems using the system.

8.4. Eliciting business/user requirements

Requirement elicitation is the process of studying and identifying the system's requirements from end-users, clients, and other stakeholders. The term "requirement gathering" is often used to describe the process. To gather requirements for the "Smart Agro" project four requirement gathering techniques are use (Interview, Survey, Observation, and Document Analysis).

8.4.1. Summary/Analysis of interview

Interviews play an important role in the requirement gathering process. It is the most widely used requirement gathering technique. To gather requirements for this “Smart Agro” project few interviews were conducted both online and offline. Due to the COVID 19 outbreak and lockdowns all over the country, conducting interviews was a difficult task.

The list of questions asked to different types of participants are listed below:

✓ **Farmer:**

Q1. What is the current market condition of the products that you produce?

Q2. Why do you think you are not able to get the proper value of your products?

Q3. What are the problems you are facing in the crop production process?

Q4. According to your opinion, what can be improved about the farming business?

Q5. What changes in the market can be beneficial to you and other farmers?

Q6. Can you afford a smartphone? And if you can, how well you can use it?

Q7. How challenging it is to cope up with unpredictable weather conditions?

Q8. Do you know about any software solution/app that could help you mitigate the problems you are facing.

✓ **Retailer:**

Q9. Why the product price rises so much as it arrives from field to customer?

Q10. How often you need to pay a bribe during transport?

Q11. Will a supply chain management system help in your process?

✓ **Agro Officer:**

Q12. Why are you not able to reach rural farmers?

Q13. What are the major challenges farmers are facing these days?

✓ **General customer/consumer:**

Q14. Why do you think product price in the market is too high?

Q15. According to your opinion, what can be done or action can be taken to control the uncertain market condition and politics?

A summary of interviews is available in **Appendix C**.

8.4.2. Summary/Analysis of survey

Surveys or questionnaires are commonly used and efficient data collection techniques. Questionnaires were used to perform a survey among the end-users. Questionnaires were provided to the Retailers and agricultural officers. As most farmers are illiterate a verbal survey was performed between them. The questionnaires included both open-end and closed-end questions.

A summary of the survey is available in **Appendix C**.

8.4.3. Summary/Analysis of document analysis

Extensive document research was performed in the literature review section. The data were collected from various online sources like established journals, articles, research papers, books, etc. These documents were collected online from different search engines and digital libraries like Google Scholar, Science Direct, IEEE Digital Library, ACM Digital Library, etc. After analyzing the document the problems were identified and probable solutions were also found.

8.4.4. Summary/Analysis of observation and experience

The observation technique was performed to gather requirements for the “Smart Agro” project. The real market scenario was observed in real-time. The interaction of farmer to middleman and middle-man to retailers were observed. The working process of the market and the role of the agriculture officer was also observed

A summary of observation is available in **Appendix C**.

8.5. Specific problem area identification and description

After conducting the requirements gathering process some specific problem areas are identified, which are outlined below:

- Farmers do not get the actual value for their produced crops from the middlemen. Farmers claim that due to the lack of information of current market-price middlemen can cheat them.

- Agricultural officers are not available all the time and they cannot or do not want to reach rural farmers.
- Rural farmers still follow the traditional farming strategies, therefore their production is limited.
- Farmers are not aware of new diseases or climate change due to the information gap. This causes loss in their wealth and increases poverty.
- Lack of quality full planting materials (seeds, etc.) leads to poor production or yield. Recently some farmers were cheated by a seed company as they provided fake onion seeds to the farmers.
- Most farmers are still dependent on rain and climate change. They are not able to accurately predict weather conditions.
- Farmers do not have the proper knowledge of using a balanced fertilizer required for higher yield.
- There is no e-commerce marketplace for farmers to sell their agricultural products.
- General consumers have to pay a high value for fruits vegetables and other agricultural products.
- Farmers find the agricultural loan process difficult.

8.6. Problem solutions

After identifying the problem areas the probable solutions were found. The list of the possible solution is given below:

- ✓ An e-commerce platform for the agriculture marketing ecosystem is required. So that farmers can sell their products at a good price eliminating the mediator (middleman).
- ✓ A knowledge center and a new page need to be developed for farmers. It will allow farmers to get the latest information on agriculture.
- ✓ An efficient way needs to be developed that allows flawless communication between farmer, retailer, customer, and agricultural officer.
- ✓ A crop planting recommendation will be very helpful for farmers to take decision on what crops to plant.
- ✓ A system can be developed that allows farmers to plan and manage their farming data to have a better understanding of the cash inflow and outflows.
- ✓ Disease and pest control is a major problem. A system could be developed that allows farmers to upload infected leaf images and the system will process the image and suggest necessary precautions.
- ✓ Farmers should be able to easily communicate with the agriculture officer and talk about their problem and request suggestions.

8.7. System requirements from a different personnel perspective

System requirements from a personal perspective are given below:

ID	Requirements
001	As a farmer, I want to get the latest news on agriculture so that I can stay updated.
002	As a farmer, I want to sell my products in the local market or to consumers so that I can get a good value for my products.
003	As a farmer, I want to communicate with the agriculture officers so that I can discuss my problems.
004	As a consumer, I want to buy products directly from the farmers so that I can get fresh and good quality food.
005	As a farmer, I want to be able to manage my farm data using the system so that I don't have to maintain manual record-keeping books.
006	As a farmer, I want to be updated with all the latest modern agriculture techniques so that I can increase my yield.
007	As a farmer, I want to get the latest weather prediction so that I can judge the perfect time to cultivate my crops.
008	As a farmer, I want to buy quality planting material, fertilizer, and pesticides for my field.

009	As an agricultural officer, I want to communicate with the rural farmers using the system so that I don't have to travel long distances.
010	As a farmer, I want to get suggestion on precautions to take when my plants are infected by insects or diseases so that I can mitigate them before it spreads.

8.8. Requirement list with specifications

8.8.1. Functional requirements

The functional requirements of the “Smart Agro” system are given below:

- Users must be able to log in and create an account in the system using their credentials or social account.
- Users should be able to manage and update their accounts/profiles.
- Users must be able to access their dashboard.
- Users must be able to communicate with each other using a chat system.
- Farmers should be able to advertise their products in the system.
- Farmers should be able to input farming data in the system and the system would be able to generate tallies.
- The system should show a detailed current weather update and weather record of the past eight years.
- Retailers should be able to purchase and order products using the system.

- An online payment system should be implemented for faster transactions.
- Farmers should be able to mark their land on the map.
- Admin users should be able to create, update, retrieve and delete articles.
- Admin users should be able to create, update, retrieve and delete news.
- Users should be able to upload disease-infected leaf images to the system.
- The system should suggest precautions to take for infected plants.
- The system should be able to suggest crops to plant in the next upcoming season.
- Admin should be able to add products like fertilizer, seed, and other planting material to the agro bank.
- Farmers should be able to apply for loans using the system.
- Users should be able to add products to the cart.

8.8.2. Non-functional requirements

The non-functional requirements are given below:

- **Reliability:** The system should be reliable.
- **Security:** The system should be secure.
- **Availability:** The system should be accessible from different devices like smartphones, tab, computers, etc.
- **Usability:** The system should be simple and easy to use.
- **Maintainability:** The system should be easily maintainable.
- **Backup:** Data backup needs to be ensured.

8.9. Prioritized requirement list

Requirement prioritization is an essential part of project management. The requirements are prioritized so that the most important features can be developed and delivered earlier. The MoSCoW prioritization rule is followed to prioritize the requirements, where M is Must have, S is should have, C is could have, and W is won't have this time.

8.9.1. MUST have requirements

The must-have requirements are listed below:

Requirements ID	Requirements
R01	User authentication (login/registration).
R02	Manage posts/articles.
R03	Weather update.
R04	Manage inventory.
R05	Manage agro bank.
R06	Browse articles and news.
R07	Manage product cart.
R08	Upload disease-infected plants image.
R09	Manage shipments.
R10	Farmers can ask questions using the system.

8.9.2.SHOULD have requirements

Should have requirements are listed below:

Requirements ID	Requirements
R11	Manage user account/profile.
R12	Logout functionality.
R13	Live chat system
R14	Audio and Video chat.
R15	Farmers should be able to apply for a loan.
R16	Suggest best crops to plant before the next season based on farmer location.

8.9.3.COULD have requirements

Could have requirements are listed below:

Requirements ID	Requirements
R17	Satellite imagery integration.
R18	Mark lands in maps.
R19	Notification system.
R20	Online payment system.
R21	Search articles and news.
R22	Track loan progress.
R23	Comment on articles and news.

8.9.4. WON'T have these time requirements

Won't have requirements are listed below:

Requirements ID	Requirements
R24	Automatic disease detection and suggest precaution.
R25	Product review, rating, and feedback.
R26	Get feedback from the users.

8.10. Requirement catalog

After analyzing and prioritizing the requirement list for the proposed system the requirements catalog is created. The requirement catalog for this proposed system is given below.

User authentication:

Source:	Sign Off:	Priority:	Requirement ID:
Admin	All Users	Must have	R01
Functional requirement: Authenticate user.			
Not authenticated users should be able to log in and register into the system.			
Non-Functional requirements: A maximum of 5 failed login attempts is allowed after that the user will be locked for 10 minutes.			
Criteria	Target value		Acceptable range
Login and register limit per day		3000	3500
Comments: Users must be able to log in and register to the system easily.			

Manage account:

Source:	Sign Off:	Priority:	Requirement ID:
Admin	All Users	Should have	R11
Functional requirement: Manage user accounts.			
Users will be able to change their account details and manage their accounts.			
Criteria		Target value	Acceptable range
Manage account limit per day		200	300
Comments: Users should be able to manage their accounts.			

Manage Inventory:

Source:	Sign Off:	Priority:	Requirement ID:
Admin	Admin, Farmers	Must have	R04
Functional requirement: Inventory management.			
Admins and other users should be able to manage the inventory and add, edit, update and delete products.			
Criteria		Target value	Acceptable range
Limit per day		2000	2500
Comments: Users will be able to manage inventory efficiently.			

Manage posts/articles:

Source:	Sign Off:	Priority:	Requirement ID:
Admin	Admin, officer	Must have	R02
Functional requirement: Manage News, articles, and blog posts.			
Admin and agriculture officers will be able to manage posts.			
Non-Functional requirements: To allow post/articles management users must be logged in to the system.			
Criteria	Target value	Acceptable range	
Limit per day	40	60	
Comments: Users will be able to manage posts efficiently.			

More requirement catalogs in **Appendix C**.

9. New system design and architecture

9.1. Use case diagram

Full use case diagram of the new system is given below:



Figure 23: Use Case diagram.

9.2. Use case documentation

9.2.1. Primary and secondary use case scenario

Use Case Description:

Use Case ID	UC001
Use Case Name	Authentication
Primary Actor	All Users
Use Case Description	Users Login or register to the system.
Pre-Condition	
Post Condition	Must verify email after registration.
Flow of events	<ol style="list-style-type: none">1. Visit the login or register page.2. Provide user credentials.3. Submit form.

Use Case ID	UC002
Use Case Name	Manage account
Primary Actor	All Users
Use Case Description	Users can manage their profiles.
Pre-Condition	1. Users must be authenticated.
Post Condition	Success and error message on profile update failure and success.

Flow of events	<ol style="list-style-type: none"> 1. Visit profile update page. 2. Fill in or change form data. 3. Submit form.
-----------------------	---

Use Case ID	UC002
Use Case Name	Manage inventory
Actor	Admin, Farmer
Use Case Description	Farmers can add, update, delete and view products in inventory.
Pre-Condition	1. The user must be logged in.
Post Condition	Display success message on successfully adding products. Admins need to approve the advertisement.
Flow of events	<ol style="list-style-type: none"> 1. Visit the inventory page. 2. Fill in product details. 3. Submit form.

More use case description is provided in **Appendix D**.

9.3. Database design

9.3.1. Entity-relationship diagram

The Initial Entity-relationship diagram ERD of the “Smart Agro” system is given below:

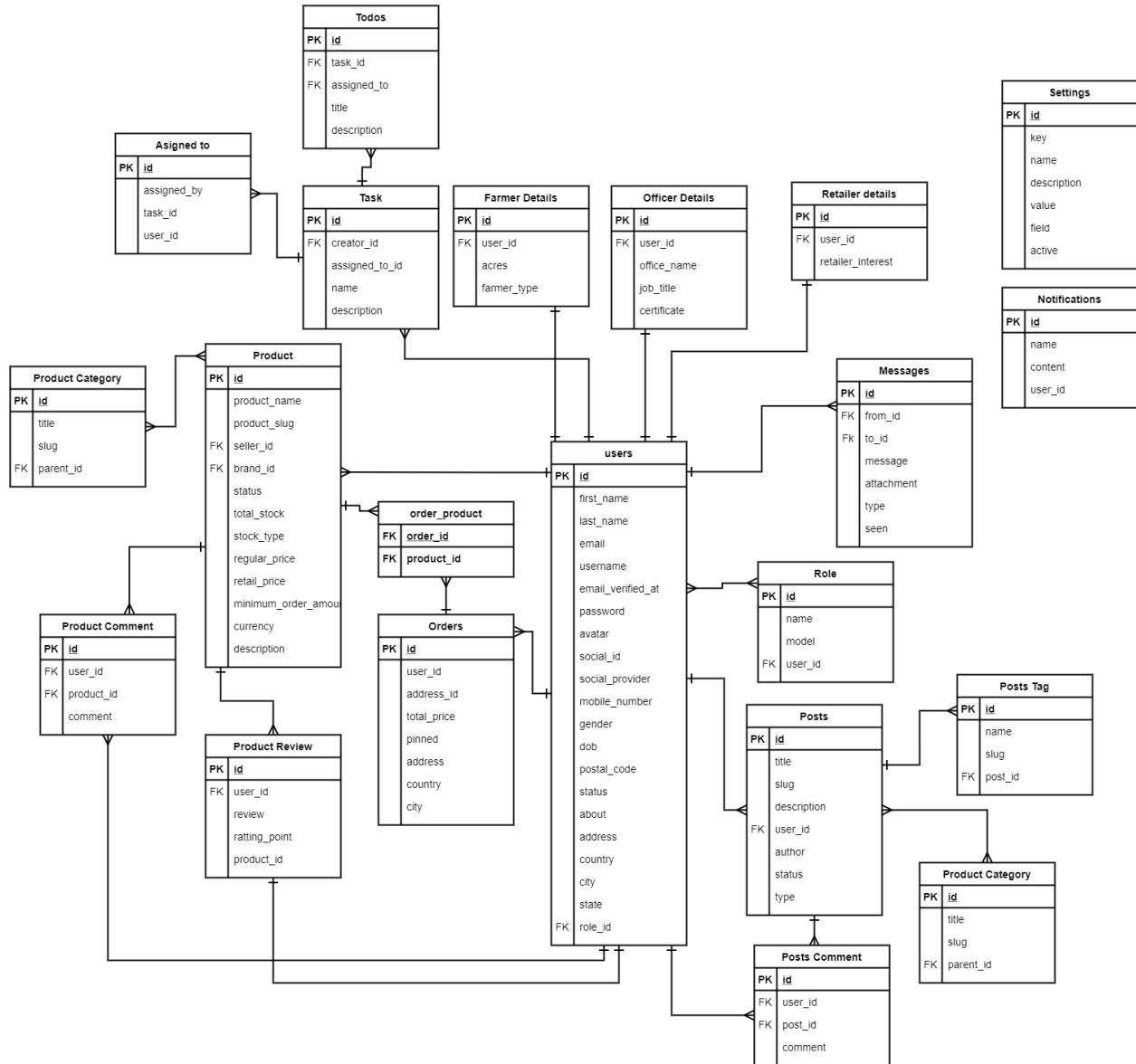


Figure 24: Initial ERD diagram.

9.3.2. Database mapping

Database mapping for the proposed system is given below:

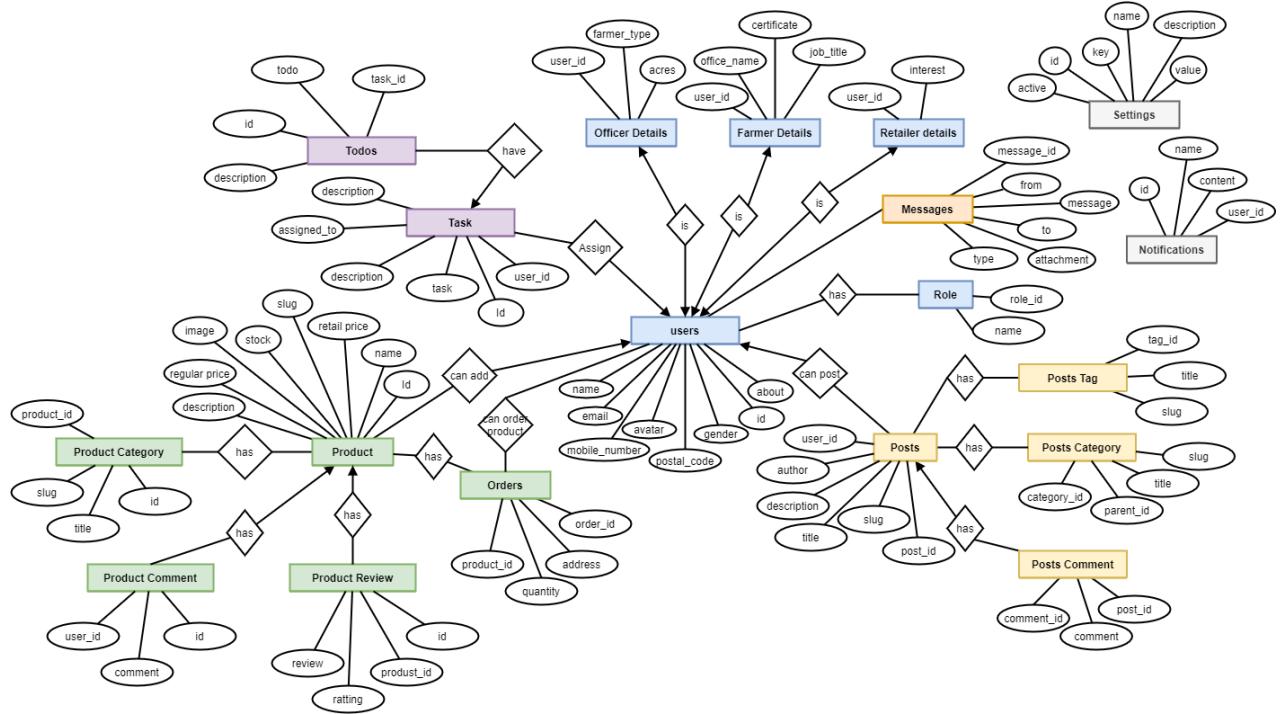


Figure 25: Database mapping.

9.3.3. Normalization (3rd normal form)

The initial ERD is normalized to the third normal form to reduce the redundancy of data and resolve the problems with many to many relationships. The figure below shows the normalized ERD to the third normal form.

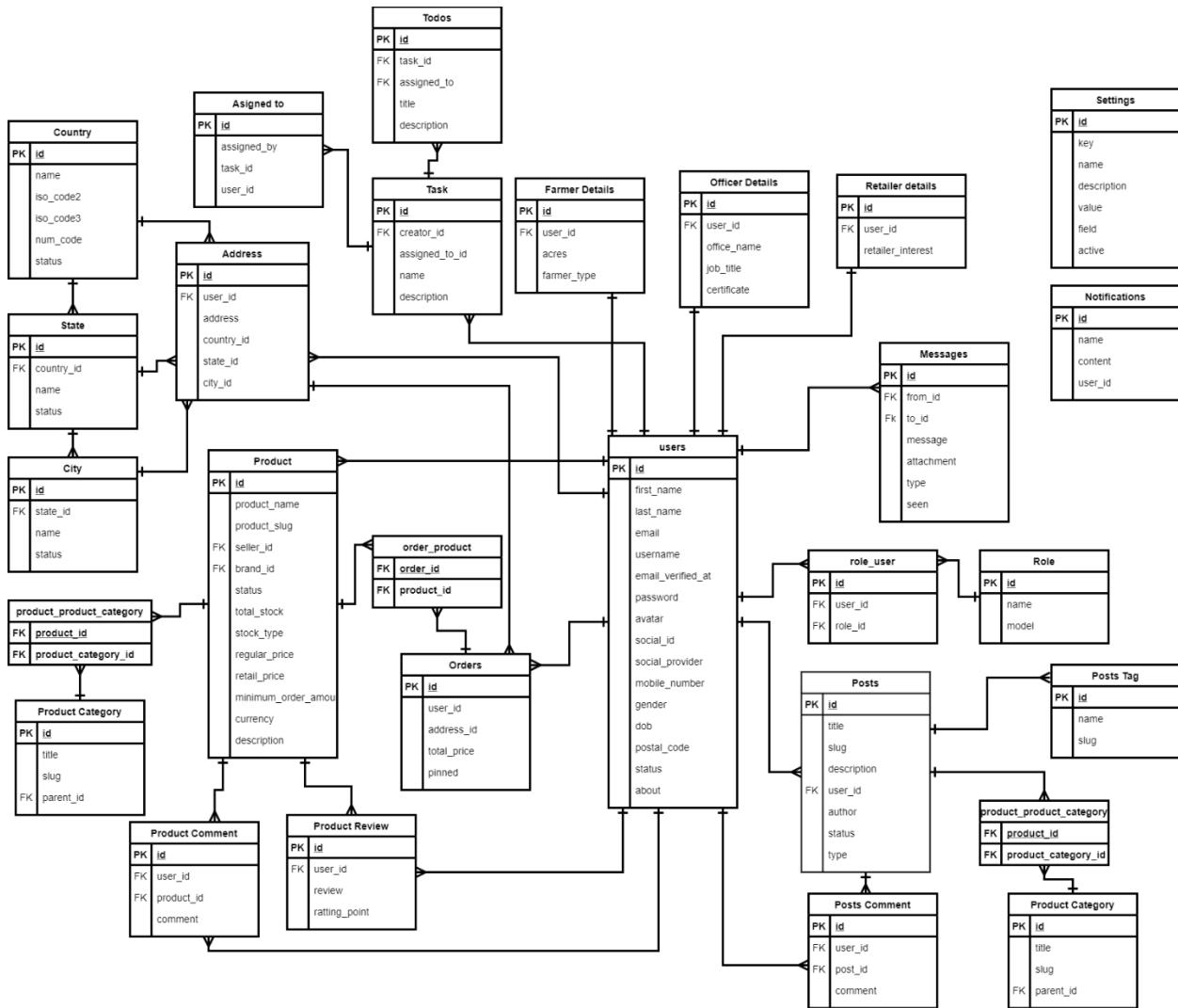


Figure 26: Entity relationship diagram (ERD) 3rd normal form.

The data dictionaries are provided in [Appendix E](#).

9.4. Class diagram

The figure below represents the class diagram of the proposed system.

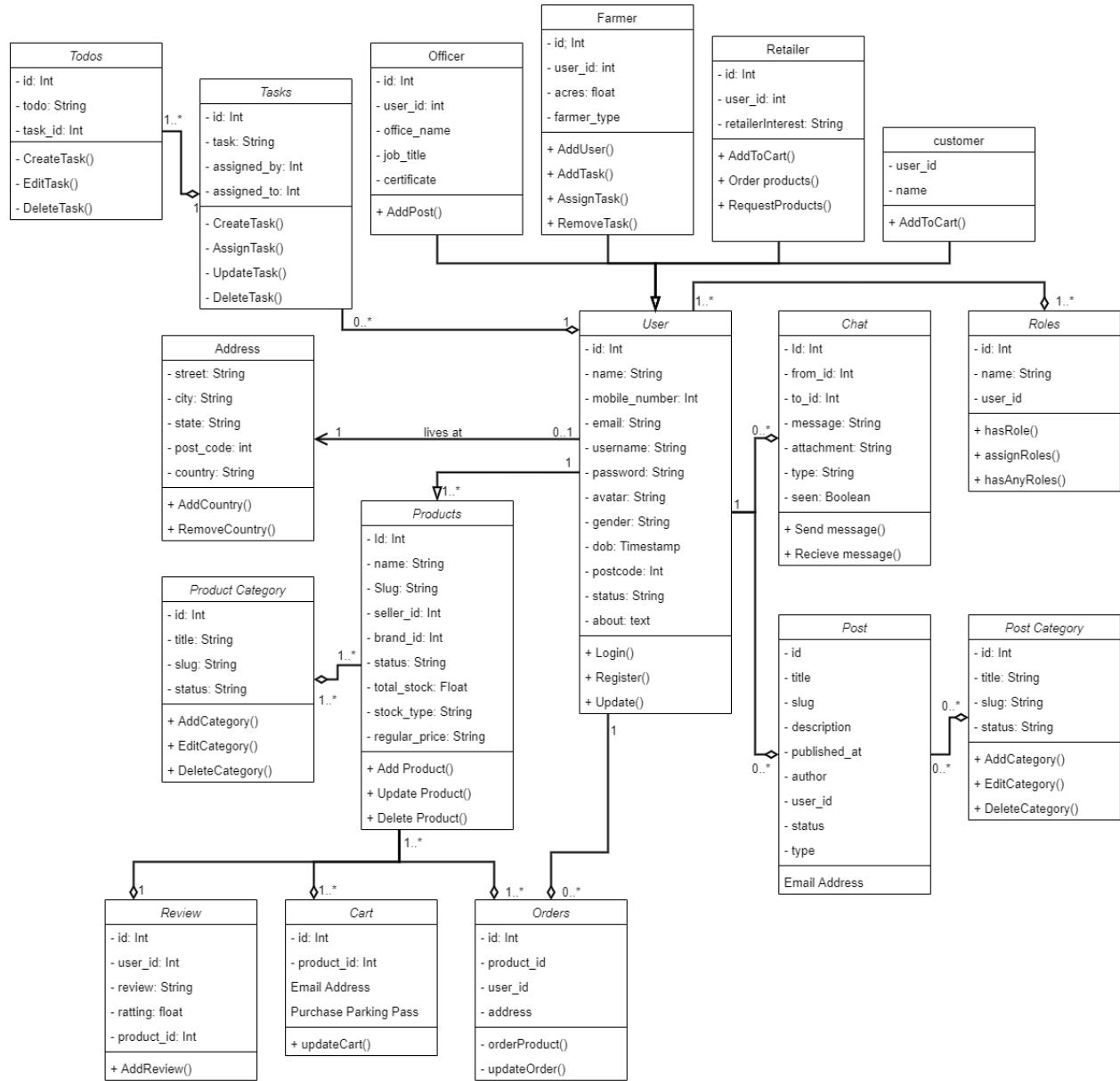


Figure 27: Class Diagram.

9.5. Sequence diagram

The sequence diagrams for the given scenario is given below:

Inventory management:

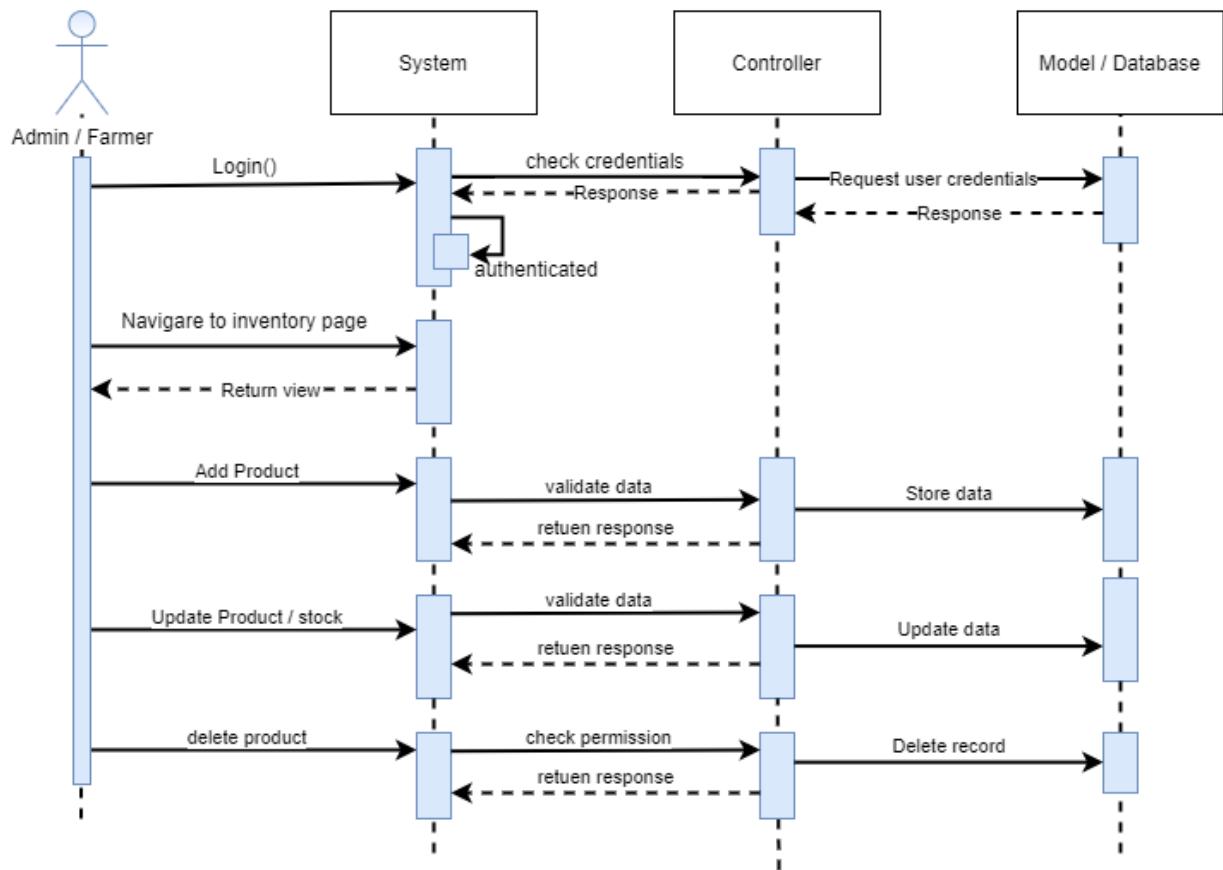


Figure 28: Manage Inventory sequence diagram.

Shopping Cart:

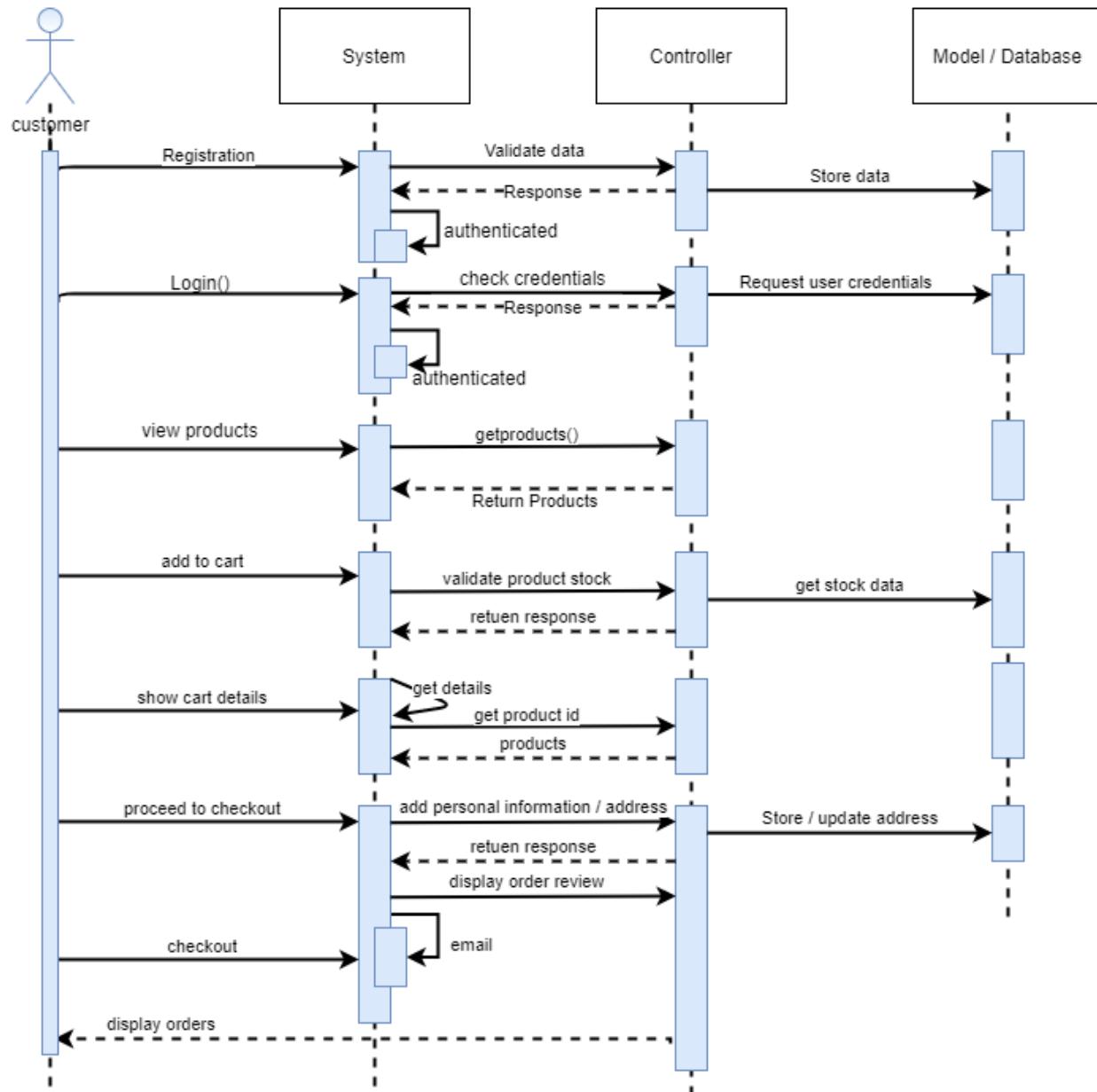


Figure 29: Shopping cart sequence diagram.

Manage post:

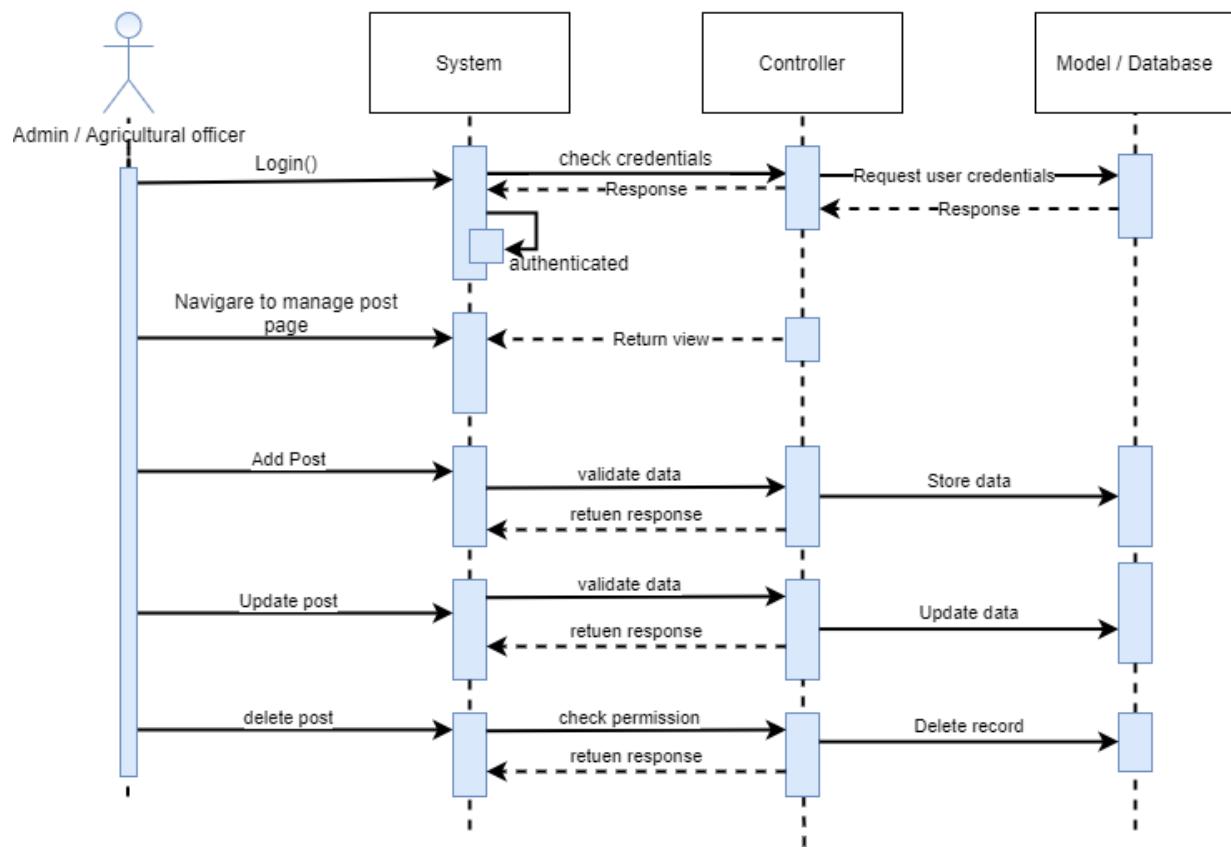


Figure 30: Sequence diagram for manage post.

Task management:

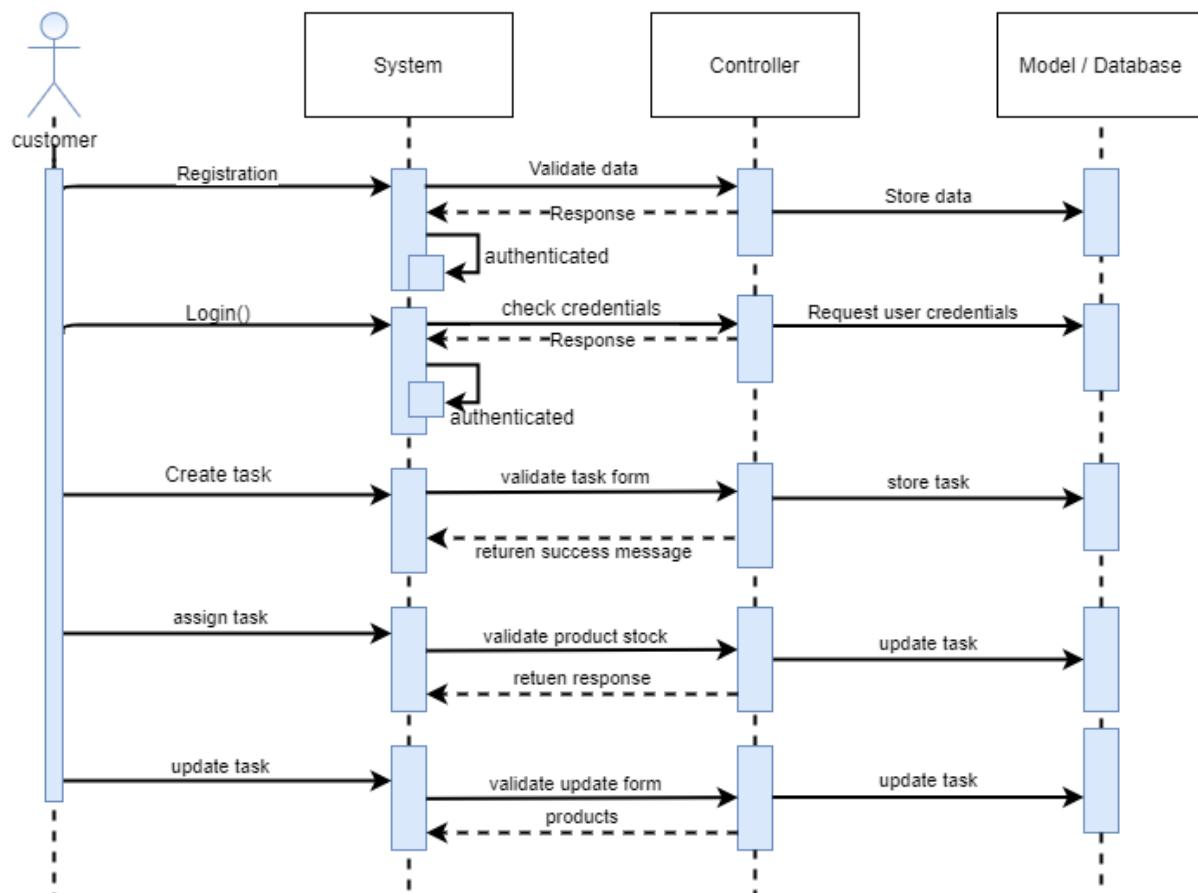


Figure 31: Manage task sequence diagram.

9.6. Component diagram

The component diagram helps to visualize the physical aspects, artifacts or executables, and relationships of the system. The figure below represents the component diagram for the “Smart Agro” system.

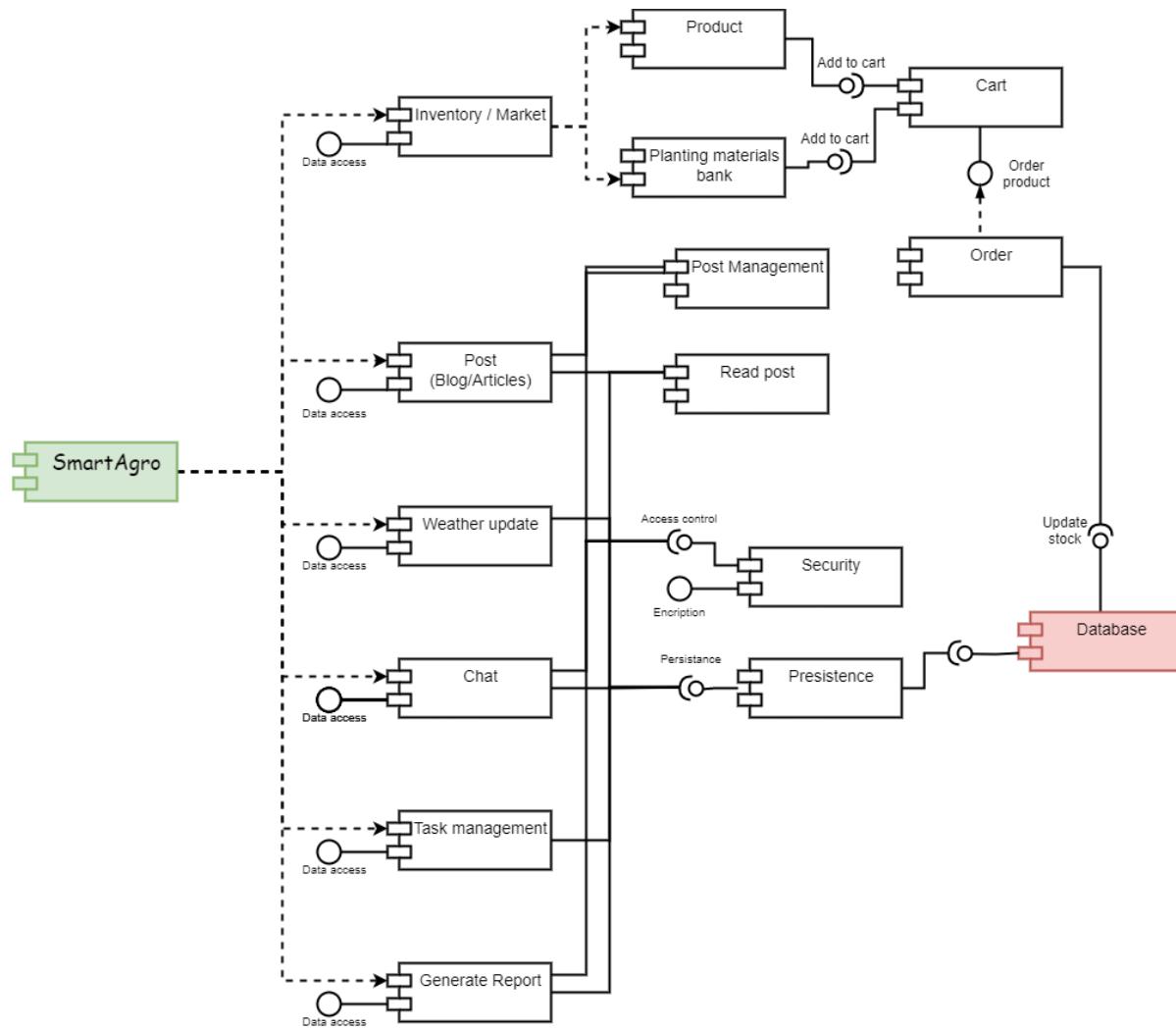


Figure 32: Component diagram.

9.7. Deployment diagram

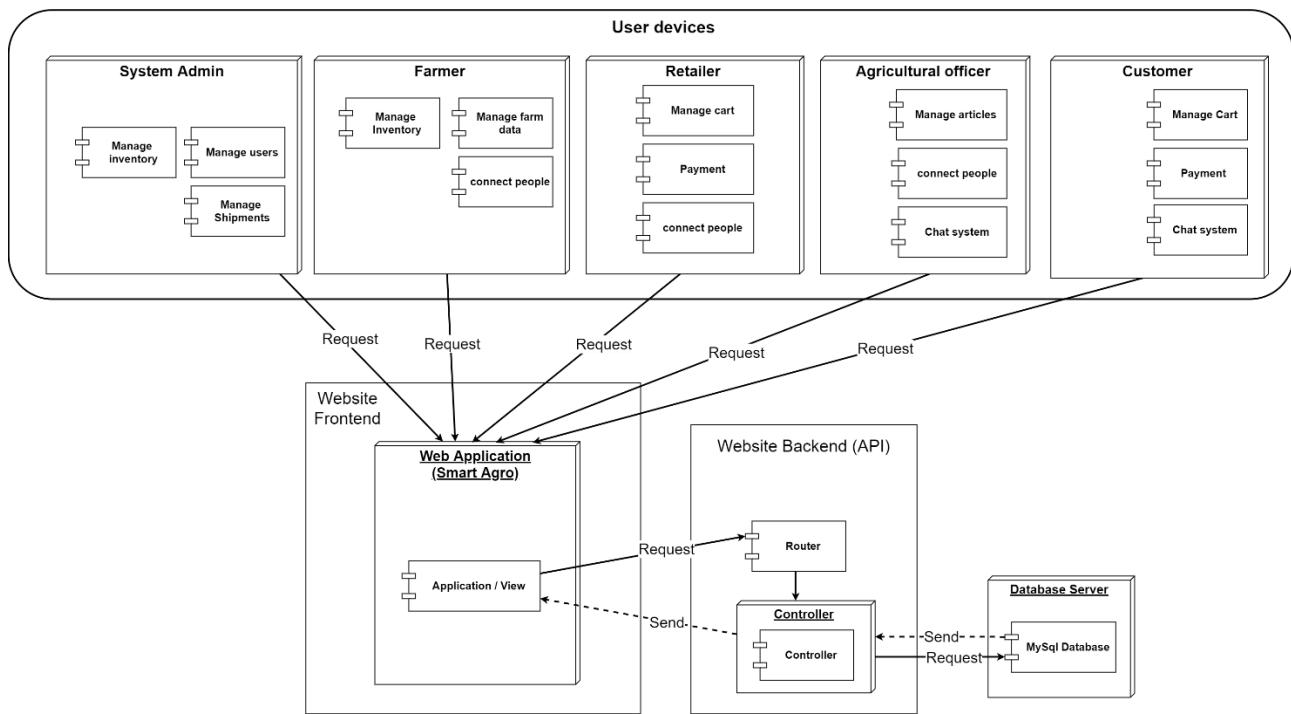


Figure 33: Deployment diagram.

9.8. Low-fidelity wireframes for prototypes

Login page

Email: smartagro.bd@gmail.com | Contact: +880134567891 [Register](#)

SmartAgro [HOME](#) [MARKET](#) [POSTS](#) [WEATHER](#) [AGRO MATERIALS](#) [ABOUT](#) [CONTACT](#) [Cart](#)

Login

Phone number / Username / Email
john123, john@example.com, 01*****

Password

Remember me

[Forgot Password?](#)

[Login](#)

Or sign in with social account

[Facebook](#) [Twitter](#) [Github](#)

Don't have an account? [Register](#)

Select Language [▼](#)

Register page

Email: smartagro.bd@gmail.com | Contact: +880134567891 [Login](#)

SmartAgro [HOME](#) [MARKET](#) [POSTS](#) [WEATHER](#) [AGRO MATERIALS](#) [ABOUT](#) [CONTACT](#) [Cart](#)

Register

Who are you?

 Farmer  Retailer  Agro Officer  Customer

Fill the form

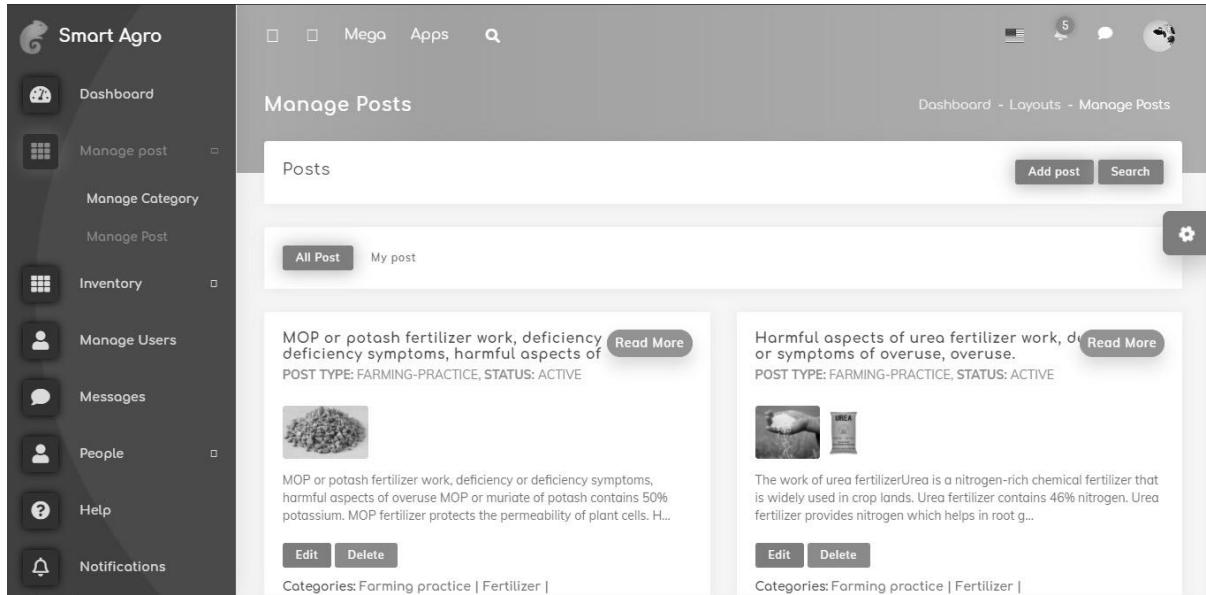
First Name (*) John	Last Name (*) Doe
Username (*) john123	Email (*) example@gmail.com
Password (*) *****	Confirm Password (*) *****
Mobile Number (*) 01*****	Postal Code 1205

[Register](#)

By creating an account you agree to our [terms of service](#)

Already have an account? [Login](#)

Product management



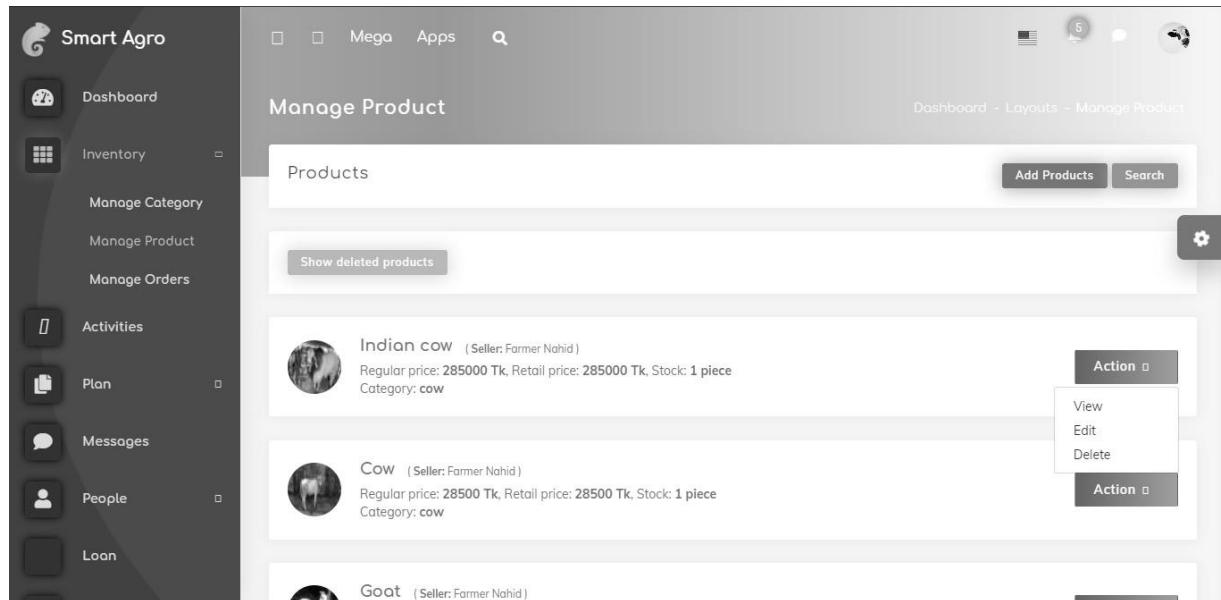
The screenshot shows the 'Manage Posts' section of the Smart Agro application. The left sidebar includes links for Dashboard, Manage post, Manage Category, Manage Post, Inventory, Manage Users, Messages, People, Help, and Notifications. The main area has tabs for 'Posts' and 'All Post' (selected). It displays two posts: one about MOP or potash fertilizer work and another about harmful aspects of urea fertilizer. Each post includes a 'Read More' button, an image, and edit/delete buttons.

MOP or potash fertilizer work, deficiency
deficiency symptoms, harmful aspects of
POST TYPE: FARMING-PRACTICE, STATUS: ACTIVE

Harmful aspects of urea fertilizer work, do
or symptoms of overuse, overuse.
POST TYPE: FARMING-PRACTICE, STATUS: ACTIVE

Categories: Farming practice | Fertilizer |

Inventory page



The screenshot shows the 'Manage Product' section of the Smart Agro application. The left sidebar includes links for Dashboard, Inventory (selected), Manage Category, Manage Product, Manage Orders, Activities, Plan, Messages, People, and Loan. The main area has tabs for 'Products' and 'Show deleted products'. It lists three items: Indian cow, Cow, and Goat, each with a seller note, regular price, retail price, stock count, category, and an 'Action' menu (View, Edit, Delete).

Indian cow (Seller: Farmer Nahid)
Regular price: 28500 Tk, Retail price: 285000 Tk, Stock: 1 piece
Category: cow

Cow (Seller: Farmer Nahid)
Regular price: 28500 Tk, Retail price: 28500 Tk, Stock: 1 piece
Category: cow

Goat (Seller: Farmer Nahid)

Cart

The screenshot shows the SmartAgro website with a dark-themed header. The header includes the email 'smartagro.bd@gmail.com' and phone number '+880134567801', a 'Login' button, and a navigation bar with links: HOME, MARKET, POSTS (with a dropdown arrow), WEATHER, AGRO MATERIALS, ABOUT, CONTACT, and a shopping cart icon with a notification badge showing '9'.

The main content area features a large image of a plant leaf. Below it, there's a breadcrumb navigation with 'Home' and 'Market'. A message 'Showing 1–12 of 12 results' is displayed. A central modal window titled 'Cart' is open, listing four items:

#	Image	Item	Total stock	Quantity	Price	Action
0		Corn	1000 piece	4 piece	+ - BDT 120.00	X
1		Sugarcane	1000 piece	4 piece	+ - BDT 240.00	X
2		Jackfruit	1000 piece	2 piece	+ - BDT 120.00	X
3		Bombay Lychee	1000 kg	2 kg	+ - BDT 120.00	X

Below the table, the total amount is shown as 'Total Amount 12 BDT 600.00'. At the bottom of the modal are two buttons: 'Clear Cart' and 'Checkout'.

Shop page

Email: smartagro.bd@gmail.com | Contact: +880134567801 [Login](#) [Register](#)

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MARKET

Home Market

Showing 1–12 of 12 results

Grid View

Catagories

All

Crop (3)

- Sugarcane (1)
- Rice (1)
- Wheat (0)
- Corn (1)

Fruit (5)

- Mango (1)
- Lychee (3)
- Jackfruit (1)

Banana (0)

Vegetables (0)

- Potato (0)
- Tomato (0)
- Cabbage (0)

Livestock (4)

- cow (3)
- Buffalo (0)
- Sheep (0)
- Goat (1)

Aquaculture (0)

- Rui (0)
- Talapia (0)

Spices (0)

Search: Product name, category, location [Clear](#)

	Indian cow 285000 TK / piece Stock: 1 piece		Cow 28500 TK / piece Stock: 1 piece		Goat 18000 TK / piece Stock: 1 piece
	Cow 1800000 TK / piece Stock: 1 piece		Sugarcane 60 TK / piece Stock: 1000 piece		Corn 30 TK / piece Stock: 1000 piece
	Rice 60 TK / lbs Stock: 4 lbs		Jackfruit 60 TK / piece Stock: 1000 piece		Lychee 60 TK / kg Stock: 1000 kg
	Lychee 60 TK / kg Stock: 1000 kg		Bombay Lychee 60 TK / kg Stock: 1000 kg		Mango 35 TK / kg Stock: 1000 kg

Knowledge center page

Email: smartagro.bd@gmail.com | Contact: +880134567801  nahid123

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BLOG



[Home](#) [blog](#)

Post on 04-23-2021 / Nahid Ferdous

Requirements for zinc rich rice.



জিএক সমৃদ্ধ ধানের প্রয়োজনীয়তাবাংলাদেশ ধান নিরাপত্তা আর্জিনে সঞ্চল হলেও পুষ্টি নিরাপত্তার রয়েছে ব্যাপক ঘটিতি। পুষ্টি নিরাপত্তা নিশ্চিতকরণে সরবরাহ তার জাতীয় পুষ্টি...

Post on 04-23-2021 / Nahid Ferdous

Mango production should be done throughout the year.



আম বাংলাদেশে একটি বাণিজ্যিক ফল। অধিক ফলন ও উৎপাদনের জন্য নিম্নলিখিত কার্যক্রমসমূহ বাস্তবায়ন করা প্রয়োজন মুক্তুল আসার পর (জানুয়ারি - মার্চ)মুক্ত...

Catagories

- Farming practice
- Crop
 - Crop Care
 - Improved Rice Cultivation
 - Crop Storage
 - Crop Health & Nutrition
 - Planting
 - Beef Cattle Farming
 - Poultry Farming
 - Goat Farming
 - Soil Improvement Techniques
 - Intensive Fruit Farming
 - Seeds
 - Quality seed
 - Seed Preparation
 - Weather Mitigation
 - Machinery
 - Fertilizer

Recent News

 - US milk production continues its upward trajectory for 2018
18 Aug 2018
 - USDA's crop ratings more ahead for corn, drop for soybeans
18 Aug 2018
 - Auction report: Bids aplenty for massive John Deere collection
18 Aug 2018
 - Wool prices expected to remain competitive as demand is grow
18 Aug 2018

Weather update page

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SmartAgro [HOME](#) [MARKET](#) [POSTS](#) [WEATHER](#) [AGRO MATERIALS](#) [ABOUT](#) [CONTACT](#) [Cart](#)

Weather Update

11:36:03, PM - 23 Apr 2021, Friday

Your Location: Dhaka, Bangladesh, DHAKA-1205 [Change](#)

Dhanmondi R/A, BD
Location details: Dhanmondi R/A, Lalmatia, Dhaka, Dhaka District, Dhaka Division, DHAKA-1205, Bangladesh

 28°C Haze

 Feels Like: 30.54m/s S
 Wind speed: 2.72m/s S
 Humidity: 69%
 Pressure: 1008hPa

[Today](#) [8 day forecast](#)

Select Language [English](#) [Bangla](#)

Sunrise: 05:30 am,  Sunset: 06:22 pm

Search

City Name: Eg: dhaka ... [Search](#)

 A satellite map of the world showing cloud cover. A black location marker is placed over South Asia. The map includes a legend for 'Map' and 'Satellite' views, zoom controls (+/-), and a person icon. The Google logo is visible at the bottom left, and a small text at the bottom right reads 'Map data ©2021 Imagery ©2021 NASA | Terms of Use'.

10. Review of technology

There are various technologies available that can be used to implement a working system. These technologies may include Web, Android, IOS, or Desktop applications. In this section, a proper technology will be chosen and the justification is given.

10.1. What technology to be implemented:

All the technologies mentioned can be classified into two parts, web application or client-server application.

Client-server application: A client-server application is a type of application that is installed on the client or user's end, which sends requests to the server to access data using its UI. A client-server application can be cross-platform and also platform-specific. To use this kind of application the application must be installed on the user device.

Advantages:

- Response and load time are generally faster.
- Less chance of getting hacked.

Drawbacks:

- Can be platform-specific.
- Installation is required.
- Can be accessible only from installed devices.
- Two-tier architecture.
- Lack of robustness.

Web application: A web application is a type of application that can be accessed from anywhere and any device (Android, IOS, laptop, computer, etc.) through a web browser, without the hassle of installation. It follows a multi-tier architecture and is platform-independent. It sends requests to the server from the browser to get access to data.

Advantages:

- No installation is required.
- Can be accessed from any device with a browser.
- Open to all platforms.
- Multi-tier architecture.

Disadvantage:

- Response and load time slower than client-server application.
- More chance of getting hacked.

10.2. Recommendation and justification:

After analyzing the technologies the recommended technology to implement the system is a web server application or web application. Justification for choosing a web server application is given below:

- **Accessible from anywhere and any device:** Only one code base will be required to develop the application, but it will be platform-independent and can

be accessed from anywhere and any device through a browser like Chrome, Firefox, etc.

- **No hassle of installation:** Farmers can easily use the application without installing it into their device.
- **Robustness:** The application can be robust, due to less chance of machine and server fail as all the requests will be handled by the browser.
- **Possibility of data loss is reduced:** There is a reduced chance of data loss as all the data will be stored in the webserver.

10.3. Review of development technologies.

10.3.1. Programming Language:

There are various programming languages available that can be used to develop a web application, for example, PHP, Python, ASP.net, Node JS, etc. PHP is the most used and popular backed-end programming language for developing web solutions. Researches show that around 80% of the web uses PHP. To develop this project a PHP framework named LARAVEL will be used. LARAVEL is the most popular PHP framework, it follows the Model View Controller (MCV) design pattern and is an Object-Oriented (OO) framework. To design the websites UI HTML, CSS, and Bootstrap will be used. As a frontend programming language JavaScript and its framework VueJs will be used.

10.3.2. Database:

To store data a database management system is required. MySQL database will be used to store data and as a database management tool PHPMyAdmin will be used.

These programming languages, databases, and tools are used to develop the project because the developer has experience of using these languages and tools therefore it will be handy to develop the proposed system. More over all the requirements of the system can be fulfilled using these technical tools.

11. Development

11.1. New system modules

The required functionalities of the proposed system are arranged into modules. The module for the new system is given below:

No.	Module name	Covered Area
1	User authentication, users, and user account management module.	Login, registration, user account management, user management.
2	Knowledge and information center module.	Manage articles, blog posts, and news.
3	Weather update module.	Shows live weather updates and track past weather records.
4	Seed and planting material bank module.	Add seeds and fertilizer to the agro materials shop for sale.
5	Chat system module.	Communication between users.
6	Inventory management module.	Manage product, cart, and orders.
7	Payment module.	Payment system for buying products.
8	Land management module	Integrate map, manage the land area, and calculate estimated yields.
9	Disease and crop prediction module.	Crop suggestion for next season, detect plant disease.
10	Website settings and UI customization module.	Customize user setting and the user interface look.

11.2. High-fidelity prototypes of new modules

The high fidelity prototype of the proposed system is given below:

Home page:

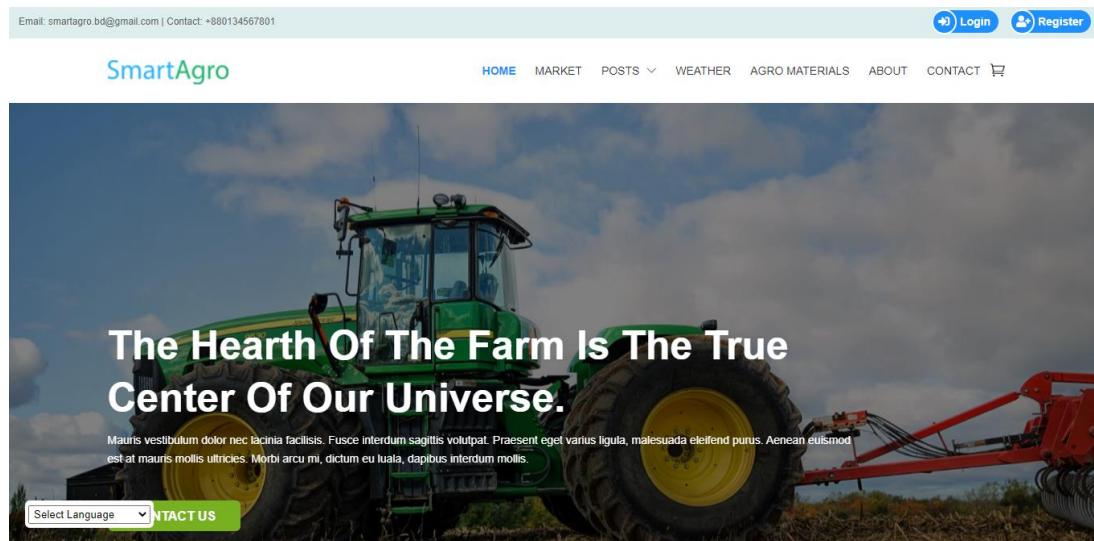


Figure 34: Home page.

Login page:

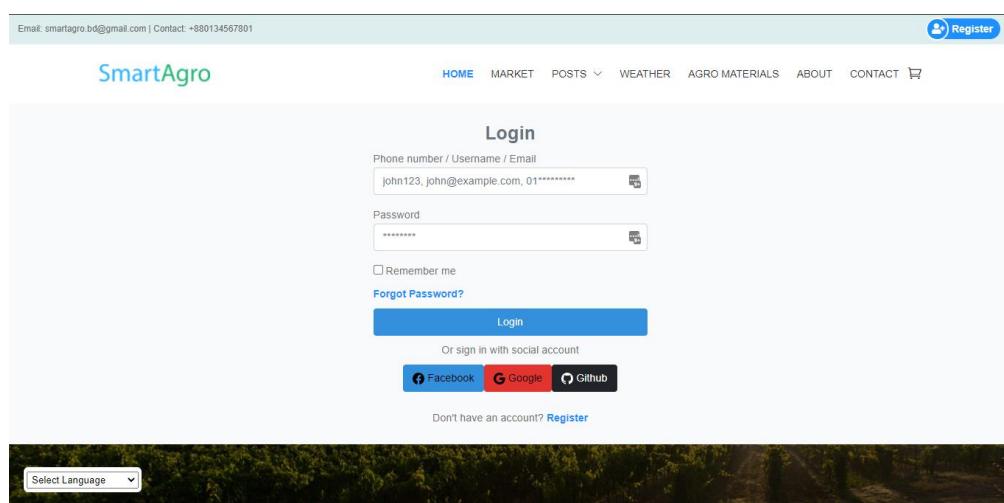
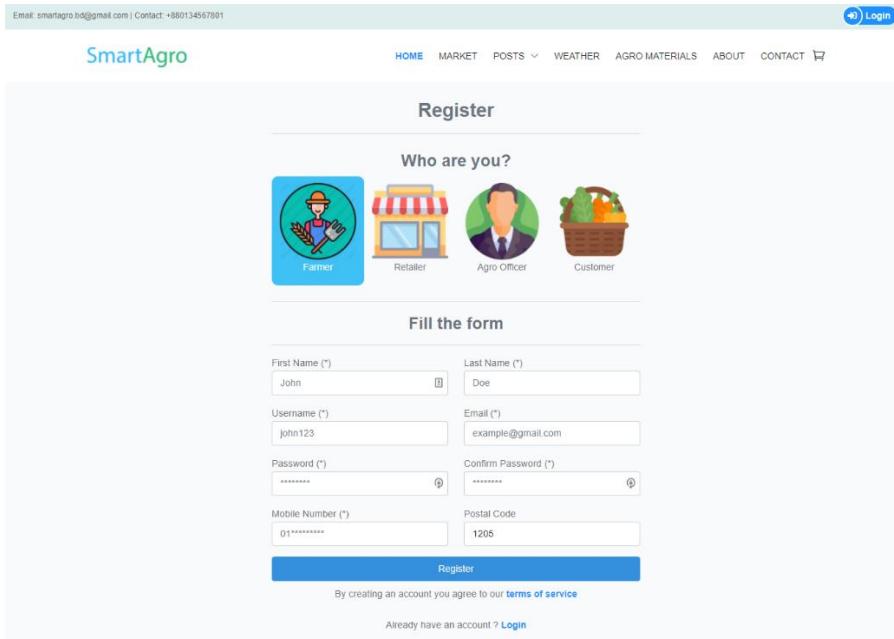


Figure 35: login page.

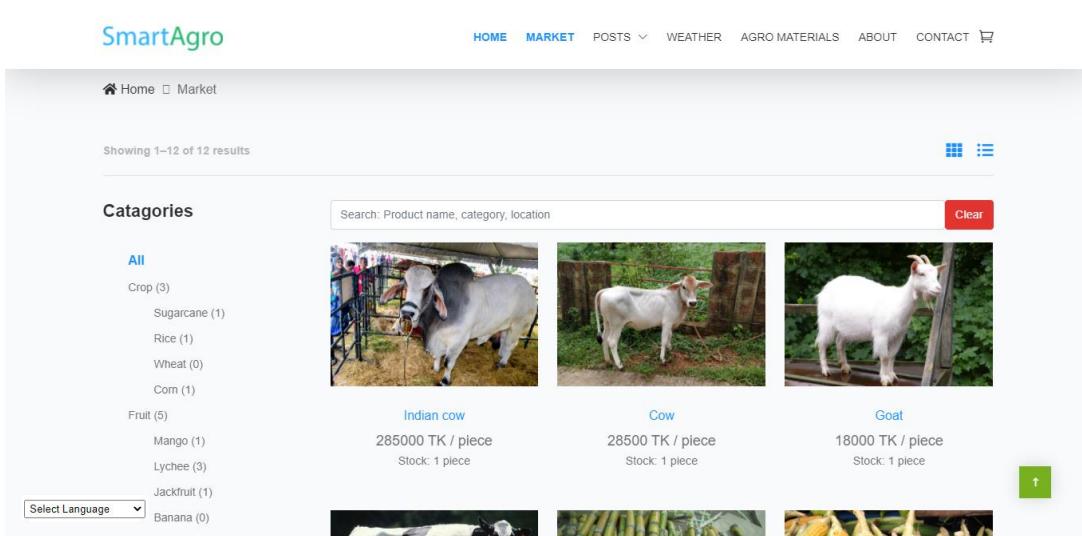
Registration page:



The screenshot shows the registration page for SmartAgro. At the top, there is a header with links for HOME, MARKET, POSTS, WEATHER, AGRO MATERIALS, ABOUT, and CONTACT. A 'Login' button is also present. Below the header, the page title 'Register' is centered. A section titled 'Who are you?' contains four circular icons: 'Farmer' (a person holding a crop), 'Retailer' (a storefront), 'Agro Officer' (a person in a suit), and 'Customer' (a basket of vegetables). The main form area is titled 'Fill the form' and includes fields for First Name, Last Name, Username, Email, Password, Confirm Password, Mobile Number, and Postal Code. Each field has a placeholder and a password strength indicator icon. A 'Register' button is at the bottom of the form. Below the form, a note states 'By creating an account you agree to our terms of service'. A link to 'Login' is also provided.

Figure 36: Registration page.

Market place:



The screenshot shows the products page for the SmartAgro market place. The top navigation bar includes links for HOME, MARKET, POSTS, WEATHER, AGRO MATERIALS, ABOUT, and CONTACT. A 'Select Language' dropdown menu is also visible. The main content area shows a search bar with the placeholder 'Search: Product name, category, location' and a 'Clear' button. Below the search bar, there is a 'Categories' section with a 'All' link and links for Crop (3), Sugarcane (1), Rice (1), Wheat (0), Corn (1), Fruit (5), Mango (1), Lychee (3), Jackfruit (1), and Banana (0). To the right of the categories, there are three product cards: 'Indian cow' (285000 TK / piece, Stock: 1 piece), 'Cow' (28500 TK / piece, Stock: 1 piece), and 'Goat' (18000 TK / piece, Stock: 1 piece). Each card includes an image of the animal and its price per piece. A green 'Upload' button is located in the bottom right corner of the product cards.

Figure 37: Products page.

Cart view:

Cart						
#	Image	Item	Total stock	Quantity	Price	Action
0		Cow	1 piece	1 piece	+ - BDT 28,500.00	X
1		Corn	1000 piece	1 piece	+ - BDT 30.00	X
2		Jackfruit	1000 piece	1 piece	+ - BDT 60.00	X
Total Amount			3		BDT 28,590.00	
Clear Cart				Checkout		

Figure 38: Cart view.

Checkout page:

Email: smartagro.bd@gmail.com | Contact: +880134567801  jahid_re

[SmartAgro](#) [HOME](#) [MARKET](#) [POSTS](#) [WEATHER](#) [AGRO MATERIALS](#) [ABOUT](#) [CONTACT](#) 

Checkout				
#	Image	Item	Quantity	Price
0		Cow	1 piece	BDT 28,500.00
1		Corn	1 piece	BDT 30.00
2		Jackfruit	1 piece	BDT 60.00
Total Amount				BDT 28,590.00
<div style="display: flex; justify-content: space-between;"> <div style="flex: 1;"> Payment method <input type="checkbox"/> Cash on delivery </div> <div style="flex: 1;"> Address <input checked="" type="radio"/> Road 32, Dhanmondi Dhaka , Dhaka , Bangladesh Add new address </div> </div>				
Confirm Order				

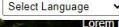
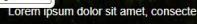
Select Language   [QUICK LINK](#) [RECENT NEWS](#) [STAY CONNECTED](#)

Figure 39: Checkout page.

Post page:

The screenshot shows the SmartAgro website's post page. At the top, there is a navigation bar with links for HOME, MARKET, POSTS, WEATHER, AGRO MATERIALS, ABOUT, and CONTACT. A search bar is also present. Below the navigation, there is a sidebar titled "Categories" with a "All" tab selected. Other tabs include Farming practice (8), Crop (2), Crop Care (0), Improved Rice Cultivation (0), Crop Storage (0), Crop Health & Nutrition (0), Planting (4), Beef Cattle Farming (0), Poultry Farming (0), Goat Farming (0), Soil Improvement Techniques (0), Intensive Fruit Farming (0), and Select Language (Bengali). To the right, there are two articles: "MOP or potash fertilizer work, deficiency or deficiency symp..." and "Harmful aspects of urea fertilizer work, deficiency or sympt...". Each article has a small image and a brief description.

Figure 40: Post page.

Weather update:

The screenshot shows the SmartAgro website's weather update page. At the top, there is a navigation bar with links for HOME, MARKET, POSTS, WEATHER, AGRO MATERIALS, ABOUT, and CONTACT. A search bar is also present. Below the navigation, the page title is "Weather Update". It displays the current time (08:23:21 PM - 29 Apr 2021, Thursday) and location (Pantha Path, Dhaka, Bangladesh, 1205). The main content area shows the current temperature (32°C Haze), feels-like temperature (34.61m/s S), wind speed (1.54m/s S), humidity (51%), and pressure (1007hPa). There are buttons for "Today" and "8 day forecast". Below this, it shows sunrise at 05:25 am and sunset at 06:25 pm. A map of the area around Pantha Path, Dhanmondi R/A, BD is displayed, showing various landmarks like Health and Hope Hospital, DPL Restaurant, and Bashundhara City Shopping Complex. A search bar for city names is also present.

Figure 41: Weather update page.

Chat system:

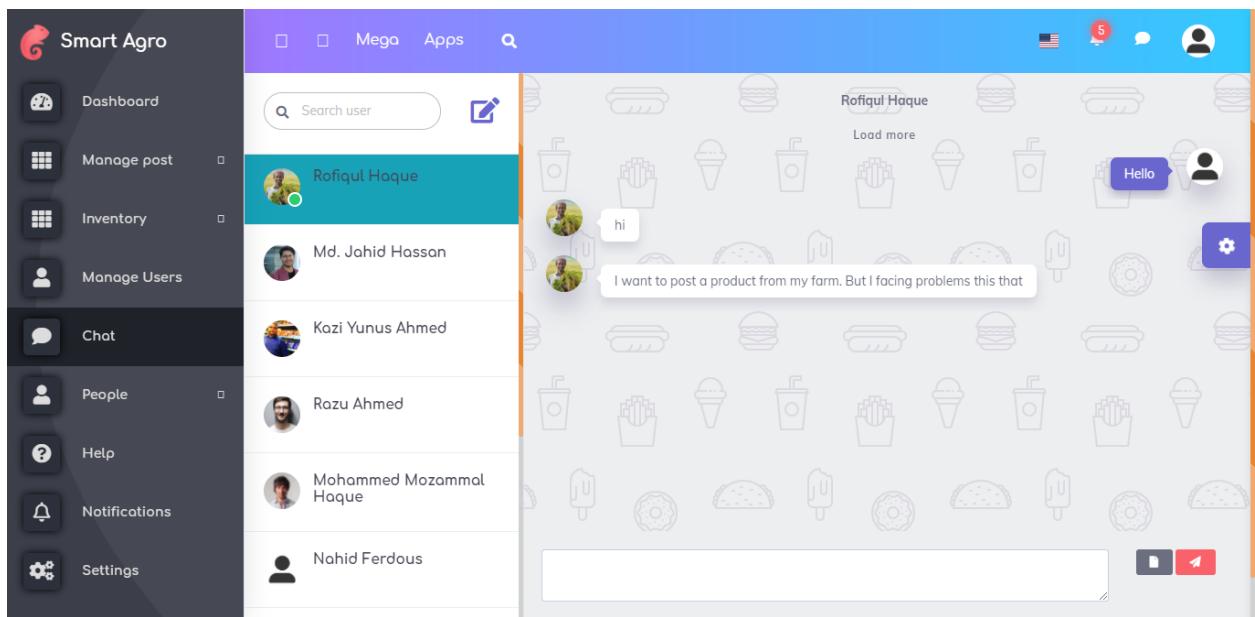


Figure 42: Chat system.

Inventory, manage product:

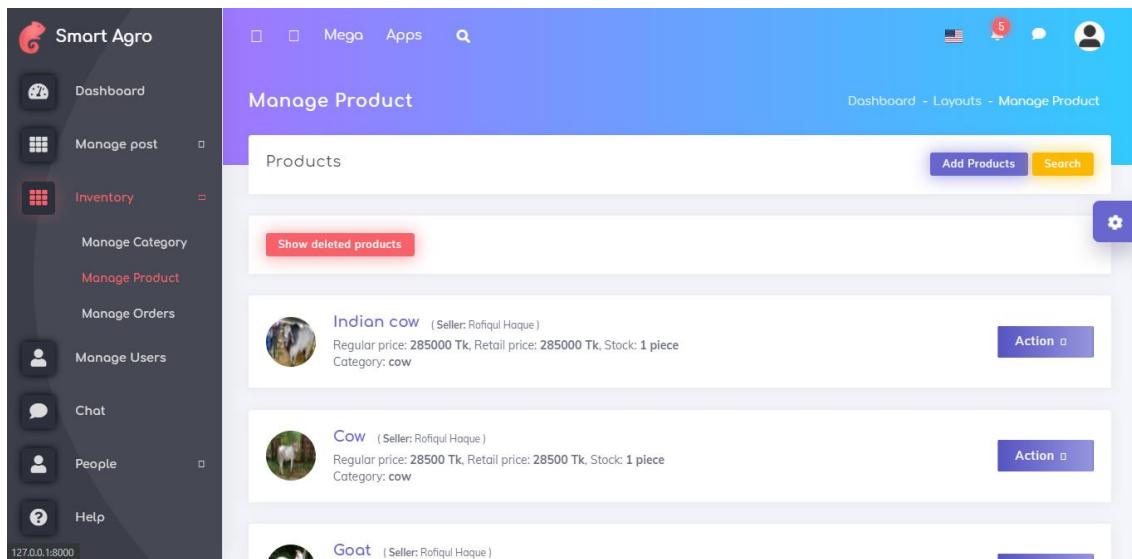


Figure 43: Manage products.

Manage users:

The screenshot shows the 'Manage Users' section of the Smart Agro application. On the left is a dark sidebar with various icons and links: Dashboard, Manage post, Inventory, Manage Users (which is highlighted in red), Chat, People, Help, Notifications, and Settings. The main area has a blue header with the 'Smart Agro' logo, a search bar, and user status indicators. Below is a table with columns: #, Name, Username, Email, Mobile, Status, Role, and Actions. The table lists eight users with their details and roles (farmer, customer, agricultural-officer, retailer). Each row has an edit icon and a delete icon in the Actions column. A gear icon is located at the top right of the table.

#	Name	Username	Email	Mobile	Status	Role	Actions
1	Khwaja Salimullah	salimullah_far	salimullah@gmail.com	01819945156	active	farmer,	
2	Nawab Syed Shamsul Huda	Syed_far	sayed@gmail.com	01819905156	active	farmer,	
3	Customer Three	customer3	customer3@gmail.com	01851232870	active	customer,	
4	Rupali Akhter	rupali_cu	rupali@gmail.com	01857112870	active	customer,	
5	Nahid Ferdous	nahid_cu	nahid@gmail.com	01157832230	active	customer,	
6	Mohammed Mozammal Haque	mozammal_of	mozammal123@gmail.com	01849344556	pending	agricultural-officer,	
7	Razu Ahmed	razu_of	razu36@gmail.com	01869341346	active	agricultural-officer,	
8	Kazi Yunus Ahmed	younus_re	younus_bd@gmail.com	01861245616	active	retailer,	
9	Md. Jahid	jahid_re	jahid@gmail.com	01867856656	active	retailer,	

Figure 44: Manage users.

Manage post categories:

The screenshot shows the 'Category list' section of the Smart Agro application. The sidebar includes: Dashboard, Manage post (highlighted in red), Inventory, Manage Category, Manage Product, Manage Orders, Manage Users, Chat, People, and Help. The main area has a blue header with the 'Smart Agro' logo, a search bar, and user status indicators. Below is a list titled 'Category list' with a tree structure of categories and sub-categories. At the top right are buttons for '+ Save' and 'x'. To the right of the list is a grid of icons for creating new items and managing existing ones. The categories listed are: Crop (Sugarcane - (1), Rice - (1), Wheat, Corn - (1)), Fruit (Mango - (1), Lychee - (3), Jackfruit - (1), Banana), and Vegetables (Potato, Tomato).

- Crop
 - Sugarcane - (1)
 - Rice - (1)
 - Wheat
 - Corn - (1)
- Fruit
 - Mango - (1)
 - Lychee - (3)
 - Jackfruit - (1)
 - Banana
- Vegetables
 - Potato
 - Tomato

Figure 45: Manage post categories.

User profile:

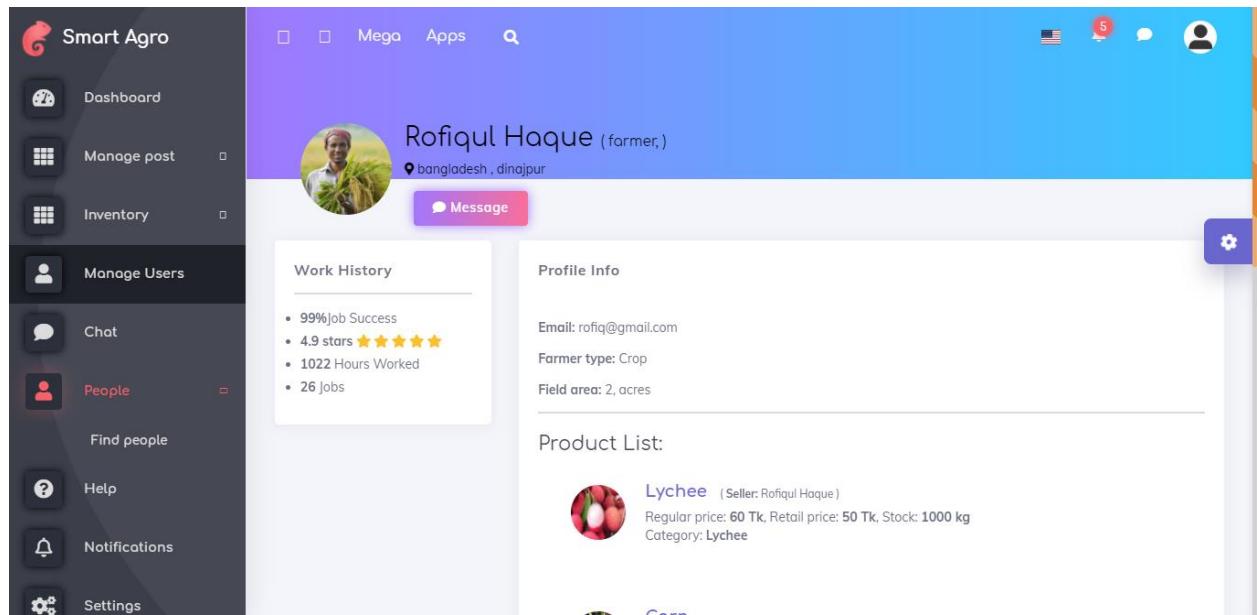


Figure 46: User profile view.

11.3. Timeboxing breakdown by modules

	Timebox	Date	Deliverables
Design	1	08-03-21 To 13-03-21	<ol style="list-style-type: none">1. System design (web pages).2. Database design and implement
Development	2	14-03-21 To 21-03-21	<ol style="list-style-type: none">1. User authentication, view profile, and update profile.2. Role-based login and permission.3. User management.

	3	24-03-21 To 31-03-21	1. Inventory, shopping cart, and manage orders. 2. Generate invoice.
	4	2-04-21 To 09-04-21	1. Post management module.
	5	10-04-21 To 15-04-21	1. Chat system module. 2. FAQ and Contact module.

11.4. Possible problem breakdown in the complex module, with respective coding samples.

The breakdown of complex modules with their respective coding samples is provided in this part. The section below will outline the iterations that have been performed to develop the features of the system.

11.4.1. Authentication and user management module (Iteration 1)

✓ User Registration:

Code sample of backend authentication controller:

```
***  
public function create(array $input)  
{  
    $user_type = $input['user_type'];  
    Validator::make($input, [  
        'user_type' => ['required', 'string'],  
        'first_name' => ['required', 'string', 'min:3', 'max:40'],  
        'last_name' => ['required', 'string', 'min:3', 'max:40'],  
        'email' => ['required', 'string', 'email', 'max:80', Rule::unique(['table' => User::class])],  
        'username' => ['required', 'string', 'max:15', 'min:3', Rule::unique(['table' => User::class])],  
        'postal_code' => ['required_if:user_type,!=>customer', 'numeric', 'regex:/[0-9]{4,5}/'],  
        'mobile_number' => ['required', 'numeric', 'digits:11', 'regex:(01)[0-9]{9}/', Rule::unique(['table' => User::class])],  
        'password' => $this->passwordRules(),  
    ])->validate();  
  
    $user = new User();  
    $user->first_name = ucfirst($input['first_name']);  
    $user->last_name = ucfirst($input['last_name']);  
    $user->username = $input['username'];  
    $user->mobile_number = $input['mobile_number'];  
    $user->postal_code = $input['postal_code'];  
    $user->email = $input['email'];  
    $user->password = Hash::make($input['password']);  
    if ($user_type == 'agricultural-officer') {  
        $user->status = 'pending';  
    }  
    $user->save();  
  
    $user->assignRole($user_type);  
    return $user;  
}
```

Figure 47: Validating user registration request and creating a user.

Frontend user registration logic and validation:

```
async register() {
    let __this = this;
    __this.$Progress.start();
    this.clearAuthError();
    __this.errors = {};
    __this.processing = true;
    this.validateRequest();
    if (Object.keys(__this.errors).length) {
        __this.$Progress.fail();
        __this.processing = false;
        return
    }
    await this.registerAction(__this.registrationData).finally( onFinally: () => {
        __this.processing = false;
    });
    if (auth.state.error != null) {
        __this.$Progress.fail();
        __this.errors = auth.state.error;
        return
    }
    __this.$Progress.finish();
    // Automatic login is enabled after Registration ...
    if (auth.state.user) window.location.href = 'email/verify'; // Reload window to fetch user data ....
    else await __this.$router.replace( location: {name: 'Login'});
},

```

Figure 48: Frontend User registration logic.

Frontend user registration request:

```
async register({dispatch, commit}, credentials) {
    let err = null;
    await axios.post('/register', credentials)
        .then(() => {
            if (!err) return dispatch('me'); // Login the user ...
            dispatch('snackbar/addSnack', {color: 'success', msg: 'Registration successful, please login.', snackBarType: 'Success'}, {root: true});
        })
        .catch(error => {
            generateErrors( {commit, dispatch}: {commit, dispatch}, error, err, msg: "Error Logging in!", showSnackBar: false);
        });
},

```

Figure 49: Frontend Axios request for user registration.

✓ User Login:

User login backend controller:

```
Fortify::authenticateUsing(function (Request $request) {
    $user = User::where('email', $request->username)
        ->orWhere('mobile_number', $request->username)
        ->orWhere('username', $request->username)
        ->with('roles')
        ->first();
    if ($user && Hash::check($request->password, $user->password)) {
        return $user;
    }
});
```

Figure 50: Backend authentication controller.

User login frontend logic:

```
async login() {
    let __this = this;
    this.processing = true;
    __this.$Progress.start();
    __this.errors = {};
    this.clearAuthError(); // If error is not cleared in Vuex auth state... Home page is not shown on successful login ..
    if (!__this.loginCredentials.username.trim()) __this.errors.username = 'Username or Email is required!';
    if (!__this.loginCredentials.password.trim()) {
        __this.errors.password = 'Password is required!';
    } else if (__this.loginCredentials.password.trim().length < 8) {
        __this.errors.password = 'Password should be at least 8 characters!';
    }
    if (Object.keys(__this.errors).length) {
        __this.$Progress.fail();
        __this.processing = false;
        return
    }
    await this.loginAttempt(this.loginCredentials).finally( onFinally: () => {
        __this.processing = false;
    });
    if (auth.state.error != null) {
        __this.$Progress.fail();
        __this.errors = auth.state.error;
        return
    }
    if (auth.state.user != null) {
        if (auth.state.user.email_verified_at != null) {
            __this.$router.replace({ location: { name: 'Index' }});
            await this.$store.dispatch( type: 'snackbar/addSnack', payload: {color: 'success', msg: 'Login Successful.', snackbarType: 'Success'}, options: {root: true});
        } else {
            __this.$router.replace({ location: { name: 'EmailVerification' }});
            await this.$store.dispatch( type: 'snackbar/addSnack', payload: {color: 'success', msg: 'Login Successful. Please verify email address.', snackbarType: 'Success'}, options: {root: true});
        }
        __this.$Progress.finish();
    } else {
        __this.$Progress.fail();
    }
}
```

Figure 51: User login frontend logic.

Frontend user login request:

```
async login({dispatch, commit}, credentials) {
  let err = null;
  await axios.get('/sanctum/csrf-cookie')//.then(response =>{console.log(response)})
  await axios.post('/login', credentials)
    .then(() => {
      if (!err) return dispatch('me');
    }).catch(error => {
      generateErrors( {commit, dispatch}: {commit, dispatch}, error, err, msg: "Error Logging in!", showSnackBar: false);
    });
},
async logout({dispatch, commit}) {
  let err = null;
  await axios.post('/logout')
    .catch(error => {
      generateErrors( {commit, dispatch}: {commit, dispatch}, error, err, msg: "Error Logging out!", showSnackBar: false);
    });
  return dispatch('me');
},
me({dispatch, commit}) {
  return axios.get('/api/user').then((response) => {
    //dispatch('auth/userAbilities', response.data, {root: true});
    commit('SET_AUTHENTICATED', true);
    commit('SET_USER', response.data.user);
    commit('SET_ROLES', response.data.roles);
    commit('SET_PERMISSIONS', response.data.permissions);
  }).catch(() => {
    commit('SET_AUTHENTICATED', false);
    commit('SET_USER', null);
    commit('SET_ROLES', null);
    commit('SET_PERMISSIONS', null);
  });
};
```

Figure 52: Frontend Axios request for user login.

✓ **Email verification:**

Email verification backend controller:

```
class VerifyEmailController extends Controller
{
    /**
     * Mark the authenticated user's email address as verified.
     *
     * @param \Laravel\Fortify\Http\Requests\VerifyEmailRequest $request
     * @return \Illuminate\Http\RedirectResponse
     */
    public function __invoke(VerifyEmailRequest $request): RedirectResponse
    {
        if ($request->user()->hasVerifiedEmail()) {
            //return redirect()->intended(config('fortify.home').'?verified=1');
            return redirect( to: config( key: 'fortify.home').'?verified=1');
        }

        if ($request->user()->markEmailAsVerified()) {
            event(new Verified($request->user()));
        }

        //return redirect()->intended(config('fortify.home').'?verified=1');
        return redirect( to: config( key: 'fortify.home').'?verified=1');
    }
}
```

Figure 53: Email verification controller.

Search user controller:

```
public function searchPeople(): \Illuminate\Http\JsonResponse
{
    $query = request()->input( key: 'searchQuery');
    $searchRole = request()->input( key: 'searchRole');
    $searchStatus = request()->input( key: 'searchStatus') ?: 'active';

    $Users = User::query()
        ->where( column: 'id', operator: '!=', \auth()->id())
        ->where( column: 'status', operator: '=', value: 'active')
        ->where( column: 'email_verified_at', operator: '!=', value: null)
        ->orderBy( column: 'id', direction: 'DESC')
        ->withFilters($query, $searchRole, $searchStatus);

    return (UserResource::collection($Users->latest()->paginate(30)))->response();
}
```

Figure 54: Search user backend logic.

Delete and restore user controller:

```
public function restoreUser($id): \Illuminate\Http\JsonResponse
{
    $user = User::withTrashed()->findOrFail($id);
    if (!$user->restore()) {
        return response()->json(['error' => "Failed to restore user!"], status: 500);
    }
    return (new UserResource($user))->response();
}

public function delete($id): \Illuminate\Http\JsonResponse
{
    $user = User::findOrFail($id);
    if (!$user->delete()) {
        return response()->json(['error' => "Failed to delete user!"], status: 500);
    }
    return (new UserResource($user))->response();
}
```

Figure 55: Delete and restore user backend logic.

11.4.2. Manage post module (Iteration 2)

✓ Add a new post:

Validate add post request:

```
public function store(Request $request): \Illuminate\Http\JsonResponse
{
    $this->validate($request, [
        'title' => ['required', 'string', Rule::unique( table: Post::class)],
        'slug' => ['required', 'string', Rule::unique( table: Post::class)],
        'type' => ['required', 'string'],
        'author' => ['required', 'string'],
        'description' => ['required', 'string'],
        'category' => "required|array|min:1", /// category for displaying error in vue js ...
        'category.*' => "required|string", /// category for displaying error in vue js ...
        'images' => "sometimes|nullable|array|between:0,4",
        'images.*' => "image|mimes:jpeg,jpg,png,gif|max:2048",
    ]);
}
```

Figure 56: Add post request validation.

Add post request logic:

```
$post = new Post();
$post->title = $request->title;
$post->slug = $request->slug;
$post->type = $request->type;
if ($request->status == 'false') {
    $post->status = false;
} else {
    $post->status = true;
}
$post->user_id = auth()->id();
$post->author = $request->author;
$post->description = $request->description;
$post->save();
if ($request->category) {
    foreach ($request->category as $categoryId) {
        $post->postCategory()->attach($categoryId);
    }
}
if ($request->images) {
    foreach ($request->images as $file) {
        try {
            $post->addMedia($file)->toMediaCollection( collectionName: 'posts');
        } catch (DiskDoesNotExist | FileDoesNotExist | FileIsTooBig $e) {
            return response()->json(['error', $e], status: 500);
        }
    }
}
return (new PostResource($post))->response();
```

Figure 57: Post controller, add post logic.

✓ **Search post:**

View and search post backend logic:

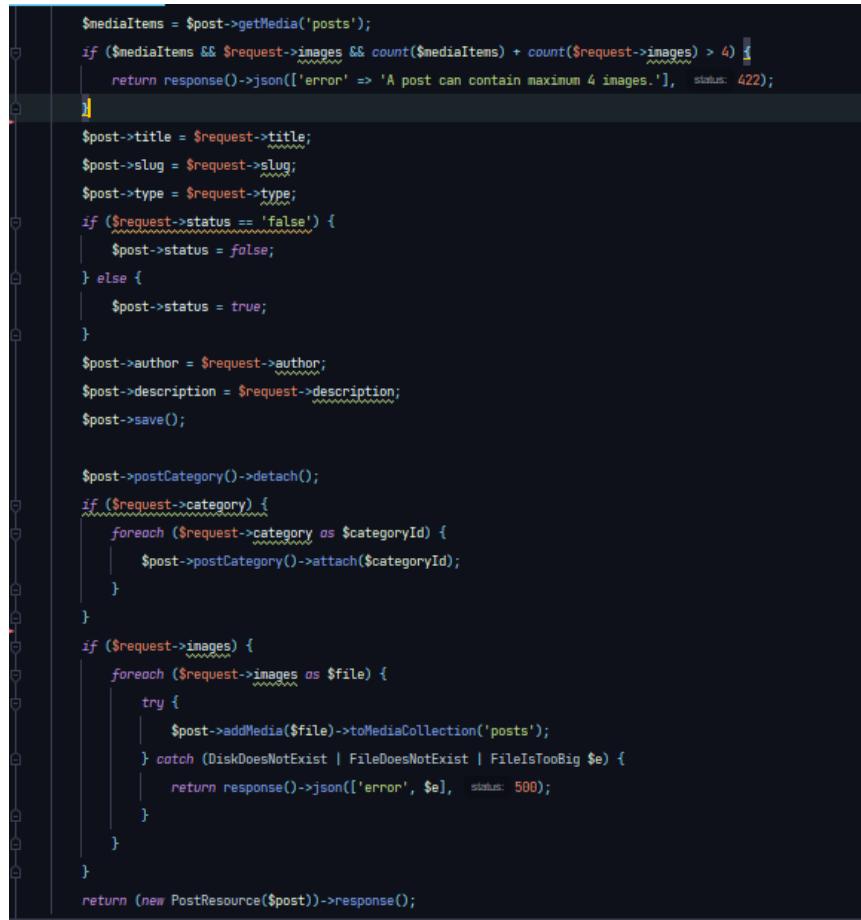
```
public function getPostFrontend(): \Illuminate\Http\JsonResponse
{
    $query = request()->input( key: 'query');
    $category = request()->input( key: 'categories', []);
    $postType = request()->input( key: 'articles_type');
    $paginateLimit = request()->input( key: 'limit') ? request()->input( key: 'limit') : 8;

    $posts = Post::query()
        ->with(['postCategory', 'user'])
        ->where( column: 'type', $postType)
        ->where( column: 'status', operator: 1)
        ->orderBy( column: 'id', direction: 'DESC')
        ->withFilters($query, $category);

    return (PostResource::collection($posts->latest()->paginate($paginateLimit)))->response();
}
```

Figure 58: Post controller, Search and view post backend logic.

✓ **Edit post:**



The screenshot shows a code editor with a dark theme. The code is written in PHP and handles the logic for updating a post. It starts by checking if the post has more than 4 media items and returning an error if so. Then it sets the post's title, slug, and type from the request. It checks the status (false) and saves the post. It then attaches categories and adds images to the media collection. Finally, it returns a PostResource response.

```
$mediaItems = $post->getMedia('posts');
if ($mediaItems && $request->images && count($mediaItems) + count($request->images) > 4) {
    return response()->json(['error' => 'A post can contain maximum 4 images.'], status: 422);
}

$post->title = $request->title;
$post->slug = $request->slug;
$post->type = $request->type;
if ($request->status == 'false') {
    $post->status = false;
} else {
    $post->status = true;
}

$post->author = $request->author;
$post->description = $request->description;
$post->save();

$post->postCategory()->detach();
if ($request->category) {
    foreach ($request->category as $categoryId) {
        $post->postCategory()->attach($categoryId);
    }
}

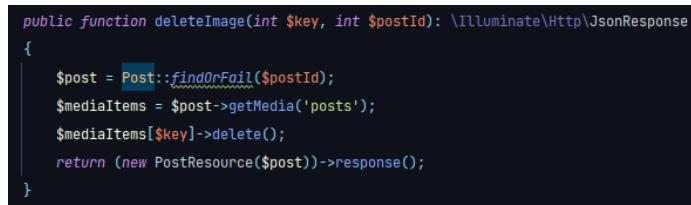
if ($request->images) {
    foreach ($request->images as $file) {
        try {
            $post->addMedia($file)->toMediaCollection('posts');
        } catch (DiskDoesNotExist | FileDoesNotExist | FileIsTooBig $e) {
            return response()->json(['error', $e], status: 500);
        }
    }
}

return (new PostResource($post))->response();
```

Figure 59: Post controller, Edit post logic.

✓ **Delete post:**

Delete post image logic:



The screenshot shows a code editor with a dark theme. The code defines a public function deleteImage that takes a key and post ID. It finds the post, gets its media items, deletes the item at the specified key, and then returns a PostResource response.

```
public function deleteImage(int $key, int $postId): \Illuminate\Http\JsonResponse
{
    $post = Post::findOrFail($postId);
    $mediaItems = $post->getMedia('posts');
    $mediaItems[$key]->delete();
    return (new PostResource($post))->response();
}
```

Figure 60: Post controller, Delete post image.

Delete post logic:

```
public function destroy(int $id): \Illuminate\Http\JsonResponse
{
    $post = Post::where('id', $id)->first();
    if (!$post->forceDelete()) {
        return response()->json(['error' => "Failed to delete post!"], status: 500);
    }
    return (new PostResource($post))->response();
}
```

Figure 61: Post controller, delete post logic.

11.4.3. Inventory and shopping cart module (Iteration 3)

✓ Add products:

Add product validation:

```
$this->validate($request, [
    'product_name' => ['required', 'string'],
    // 'product_slug' => ['required', 'string'],
    'category' => ['required', 'numeric'],
    'description' => ['required', 'string'],
    'brand_id' => 'sometimes|nullable|numeric',
    'status' => ['required', 'string'],
    'total_stock' => "required|numeric|min:1",
    'stock_type' => "required|string",
    'regular_price' => "required|numeric|digits_between:1,7|gte:retail_price",
    'retail_price' => "required|numeric|digits_between:1,7",
    'minimum_order_amount' => "required|numeric|digits_between:1,4|min:1",
    'images' => "required|array|between:0,4",
    'images.*' => "image|mimes:jpeg,jpg,png,gif|max:2048",
]);

```

Figure 62: Product controller, add product validation.

Add post logic:

```
$product = new Product();
$product->product_name = $request->product_name;
// $product->product_slug = $request->product_slug;
$product->description = $request->description;
$product->brand_id = $request->brand_id;
$product->total_stock = $request->total_stock;
$product->stock_type = $request->stock_type;
$product->regular_price = $request->regular_price;
$product->retail_price = $request->retail_price;
$product->minimum_order_amount = $request->minimum_order_amount;
$product->seller_id = Auth::id();

if ($request->status == 'false') {
    $product->status = false;
} else {
    $product->status = true;
}

$product->save();
$product->productCategory()->attach($request->category);
if ($request->images) {
    foreach ($request->images as $file) {
        try {
            $product->addMedia($file)->toMediaCollection( collectionName: 'products');
        } catch (DiskDoesNotExist | FileDoesNotExist | FileIsTooBig $e) {
            return response()->json(['error', $e], status: 500);
        }
    }
}
return (new ProductResource($product))->response();
```

Figure 63: Product controller, add product logic.

✓ Update product details

Update product validation:

```
public function update(Request $request, int $id): \Illuminate\Http\JsonResponse
{
    $this->validate($request, [
        'product_name' => ['required', 'string'],
        // 'product_slug' => ['required', 'string'],
        'category' => ['required', 'numeric'],
        'description' => ['required', 'string'],
        'brand_id' => 'sometimes|nullable|numeric',
        'status' => ['required', 'string'],
        'total_stock' => "required|numeric|min:0",
        'stock_type' => "required|string",
        'regular_price' => "required|numeric|digits_between:1,7|gte:retail_price",
        'retail_price' => "required|numeric|digits_between:1,7",
        'minimum_order_amount' => "required|numeric|digits_between:1,4|min:1",
        'images' => "sometimes|nullable|array|between:0,4",
        'images.*' => "image|mimes:jpeg,jpg,png,gif|max:2048",
    ]);
}
```

Figure 64: Product controller, update product validation.

✓ **Delete products:**

```
public function destroy(int $id): \Illuminate\Http\JsonResponse
{
    $product = Product::where('id', $id)->withTrashed()->first();
    if (!empty($product)) {
        if ($product->deleted_at) {
            if (!$product->forceDelete()) {
                return response()->json(['error' => "Failed to destroy product!"], status: 500);
            }
        } else {
            if (!$product->delete()) {
                return response()->json(['error' => "Failed to delete product!"], status: 500);
            }
        }
    }
    return (new ProductResource($product))->response();
}
```

Figure 65: Product controller, Delete project logic.

✓ **Manage cart:**

Add to cart:

```
addToCart(state, product) {
    let productInTheCart = state.cart.findIndex(item => item.product_slug === product.product_slug);
    if (productInTheCart !== -1) {
        state.cart[productInTheCart].quantity++;
    } else {
        product.quantity = 1;
        state.cart.push(product);
    }

    localStorage.removeItem( key: "cart");
    let thisCart = JSON.stringify(state.cart);
    localStorage.setItem("cart", thisCart);
},
```

Figure 66: Add to cart logic.

Update cart:

```
updateCart(state, cart) {
    state.cart = cart;

    if (!state.cart.length) {
        localStorage.removeItem( key: "cart");
    } else {
        let thisCart = JSON.stringify(state.cart);
        localStorage.setItem("cart", thisCart);
    }
},
```

Figure 67: Update cart logic.

```
updateQuantityOfProduct(state, product) {
    let productInTheCart = state.cart.findIndex(item => item.product_slug === product.product_slug);
    if (productInTheCart !== -1) {
        state.cart[productInTheCart].quantity--;
        return;
    }

    localStorage.removeItem( key: "cart");
    let thisCart = JSON.stringify(state.cart);
    localStorage.setItem("cart", thisCart);
},
```

Figure 68: Update product count in cart logic.

Remove item from the cart:

```
removeFromCart(state, index) {
    state.cart.splice(index, deleteCount: 1);

    //if (!state.cart.length) {
    //    localStorage.removeItem( key: "cart");
    //}
    let thisCart = JSON.stringify(state.cart);
    localStorage.setItem("cart", thisCart);
},
```

Figure 69: Remove item from cart logic.

✓ Checkout:

Frontend checkout logic:

```
async confirmOrder() {
  this.$Progress.start();
  if (!this.$store.state.cart.cart && !Object.keys(this.$store.state.cart.cart).length) {
    await this.$store.dispatch({ type: 'snackbar/addSnack', payload: {color: 'danger', msg: 'Cart is empty.', snakbarType: 'Error'}, options: {root: true}});
    this.$Progress.fail();
    return;
  }

  if (!this.addressId) {
    await this.$store.dispatch({ type: 'snackbar/addSnack', payload: {color: 'danger', msg: 'Please select address.', snakbarType: 'Error'}, options: {root: true}});
    this.$Progress.fail();
    return;
  }
  await axios.post('api/product/order', {
    address_id: this.addressId,
    total_price: this.total_price,
    cartData: this.$store.state.cart.cart,
  }).then((response) => {
    this.$store.dispatch({ type: 'cart/clearCart'});
    this.clearForm();
    window.location.href = `dashboard/${this.user.username}/products/orders`;
  }).catch((error) => {
    console.log(error);
  }).finally(() => {
    this.$Progress.finish();
  });
},
```

Figure 70: Frontend checkout code.

Product order backend logic:

```
public function store(Request $request)
{
  $products = $request->cartData;
  $Orders = new Order();
  $Orders->user_id = \auth()->id();
  $Orders->address_id = $request->address_id;
  $Orders->total_price = $request->total_price;
  $Orders->save();

  foreach ($products as $product) {
    $productData = Product::where('id', $product['id'])->first();
    if (!empty($productData)) {
      $checkStock = (int)$productData->total_stock - (int)$product['quantity'];
      if ($checkStock >= 0) {
        $productData->total_stock = $checkStock;
        $productData->save();
      } else {
        return response()->json(['error' => 'A product is out of stock.'], status: 400);
      }
    } else {
      return response()->json(['error' => 'Cannot find product.'], status: 400);
    }
    $Orders->products()->attach($product['id'], ['quantity' => $product['quantity']]);
  }
  return response()->json($Orders, status: 200);
}
```

Figure 71: Product Order controller, order product code.

✓ **Update orders:**

```
public function update(Request $request, $id): \Illuminate\Http\JsonResponse
{
    $order = Order::findOrFail($id);
    if ($request->status) {
        $order->order_status = $request->status;
        $order->save();
    }
    return (new OrdersResource($order))->response();
}
```

Figure 72: Update order logic.

11.4.4. Chat module (Iteration 4)

✓ **Get messages.**

```
public function getMessages($id): \Illuminate\Http\JsonResponse
{
    /*$messages = Message::where('from', $id)
    ->orWhere('to', $id)->get();*/
    Message::where('from', $id)->where('to', auth()->id())->update(['seen' => true]);

    $messages = Message::where(function ($q) use ($id) {
        $q->where('from', auth()->id());
        $q->where('to', $id);
    })->orWhere(function ($q) use ($id) {
        $q->where('from', $id);
        $q->where('to', auth()->id());
    })->get();

    return response()->json($messages, status: 200);
}
```

Figure 73: Get messages.

✓ **Send message.**

```
public function sendMessage(Request $request): \Illuminate\Http\JsonResponse
{
    $message = new Message();
    $message->from = auth()->id();
    $message->to = $request->contact_id;
    $message->body = $request->text;
    $message->save();

    broadcast(new NewMessage($message));

    return response()->json($message, status: 200);
}
```

Figure 74: Send message logic.

11.4.5. Weather update module (Iteration 5)

✓ **Get user location coordinates:**

```
async getLocationData({dispatch, commit}) {
    function getCoordinates() {
        let options = {
            enableHighAccuracy: true,
            timeout: 6000,
            maximumAge: 0
        };
        if (navigator.geolocation) {
            navigator.geolocation.getCurrentPosition(success, error, options);
        }
    }

    function success(pos) {
        commit('SET_LOCATION_PERMISSION', true)
        let crd = pos.coords;
        let coordinates = {lat: crd.latitude, lon: crd.longitude};
        getCity(coordinates);
        return;
    }

    function error(err) {
        commit('SET_LOCATION_PERMISSION', false)
        let coordinates = {lat: '25.6390262', lon: '88.6451188'};
        getCity(coordinates);
        console.warn(`data: ${err.code}: ${err.message}`);
    }

    async function getCity(coordinates) {
        let lat = coordinates.lat;
        let lon = coordinates.lon;
        const apiKey = "pk.f75abddfb2ddc6c429f5504f0d205a2";
        let apiUrl2 = 'https://us1.locationiq.com/v1/reverse.php?key=${apiKey}&lat=${lat}&lon=${lon}&format=json';
        await fetch(apiUrl2, {cache: 'no-cache'}) //Promise<Response>
            .then(response => response.json()) //Promise<any>
            .then(data => {
                commit('SET_LOCATION_DATA', data);
            });
    }
}

return getCoordinates();
```

Figure 75: Get user location.

✓ **Get weather data from API:**

```
async getWeatherData({commit, dispatch}, locationData) {
  let err = null;
  const apiKey = process.env.MIX_openweathermap_key;
  //const apiUrl = `http://api.openweathermap.org/data/2.5/weather?q=${locationData.city_name}&appid=${apiKey}&units=metric`;
  const apiUrl2 = `https://api.openweathermap.org/data/2.5/onecall?lat=${locationData.lat}&lon=${locationData.lon}&exclude=alerts&appid=${apiKey}&units=metric`;
  await fetch(apiUrl2, {cache: 'no-cache'}) Promise<Response>
    .then(response => response.json()) Promise<any>
    .then(data => {
      commit('SET_WeatherData', data)
    });
},
```

Figure 76: Get weather data from API.

✓ **Get location data from coordinates.**

```
async getSearchedLocationData({commit, dispatch}, coordinates) {
  let lat = coordinates.lat;
  let lon = coordinates.lon;
  const apiKey = "pk.f75abcdafba266cc4295504f0d205a2";
  let apiUrl2 = `https://us1.locationiq.com/v1/reverse.php?key=${apiKey}&lat=${lat}&lon=${lon}&format=json`;
  await fetch(apiUrl2, {cache: 'no-cache'}) Promise<Response>
    .then(response => response.json()) Promise<any>
    .then(data => {
      commit('SET_SEARCHED_LOCATION_DATA', data)
    });
},
```

Figure 77: Get user location data.

11.5. Potential alternative approaches

The current system developed is a web-based application which can be accessed from anywhere using internet-connected devices like laptop, smartphone, etc. The alternate approach could be developing a mobile application. But if the mobile application is developed a separate web application will be required to manage the admin panel. Within the given time limit creating two separate systems is not possible for this reason a single web application is developed which will fulfill the required functionalities.

12. Testing

Testing is an integral part of implementing a system. In this chapter, various tests will be performed like example unit test, module test, integration test, acceptance test, performance testing, etc. Testing ensures that the developed features are working as defined in the requirement and whether the features can fulfill and satisfy user requirements or needs.

12.1. Test case

12.1.1. Test case for unit test UT001.

Test Case ID: UT001		Test Type: Unit	Tester: Nahid Ferdous
Test Title		Unit test on user login.	
Test Case Description		Check empty or invalid data in the email and password field.	
Execution steps		1. Click the login button without entering any credentials. 2. Provide an invalid email or password and click login.	
Test Browser:		Test device OS:	
SL.	Actions	Expected Result	Actual result
1		Users must enter their credentials.	
2		Users must enter the correct credentials to go forward.	

12.1.2. Test case for unit test UT002.

Test Case ID: UT002		Test Type: Unit	Tester: Nahid Ferdous
Test Title		Unit test on user registration.	
Test Case Description		Check empty or invalid data in registration form fields.	
Execution steps		<ol style="list-style-type: none"> Click the register button without entering any data. Provide invalid data on fields and click register. 	
Test Browser:		Test device OS:	
SL.	Actions	Expected Result	Actual result
1		Users must enter their details.	
2		Users must enter data in the correct format to register an account.	

12.1.3. Test case for module test MT001.

Test Case ID: MT001		Test Type: Module	Tester: Nahid Ferdous
Test Title		Unique username and email validation.	
Test Case Description		A unique username and email validation.	
Execution steps		<ol style="list-style-type: none"> Insert mobile number, email, or username with which an account is already created. 	

	2. Insert a unique mobile number, username, or email that does not exist in the system.		
Test Browser:	Test device OS:		
SL.	Actions	Expected Result	Actual result
1		Error message showing username, email, and mobile number phone field is not unique.	
2		The user should be successfully registered in the system.	

12.1.4. Test case for module test MT002.

Test Case ID: MT001		Test Type: Module	Tester: Nahid Ferdous
Test Title	Add products.		
Test Case Description	Adding products to inventory.		
Execution steps	1. Add product details and click the save button.		
Test Browser:	Test device OS:		
SL.	Actions	Expected Result	Actual result
1		Add product successfully and the data is displayed.	

12.2. Test execution

In this part, various tests will be performed and the test outcomes are recorded in the following sections:

12.2.1. Unit testing

- **Unit test UT001.**

Test Case ID: UT001		Test Type: Unit	Tester: Nahid Ferdous
Test Title		Unit test on user login.	
Test Case Description		Check empty or invalid data in the email and password field.	
Execution steps		3. Click the login button without entering any credentials. 4. Provide an invalid email or password and click login.	
Test Browser: Chrome Browser		Test device OS: Windows	
SL.	Actions	Expected Result	Actual result
1	Empty fields.	Users must enter their credentials.	An error message is shown which tells users to provide some data.
2	Invalid data provided.	Users must enter the correct credentials to go forward.	Error message appears asking the user to enter correct data.

Login

Phone number / Username / Email

Username or Email is required!

Password

Password is required!

Remember me

[Forgot Password?](#)

[Login](#)

Or sign in with social account

[Facebook](#) [Google](#) [Github](#)

Don't have an account? [Register](#)

Figure 78: Empty field validation.

Login

Phone number / Username / Email

These credentials do not match our records.

Password

.....

Remember me

[Forgot Password?](#)

[Login](#)

Or sign in with social account

[Facebook](#) [Google](#) [Github](#)

Don't have an account? [Register](#)

Figure 79: Invalid credentials validation.

- **Unit test UT002**

Test Case ID: UT002		Test Type: Unit	Tester: Nahid Ferdous	
Test Title		Unit test on user registration.		
Test Case Description		Check empty or invalid data in registration form fields.		
Execution steps		3. Click the register button without entering any data. 4. Provide invalid data on fields and click register.		
Test Browser: Chrome Browser		Test device OS: Windows		
SL.	Actions		Expected Result	Actual result
1	Empty field's validation.		Users must enter their details.	An error message is shown which tells users to provide some data.
2	Invalid data validation.		Users must enter data in the correct format to register an account.	Error message appears asking the user to enter correct data.

Who are you?



Farmer



Retailer



Agro Officer



Customer

Fill the form

First Name (*)

First Name is required!

Last Name (*)

Last Name is required!

Username (*)

Username is required!

Email (*)

Email is required!

Password (*)

Password is required!

Confirm Password (*)

Mobile Number (*)

Mobile number is required!

Postal Code

Register

Figure 80: Empty field validation.

Register

Who are you?



Farmer



Retailer



Agro Officer



Customer

Fill the form

First Name (*)	Last Name (*)
<input type="text" value="nahid 123"/>	<input type="text" value="ferdous"/>
Only alphabet is expected in first name	
Username (*)	Email (*)
<input type="text" value="nahid1234"/>	<input type="text" value="nahid123@.com"/>
The email must be a valid email address.	
Password (*)	Confirm Password (*)
<input type="password" value="*****"/>	<input type="password" value="*****"/>
Mobile Number (*)	Postal Code
<input type="text" value="44803496587"/>	<input type="text" value="kkhdbv"/>
The mobile number format is invalid.	
The postal code must be a number.	

Register

Figure 81: Unit test, showing all the validation errors for each field.

- **Unit testing UT0003**

Test Case ID: UT003		Test Type: Unit	Tester: Nahid Ferdous
Test Title	Unit test on the add product form.		
Test Case Description	Check invalid data in the product form field.		
Execution steps	1. Provide invalid data on the product form and click submit.		
Test Browser:	Chrome Browser	Test device OS:	Windows
SL.	Actions	Expected Result	Actual result
1	Empty field's validation.	Valid data must be entered in product form.	Error is shown when invalid data is entered.

Add product

Product name	Mango	Total stock	100000000000	Stock type	Kg
The total stock may not be greater than 2000.					
Regular price	56	Retail price	50	Minimum order amount (in kg or number)	200
Status	Active	Category	Fruit -> Mango		
Image	Choose file...	Browse	 Origin: Bangladesh Manufacturer: Square food and beverages Ltd. The finest mangoes from the best plantations find their place inside the ruchi mango pickle jar. processed with traditional seasoning and spices, ruchi mango pickle is the first choice for the mango pickle lovers. the aroma and the taste give ruchi mango pickle a different place among all the other branded mango pickles.		
<input type="button" value="Save"/> <input type="button" value="Close"/>					

Figure 82: Errors show when wrong data is entered.

12.2.2. Module testing

- **Module test MT001**

Test Case ID: MT001		Test Type: Module	Tester: Nahid Ferdous
Test Title	Unique username and email validation.		
Test Case Description	Unique username and email validation.		
Execution steps	3. Insert mobile number, email, or username with which an account is already created. 4. Insert a unique mobile number, username, or email that does not exist in the system.		
Test Browser:	Chrome Browser	Test device OS:	Windows
SL.	Actions	Expected Result	Actual result
1	Existing email: rofiq@gmail.com	Error message showing username, email, and mobile number phone field is not unique.	An error message is shown telling the user that the field should be unique.
2	Unique email rofiqfarmer@gmail.com	The user should be successfully registered in the system.	Registers and user successfully and sends email verification to users email.

Register

Who are you?



Farmer



Retailer



Agro Officer



Customer

Fill the form

First Name (*)

Last Name (*)

Username (*)

Email (*)

The username has already been taken.

The email has already been taken.

Password (*)

Confirm Password (*)

Mobile Number (*)

Postal Code

Register

By creating an account you agree to our [terms of service](#)

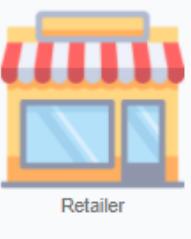
Figure 83: Insert existing username or email.

Register

Who are you?



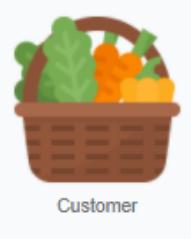
Farmer



Retailer



Agro Officer



Customer

Fill the form

First Name (*) <input type="text" value="rofiq"/>	Last Name (*) <input type="text" value="farmer"/>
Username (*) <input type="text" value="rofiq_famer"/>	Email (*) <input type="text" value="rofiqfarmer@gmail.com"/>
Password (*) <input type="password" value="*****"/>	Confirm Password (*) <input type="password" value="*****"/>
Mobile Number (*) <input type="text" value="01793845734"/>	Postal Code <input type="text" value="1205"/>
<input style="background-color: #0072BD; color: white; padding: 5px 20px; border-radius: 5px; font-weight: bold; width: 100%;" type="button" value="Register"/> By creating an account you agree to our terms of service	

Figure 84: Insert unique username and email.

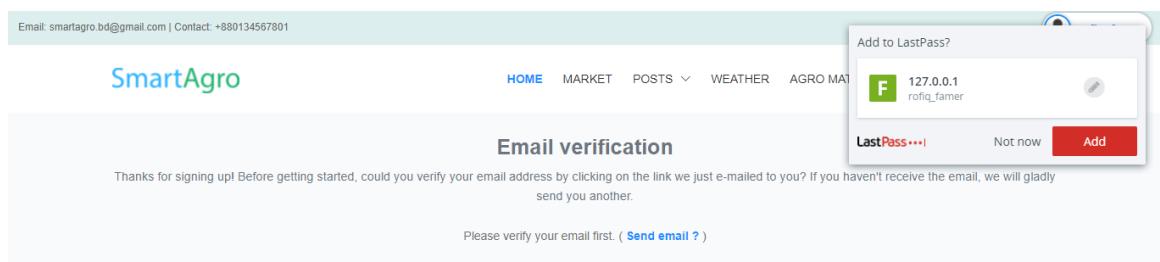


Figure 85: Email verification message.

- **Module test MT002**

Test Case ID:	MT001	Test Type:	Module	Tester:	Nahid Ferdous
Test Title	Add products.				
Test Case Description	Adding products to inventory.				
Execution steps	2. Add product details and click the save button.				
Test Browser:	Chrome Browser	Test device OS:	Windows		
SL.	Actions		Expected Result	Actual result	
1	Add product data.		Add product successfully and the data is displayed.	Successfully added new product.	

Add product

Product name: mango

Total stock: 120

Stock type: Kg

Regular price: 56

Retail price: 48

Minimum order amount (in kg or number): 5

Status: Active

Category: Fruit -> Mango

Description:

Origin: Bangladesh

Manufacturer: Square food and beverages Ltd.

The finest mangoes from the best plantations find their place inside the ruchi mango pickle jar. processed with traditional seasoning and spices, ruchi mango pickle is the first choice for the mango pickle lovers. the aroma and the taste give ruchi mango pickle a different place among all the other branded mango pickles!

Save Close

Figure 86: Module testing MT002, Add products.

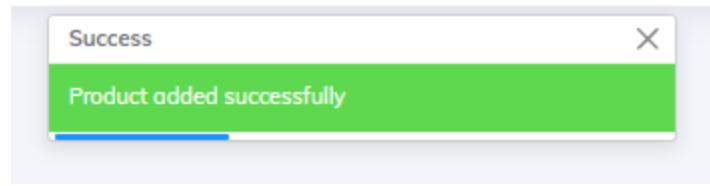


Figure 87: Product added success message is shown.

The screenshot shows a web-based application for managing products. At the top, there's a navigation bar with tabs like 'Products', 'Add Products', and 'Search'. Below the navigation, there's a red button labeled 'Show deleted products'. The main content area displays a single product entry for a 'Mango'. The product details include an image of a mango, the name 'Mango', the seller 'Khwaja Salimullah', regular price '56 Tk', retail price '48 Tk', stock '120 kg', and category 'Mango'. On the right side of the product card, there's a blue 'Action' button with a dropdown icon. At the bottom of the page, it says 'Showing (1 - 1) from 1 products' and 'Current page: 1, Total page: 1'.

Figure 88: Displaying the newly added product

12.2.3. Integration testing

- **Integration testing IT001**

Test Case ID:	IT001	Test Type:	Integration	Tester:	Nahid Ferdous
Test Title	Add post.				
Test Case Description	Add posts.				
Execution steps	1. Provide post details and submit the form.				
Test Browser:	Chrome Browser	Test device OS:	Windows		
SL.	Actions	Expected Result	Actual result		

1	Provide post details.	Add product and show a success message.	Product added and a success message is shown.
---	-----------------------	---	---

The screenshot shows the Smart Agro application interface. On the left is a dark sidebar with various navigation options: Dashboard, Manage post (which is currently selected), Manage Category, Manage Post, Inventory, Manage Users, Chat, People, Help, Notifications, and Settings. The main content area has a purple header 'Manage Post'. A central modal window titled 'Add post' is open, containing fields for 'Post title' (5 Agitech startups enabling farmers to go all digit), 'Post title slug' (5-agitech-startups-enabling-farmers-to-go-all-di), 'Author' (Admin Nahid), 'Status' (Active), 'Post type' (News), 'Image' (choose file...), 'Description' (a rich text editor with placeholder text about agitech startups), and a 'Select category' dropdown menu where 'Modern Technology' is highlighted. To the right of the modal, the main dashboard shows a list of posts with titles like 'MOP or potash fertilizer work, deficiency or deficit symptoms, harmful aspects of overuse.', 'POST TYPE: NEWS, STATUS: ACTIVE', and 'Fertilizer |'. Below the dashboard, a success message 'Post added successfully' is displayed.

Figure 89: Adding new post.

This screenshot shows the 'Manage Posts' page after a post has been added. The sidebar and header are identical to Figure 89. The main content area displays a list of posts. One post is highlighted with a red box: '5 Agitech startups enabling farmers to go all digit' (Read More). Another post is partially visible: 'MOP or potash fertilizer work, deficiency or deficit symptoms, harmful aspects of overuse.' (Read More). A success message box at the bottom right says 'Success Post added successfully'.

Figure 90: Showing post and success message.

- **Integration testing IT002**

Test Case ID: IT002		Test Type: Integration	Tester: Nahid Ferdous
Test Title	.Add products to cart.		
Test Case Description	Adding products to the cart.		
Execution steps	1. Add products to the cart.		
Test Browser:	Chrome Browser	Test device OS:	Windows
SL.	Actions	Expected Result	Actual result
1	Add to cart.	Products should be added to the cart.	The feature works expected.
2	Click add to cart tow time for a product.	Increase the product count, when a product is added 2 times.	The product count is successfully incremented.

SmartAgro

HOME MARKET POSTS WEATHER AGRO MATERIALS ABOUT CONTACT

Catagories

All

Crop (3)

- Sugarcane (1)
- Rice (1)
- Wheat (0)
- Corn (1)

Fruit (6)

- Mango (2)
- Lychee (3)
- Jackfruit (1)
- Banana (0)

Vegetables (0)

- Potato (0)
- Tomato (0)
- Cabbage (0)

Livestock (4)

- Goat (0)
- Buffalo (0)
- Cow (3)
- Sugarcane (1)

Select Language: English (3)

Search: Product name, category, location

Clear

Mango: 56 TK / kg Stock: 120 kg

Indian cow: 285000 TK / piece Stock: 1 piece

Cow: 28500 TK / piece Stock: 1 piece

Goat

Cow

Sugarcane

Figure 91: Add to cart functionality.



Showing 1-13 of 13 results

Catagories

All

Crop (3)

- Sugarcane (1)
- Rice (1)
- Wheat (0)
- Corn (1)

Fruit (6)

- Mango (2)
- Lychee (3)
- Jackfruit (1)
- Banana (0)
- Vegetables (0)
- Potato (0)
- Tomato (0)

Select Language

127.0.0.1:8000/market#

Search: Product name, category, location

	Mango 56 TK / kg Stock: 120 kg		Indian cow 285000 TK / piece Stock: 1 piece		Cow 28500 TK / piece Stock: 1 piece

Figure 92: Product added to cart.

Search: Product name, category, location

Cart

#	Image	Item	Total stock	Quantity	Price	Action
0		Mango	120 kg	<input type="text" value="2 kg"/> <input style="background-color: green; color: white" type="button" value="+"/> <input style="background-color: red; color: white" type="button" value="-"/>	BDT 112.00	<input type="button" value="X"/>
1		Cow	1 piece	<input style="background-color: green; color: white" type="button" value="+"/> <input style="background-color: red; color: white" type="button" value="-"/>	BDT 28,500.00	<input type="button" value="X"/>
Total Amount				3	BDT 28,612.00	
				<input type="button" value="Clear Cart"/>	<input style="background-color: yellow; color: black" type="button" value="Checkout"/>	

Figure 93: Showing products in the cart.

12.2.4. Acceptance testing

- User acceptance testing AT001

Test Case ID: AT001		Test Type: Acceptance	Tester: Nahid Ferdous
Test Title	Inventory management.		
Test Case Description	Farmers should be able to add products to the system.		
Execution steps	<ol style="list-style-type: none">1. Navigate to the product management page.2. Click on Add products button.		
Test Browser:	Chrome Browser	Test device OS:	Windows
SL.	Actions	Expected Result	Actual result
1	Visit manage product page.	The manage product page is shown.	The result is as expected.
2	Click on add product button.	The add product form is shown.	The result is as expected.
3	Fill the form and submit it.	The data is validated and if data is valid success message is shown.	The result is as expected.

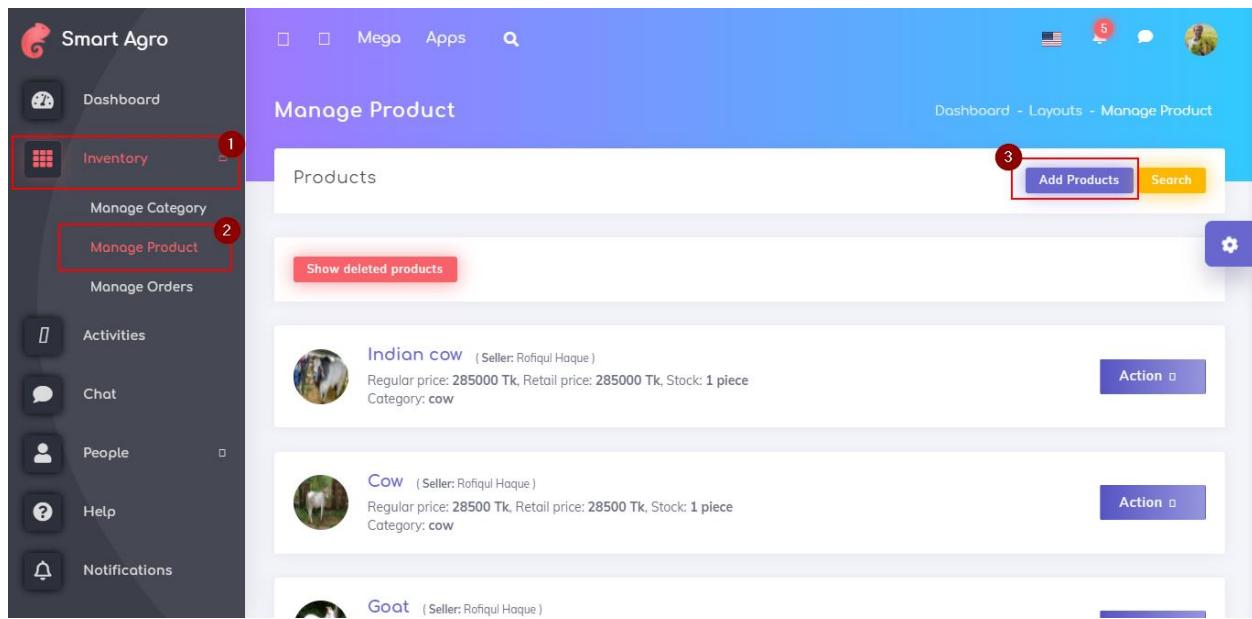


Figure 94: Inventory management.

Add product

Product name	Total stock	Stock type
<input type="text"/>	<input type="text"/>	<input type="text"/> Kg
Regular price	Retail price	Minimum order amount (in kg or number)
<input type="text"/>	<input type="text"/>	<input type="text"/>
Status	Category	
<input checked="" type="checkbox"/> Active	<input type="text"/> Select	
Image	<input type="text"/> Choose file... <input type="button"/> Browse	
Description Paragraph <input type="button"/> B <i>I</i> <input type="button"/> <input type="button"/> <input type="button"/> <input type="button"/> <input type="button"/> <input type="button"/>		
<input type="button"/> Save <input type="button"/> Close		

Figure 95: Add product form.

Add product

Product name	Total stock	Stock type
Guava	200	Kg
Regular price	Retail price	Minimum order amount (in kg or number)
40	36	10
Status	Category	
<input checked="" type="checkbox"/> Active	Fruit	
Image	Description	
<input type="button" value="Choose file..."/> <input type="button" value="Browse"/>	<input type="button" value="Paragraph"/> <input type="button" value="B"/> <input type="button" value="I"/> <input type="button" value="D"/> <input type="button" value=":="/> <input type="button" value=":="/> <input type="button" value="≡"/> <input type="button" value="≡"/> <input type="button" value="⋮"/>	
	This guava are from <u>barishal</u> district.	
<input type="button" value="Save"/> <input type="button" value="Close"/>	<input type="button" value=""/>	

Figure 96: Form is filled and the save button is clicked.

Show deleted products	
 Guava (Seller: Rofiqul Haque) Regular price: 40 Tk, Retail price: 36 Tk, Stock: 200 kg Category: Fruit	<input type="button" value="Action"/>
 Indian cow (Seller: Rofiqul Haque) Regular price: 285000 Tk, Retail price: 285000 Tk, Stock: 1 piece	<input type="button" value="Action"/>

Figure 97: product added successfully.

- **User acceptance testing AT002**

Test Case ID: AT002		Test Type: Acceptance	Tester: Nahid Ferdous
Test Title	.Chat system		
Test Case Description	Users should be able to communicate between them using the system.		
Execution steps	<ol style="list-style-type: none"> 1. Navigate to the chat system 2. Select a contact. 3. Send messages from both ends. 		
Test Browser:	Chrome Browser	Test device OS:	Windows
SL.	Actions	Expected Result	Actual result
1	Open the chat system	The chat system is opened showing the contact list.	The result is as expected.
2	Select a contact.	Display old messages with the selected contact and a text box appear.	The result is as expected.
3	Send message.	Users at both ends can send messages.	The result is as expected.

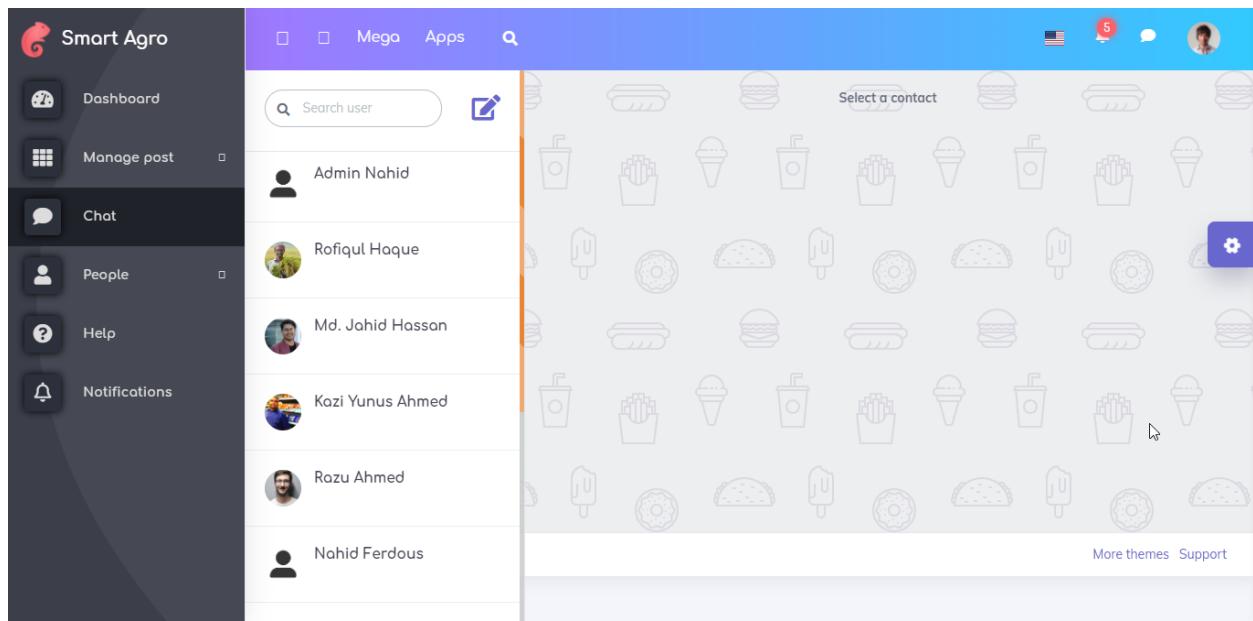


Figure 98: Chat system view. Showing contact list.

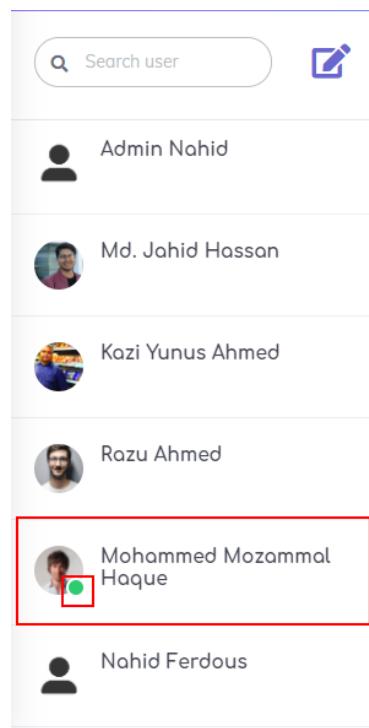


Figure 99: Showing contact list and displaying user online status.

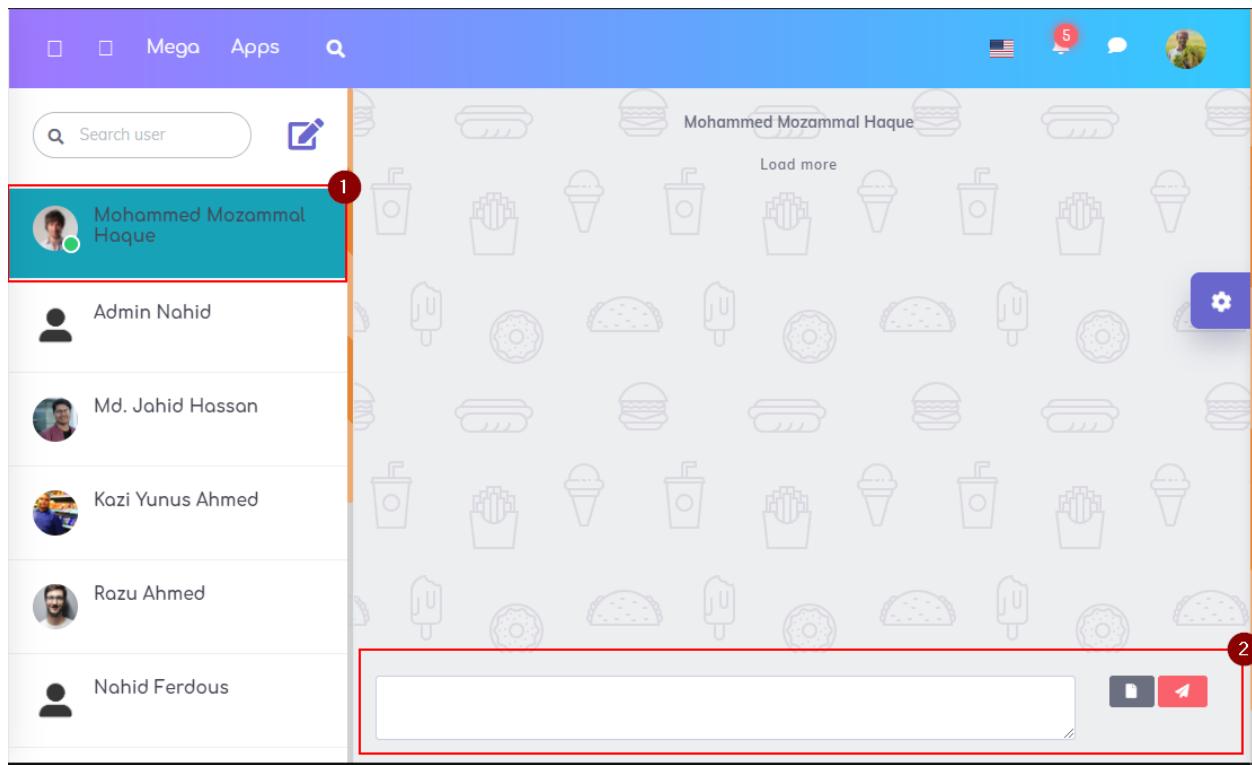


Figure 100: On selecting contacts text box appears.

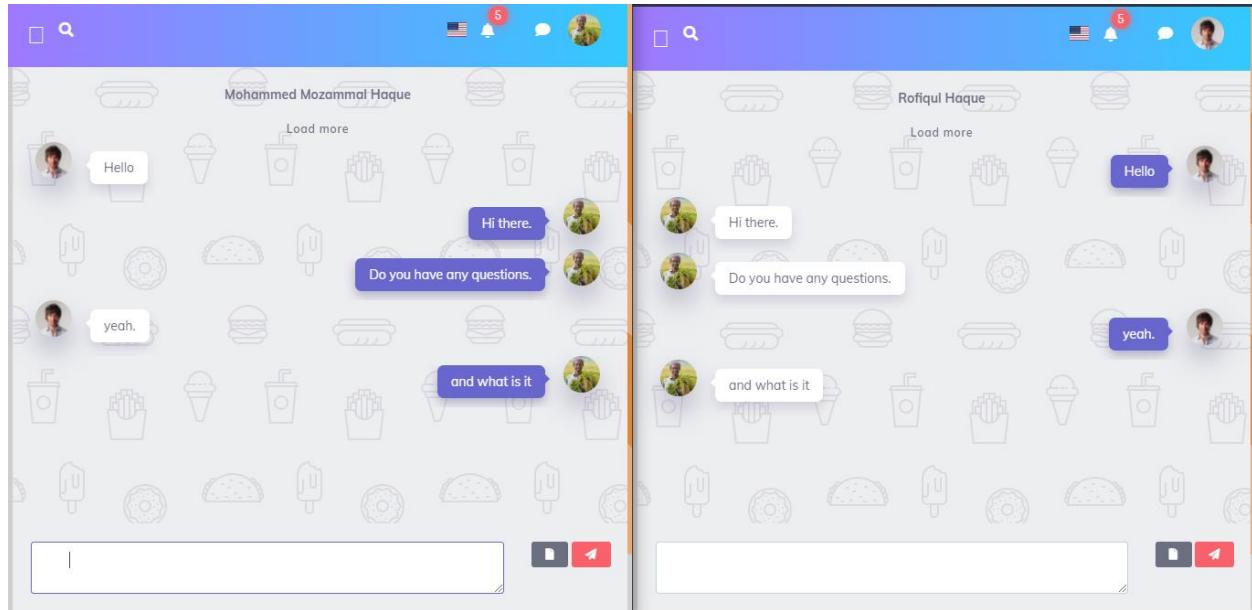


Figure 101: Sending a message in real-time from both ends.

Sl.	Specification	User acceptance status
1	User authentication.	Accepted
2	User account and password update.	Accepted
3	User management.	Accepted
4	Check if the system can get user location.	Accepted
5	Get weather updates and weather history based on user location.	Accepted
6	Users should be able to add products to the cart.	Accepted
7	Users should be able to order products.	Accepted
8	Farmers can add product categories and products.	Accepted
9	Admin and agriculture officers will be able to post blogs to the system.	Accepted
10	Real-time weather update is available.	Accepted
11	Users can create products.	Accepted
12	Users can communicate between them using the system.	Accepted

12.2.5. Performance testing

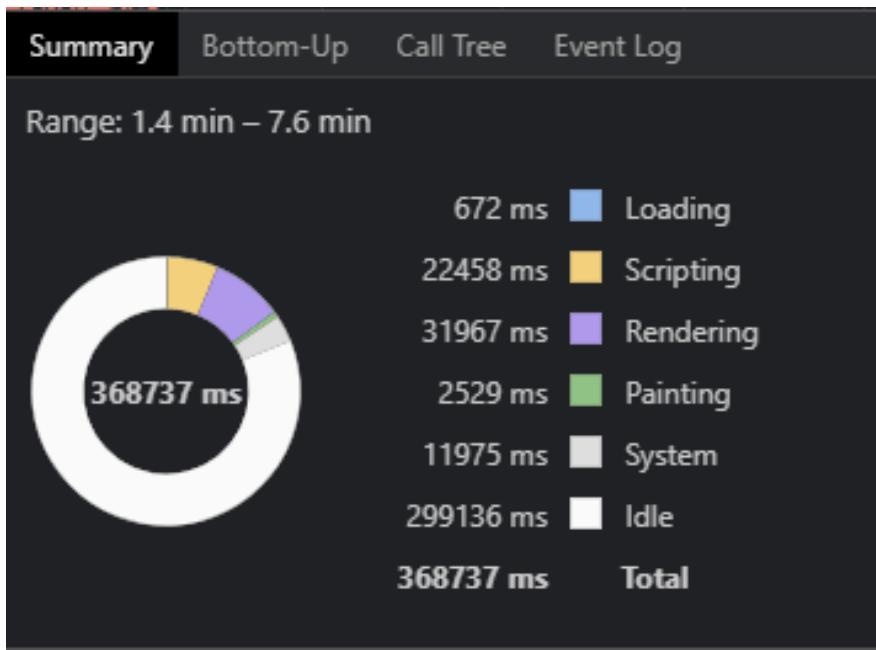


Figure 102: Performance test 1.

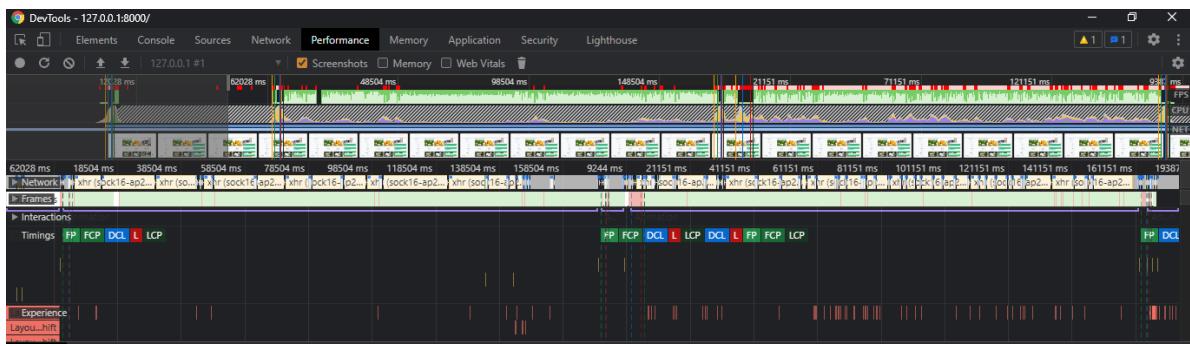


Figure 103: Performance test 2.

12.2.6. Security testing

- Security testing ST001.

Test Case ID: ST001		Test Type: Security	Tester: Nahid Ferdous
Test Title	Check password encryption.		
Test Case Description	Test that the password stored in the database are encrypted.		
Execution steps	1. Check user passwords in the GUI database panel.		
Test Browser: Chrome Browser	Test device OS: Windows	SL.	Actions
SL.	Actions	Expected Result	Actual result
1	Visit the database and check passwords are encrypted.	Passwords are encrypted.	As expected.

The screenshot shows the phpMyAdmin interface with the 'users' table selected. The table has columns: id, first_name, last_name, email, username, mobile_number, dob, gender, email_verified_at, and password. There are 12 rows of data. The 'password' column for all users contains encrypted values starting with '\$2y\$'. A red box highlights the first few rows of the password column.

										password
1	Admin	Nahid	admin@gmail.com	admin123	01857823870	NULL	NULL	2021-05-01 03:06:11		\$2y\$10\$aa0hsUj3eixTp4eiB3f1A.peCYSLD2BPYHypdkEn...
2	Rofiqul	Haque	rofqa_fa	01890905658	NULL	NULL	NULL	2021-05-01 03:06:11		\$2y\$10\$9hv4vkknHDnWr.GS2l7GXexaGorb5fVzz29PmxF...
3	Md. Jahid	Hassan	jahid_re	01867856055	NULL	NULL	NULL	2021-05-01 03:06:11		\$2y\$10\$87RgfUwAPnmv855fukwaSYxMYveO1oLMnS2...
4	Kazi Yunus	Ahmed	younus_bh@gmail.com	younus_re	01851245618	NULL	NULL	2021-05-01 03:06:11		\$2y\$10\$95hKgPaZNkD88tPERzRzegpWCwjkxsX5QXV9SL76UTS...
5	Razu	Ahmed	razu36@gmail.com	razu_of	01869241348	NULL	NULL	2021-05-01 03:06:11		\$2y\$10\$YvvwO8eCm4h6pXTTEQjMSaHhvBR0Q.hSAXsor1ZJ...
6	Mohammed	Haque	mozammal123@gmail.com	mozammal_of	01849344559	NULL	NULL	2021-05-01 03:06:11		\$2y\$10\$9fGzEhURmz2yza79ATG.B0eDEDbidXHKfSCFcy...
7	Nahid	Ferdous	nahid_uu	01878322230	NULL	NULL	NULL	2021-05-01 03:06:11		\$2y\$10\$Y7kxyaCQ1DAQcdPBC.yC55X4RN.NfT3CQjEv3vL...
8	Rupali	Ahmed	rupali@gmail.com	rupali_cu	01857112870	NULL	NULL	2021-05-01 03:06:11		\$2y\$10\$919d8U3jhLDPSpYqYwUGzLGzLzGWDj2p2jv63R...
9	Customer	Three	customer3@gmail.com	customer3	01851232870	NULL	NULL	2021-05-01 03:06:12		\$2y\$10\$11ErzXOPvbIKGAHMZF7TgOeqg84pghT7vewDvO/z...
10	Newaab	Shamsul	saiday@gmail.com	Syed_far	01819905156	NULL	NULL	2021-05-01 03:06:12		\$2y\$10\$05PEfmMOZifjgjM.NZQdGuPiwLvfyE0jxxUls37...
11	Khwaja	Salimullah	salimullah@gmail.com	salimullah_far	01819945156	NULL	NULL	2021-05-01 03:06:12		\$2y\$10\$PFJuwgp2P82xeLSXEBM.NH.La3e4g48Le37pdTC...
12	Rofiq	Farmer	rofqa_farmer@gmail.com	rofqa_farmer	01793845734	NULL	NULL	NULL		\$2y\$10\$Kgy8uy6QM/Wq0jkgEwkAchusxmLuz35x2u0j6F7aOz...

Figure 104: Passwords stored in the database are encrypted.

- Security testing ST002

Test Case ID: ST002		Test Type: Security	Tester: Nahid Ferdous
Test Title	.Check protected routes.		
Test Case Description	Ensure users are not able to enter the protected route.		
Execution steps	1. Try to enter a protected route without login in.		
Test Browser:	Chrome Browser	Test device OS:	Windows
SL.	Actions	Expected Result	Actual result
1	Enter protected route in URL.	Redirects back to the login page.	Result as expected.

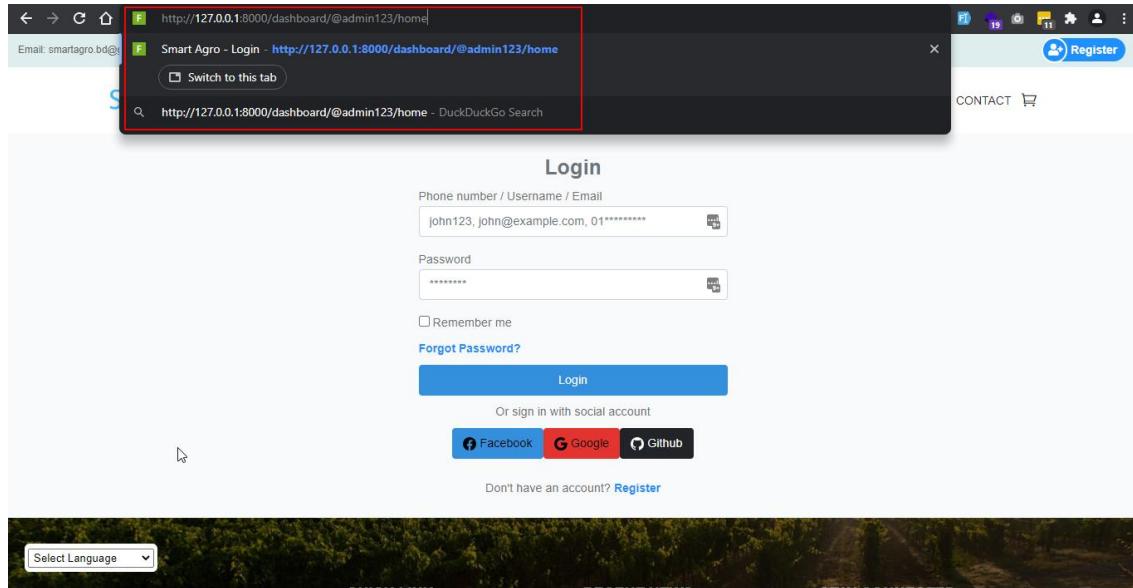


Figure 105: URL of a protected route is entered.

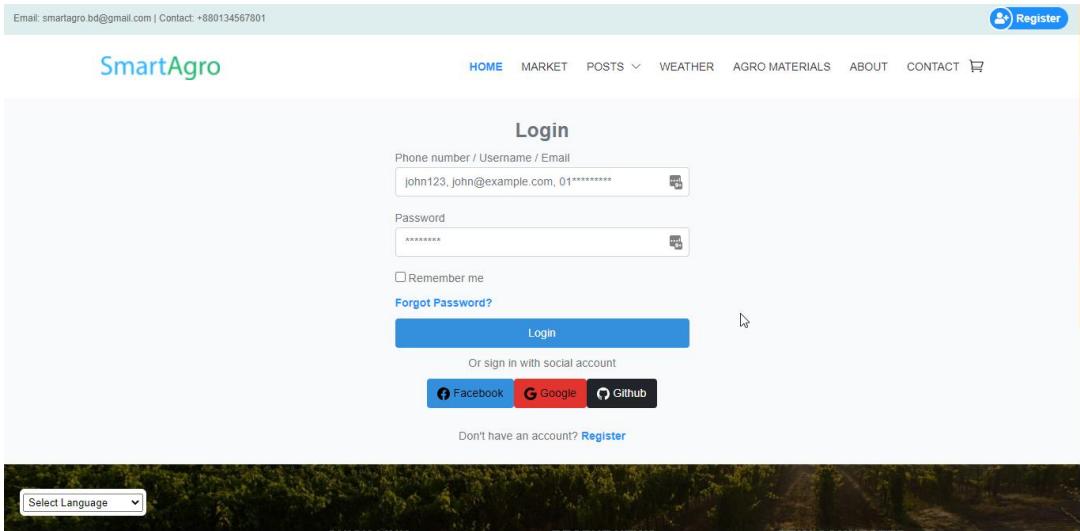


Figure 106: Redirects back to the login page.

- **Security testing ST003**

Test Case ID:	ST003	Test Type:	Security	Tester:	Nahid Ferdous
Test Title					
Test Case Description	Prevent another user to enter pages that are only available for the admin user.				
Execution steps	1. Enter URLs that are only available to admin users.				
Test Browser:	Chrome Browser	Test device OS:	Windows		
SL.	Actions		Expected Result	Actual result	
1	Enter URL protected by user roles and permission.		Redirect user to 404 pages.	As expected.	

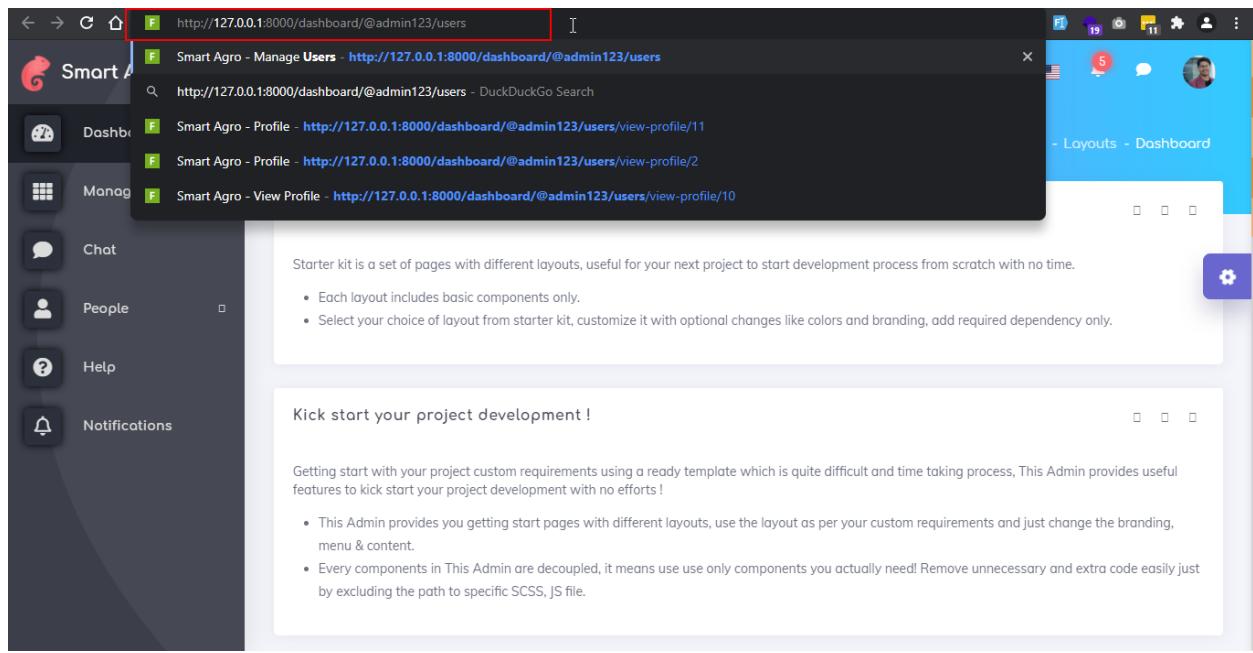


Figure 107: URL entered which is accessible to admin user only.

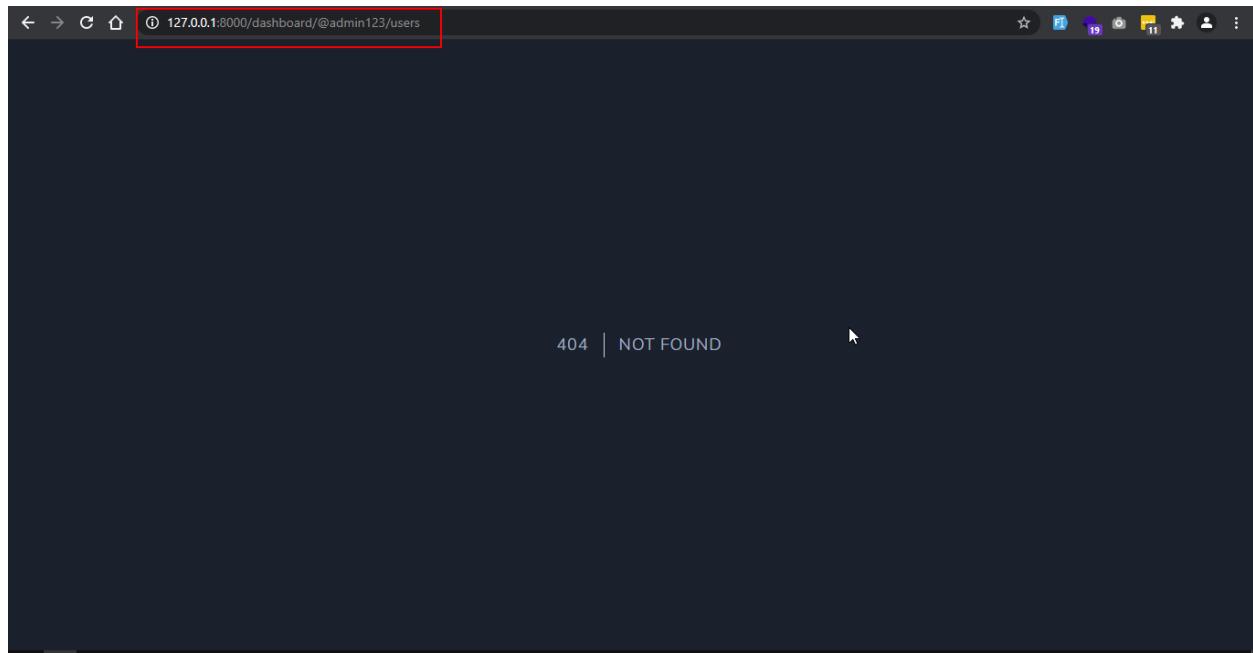


Figure 108: 404 page is shown.

12.2.7. Usability testing

- **Usability testing UT001**

Test Case ID: UT001		Test Type: Usability	Tester: Nahid Ferdous
Test Title	Usability testing, links, buttons, form element, etc.		
Test Case Description	Check if the links button and form elements can be easily identified.		
Execution steps	1. Visit different pages and verify that the buttons and links can be easily identified.		
Test Browser:	Chrome Browser	Test device OS:	Windows
SL.	Actions	Expected Result	Actual result
1	Ensure buttons and links can be identified easily.	Buttons and links are easily identified. Active links are highlighted.	As expected.

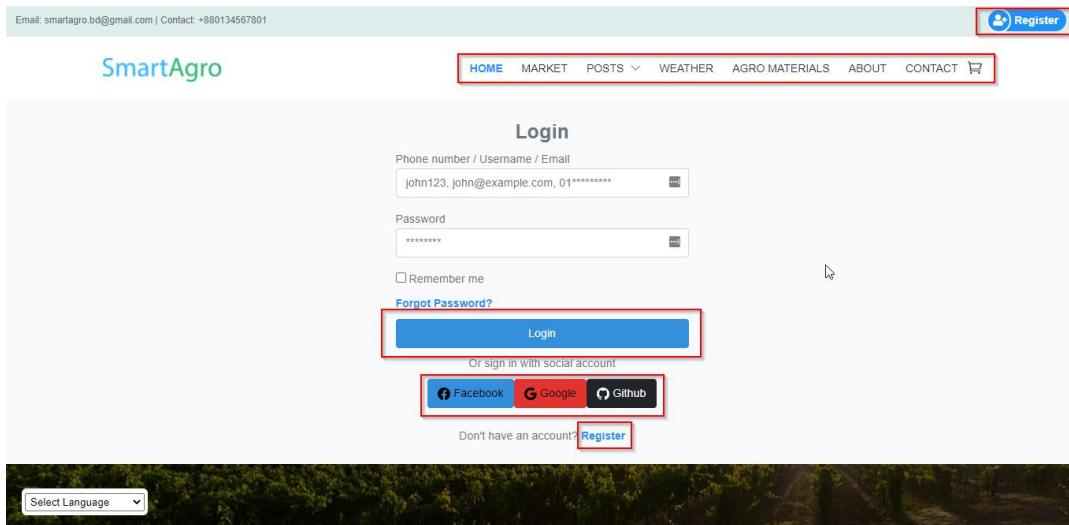


Figure 109: Buttons and links can be identified separately.

- **Usability testing UT002**

Test Case ID: UT002		Test Type: Usability	Tester: Nahid Ferdous
Test Title	Usability testing, Consistency of design and color.		
Test Case Description	Check the color and design consistency across the website.		
Execution steps	1. Visit different pages of the website.		
Test Browser:	Chrome Browser	Test device OS:	Windows
SL.	Actions	Expected Result	Actual result
1	Visit different pages of the website.	Design and color are consistent across the site.	Result as expected.

Frontend design consistency:

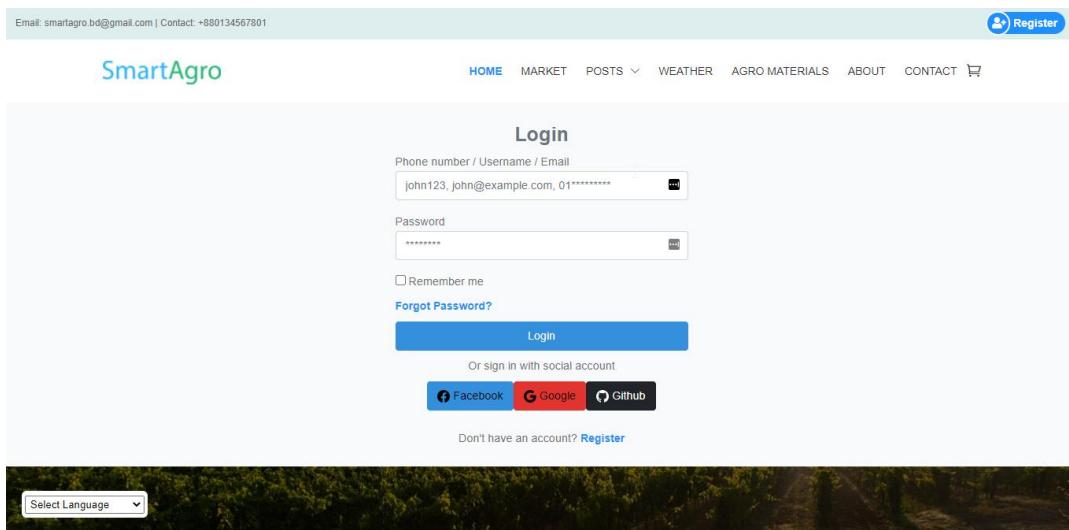


Figure 110: Login page.

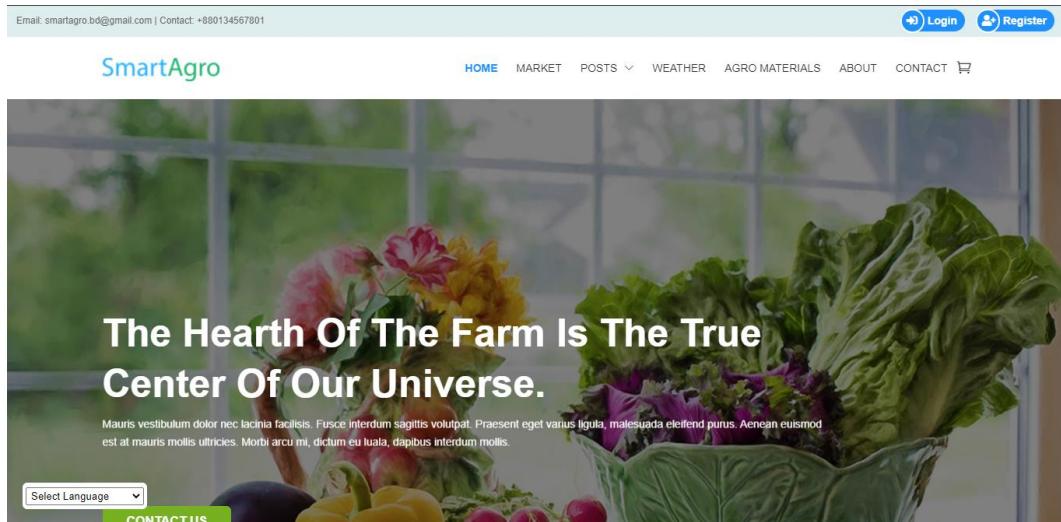


Figure 111: Home page.

The screenshot shows the Market page of SmartAgro. The top navigation bar includes 'HOME', 'MARKET' (which is highlighted in blue), 'POSTS', 'WEATHER', 'AGRO MATERIALS', 'ABOUT', 'CONTACT', and a shopping cart icon. Below the navigation is a breadcrumb trail: 'Home □ Market'. A search bar with the placeholder 'Search: Product name, category, location' and a 'Clear' button is positioned above the product grid. The products are categorized into 'Cataories' (All, Crop, Fruit) and shown in a grid format. Each product item includes an image, the name, price per unit, stock quantity, and a 'View Details' button. The 'Crop' category shows Sugarcane, Rice, Wheat, and Corn. The 'Fruit' category shows Mango, Lychee, and Jackfruit. The 'All' category shows Indian cow and Cow.

Figure 112: Market page.

Dashboard design consistency:

Smart Agro

Mega Apps 5

Manage Posts

Posts

All Post My post

5 Agritech startups enabling farmers to go all digital
POST TYPE: NEWS, STATUS: ACTIVE

Sustainable agricultural technology can transform the global food landscape. Agritech startup innovations are addressing some of the key challenges connected to agriculture and food production. Many a...

[Edit](#) [Delete](#)

Categories: Modern Technology | Author: Admin Nohid Published at: 05-01-2021

MOP or potash fertilizer work, deficiency or deficiency sympto
POST TYPE: FARMING-PRACTICE, STATUS: ACTIVE

MOP or potash fertilizer work, deficiency or deficiency symptoms, harmful aspects of overuse MOP or muriate of potash contains 50% potassium. MOP fertilizer protects the permeability of plant cells. H...

[Edit](#) [Delete](#)

Categories: Farming practice | Fertilizer | Author: Officer Nohid Published at: 05-01-2021

Harmful aspects of ureo fertilizer work, deficiency or sympto
overuse, overuse.

[Read More](#)

Benefits of using flora in rice.
POST TYPE: FARMING-PRACTICE, STATUS: ACTIVE

[Read More](#)

Figure 113: Manage post page.

Smart Agro

Mega Apps 5

Manage Users

Manage Users

Search Options
Name, Email or Mobile number

Role: All Status: All [Clear](#)

[Show removed user](#)

#	Name	Username	Email	Mobile	Status	Role	Actions
1	Rofiq Farmer	rofiq_farmer	rofifarmer@gmail.com	01793845734	active	farmer,	0
2	Khwaaja Salimullah	salimullah_far	salimullah@gmail.com	01819945156	active	farmer,	0
3	Nawaab	Syed_far	sayed@gmail.com	01819905156	active	farmer,	0

Figure 114: Manage user page.

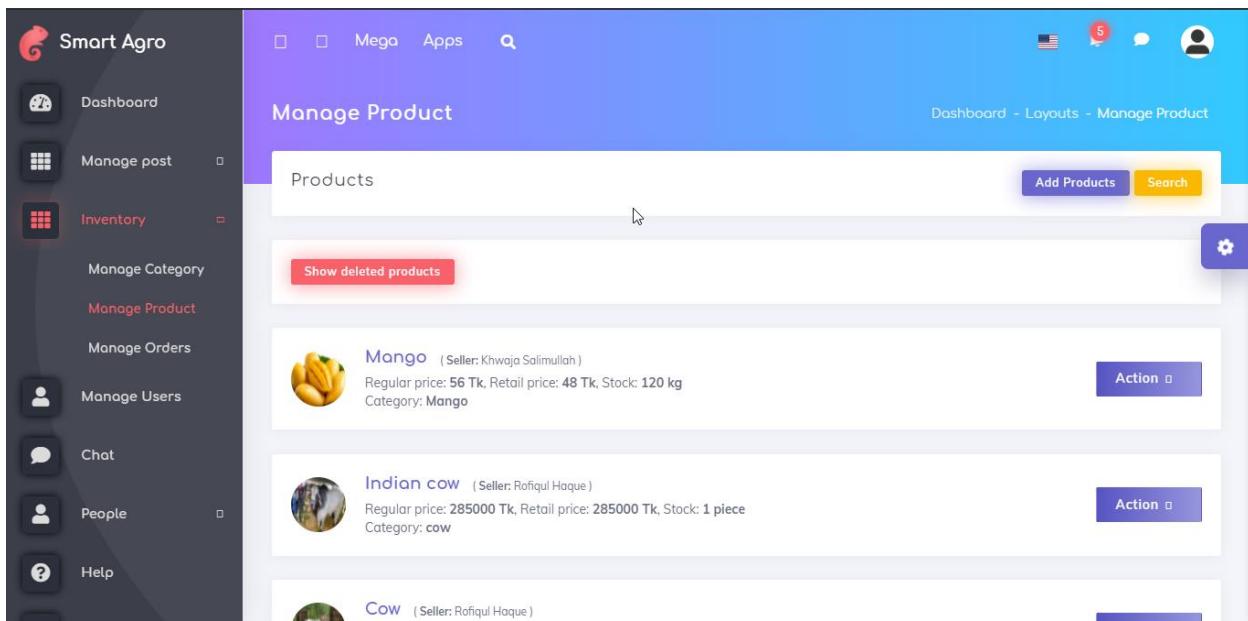


Figure 115: Mange products page.

12.2.8. Compatibility testing

- **Compatibility testing CT001**

Test Case ID:	CT002	Test Type:	Compatibility	Tester:	Nahid Ferdous
Test Title	Browser compatibility testing				
Test Case Description	Testing on different browsers.				
Execution steps	1. Test in different browsers Chrome, Frie fox, Ms. Edge.				
Test Browser:	Chrome Browser	Test device OS:	Windows		
SL.	Actions		Expected Result	Actual result	
1	Test on different browsers.		The website runs perfectly on different browsers.	Result as expected.	

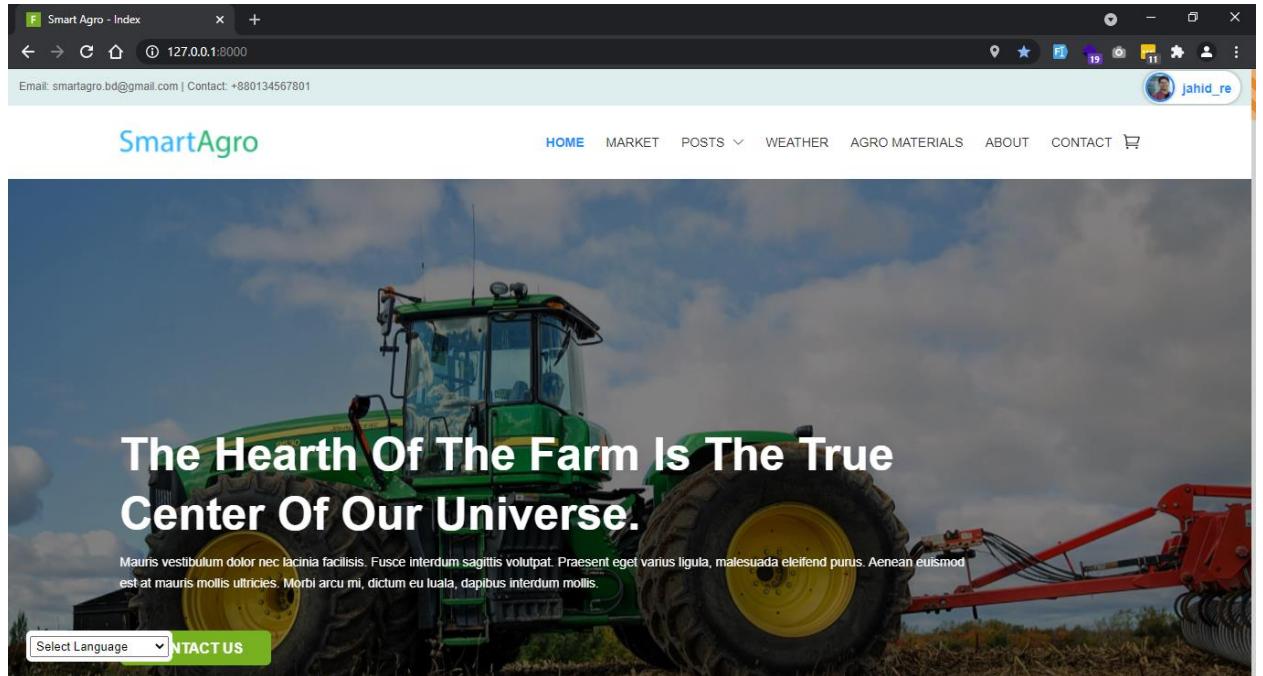


Figure 116: Chrome browser.

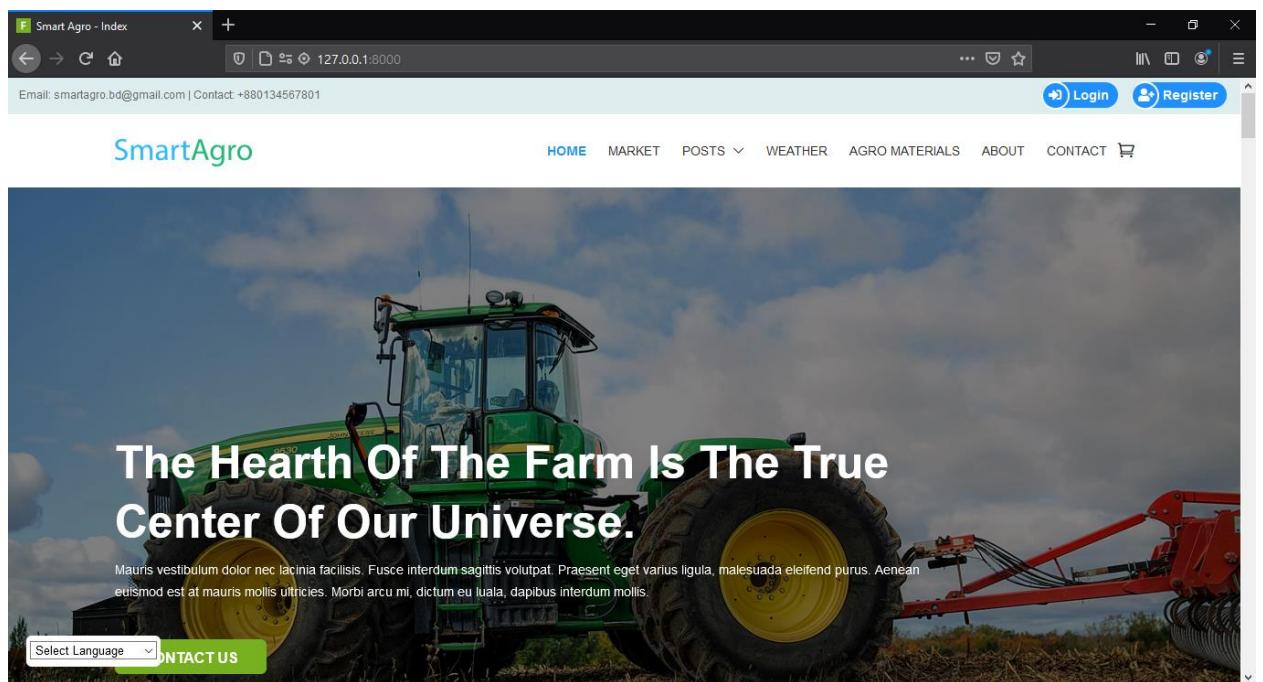


Figure 117: Fire fox browser.

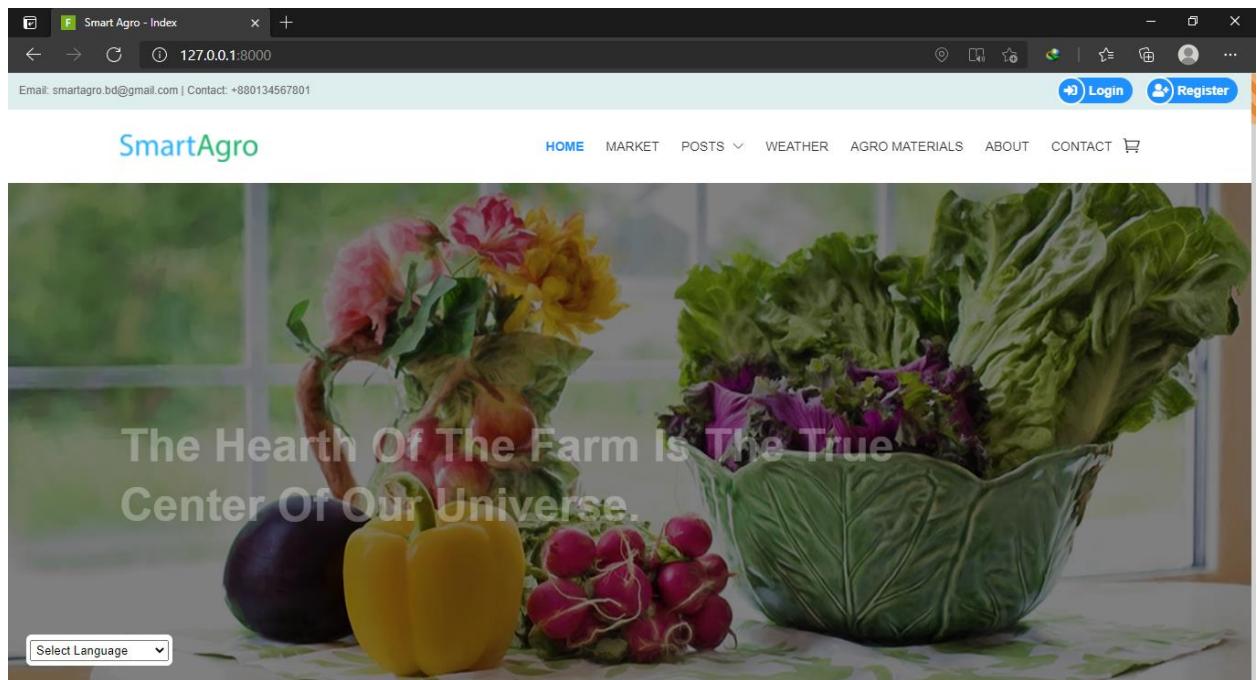


Figure 118: Microsoft Edge browser.

- **Compatibility testing CT002**

Test Case ID:	CT002	Test Type:	Compatibility	Tester:	Nahid Ferdous
Test Title	Testing on a mobile device.				
Test Case Description	Testing on a mobile device.				
Execution steps	1. Test on a website on a mobile device.				
Test Browser:	Chrome Browser	Test device OS:	Windows		
SL.	Actions		Expected Result	Actual result	
1	Run the system on a mobile device.		The website runs perfectly on mobile.	Result as expected.	

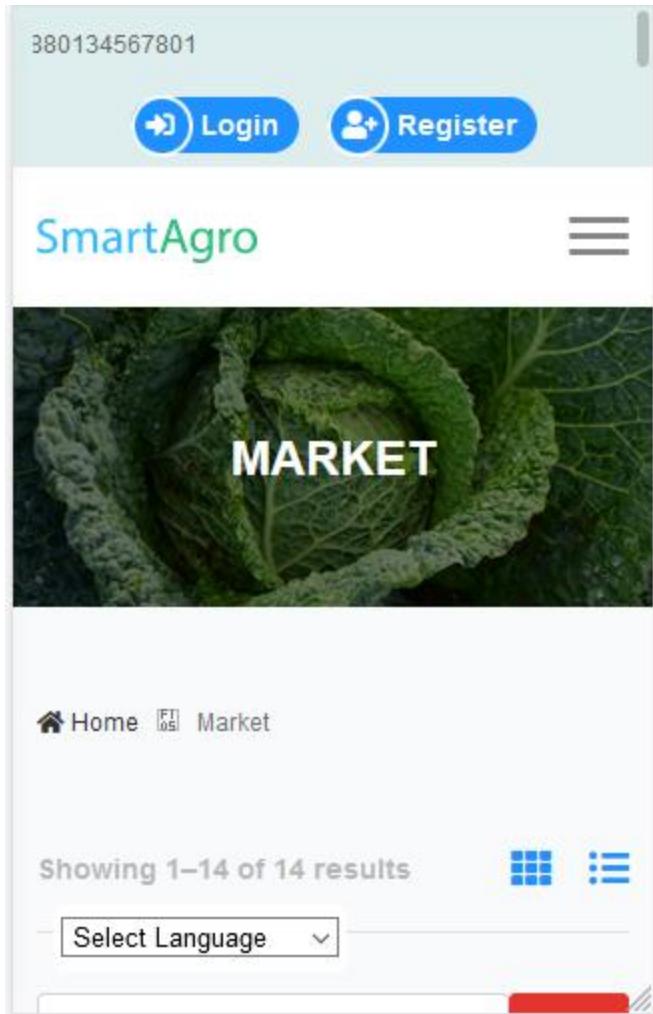


Figure 119: website running on a mobile device.

More testing is provided in **Appendix D**.

13. Deployment

13.1. Criteria for successful deployment

Deployment is all about taking the code and putting it into a production environment.

For successful deployment of software solutions, some deployment criteria must be followed. The criteria's are outlined below:

- Deployment Planning
- Data migration
- User training

13.2. Steps required for successful deployment

The steps required for successful deployment are outlined below:

- Identify software, hardware, and human resource requirements.
- Involve the maximum number of stakeholders possible.
- Choose a deployment approach.
- Identify deployment pipeline.
- Create a deployment plan.
- Test frequently.
- Communicate and collaborate before and during deployment.
- Test frequently.
- Develop a release strategy.
- Minimize change and have a rollback plan.

- Automate as much as possible.
- Monitor software performance.

13.3. Deployment method

There are various software deployment methods for deploying software projects or solutions. These methods are the big bang, pilot, parallel, phase, etc.

In the **Parallel** method, the new system is implemented besides the old system and both of the systems work at the same time. Using this method users can verify the accuracy of the output from both systems by comparing.

The **pilot** method is when the new system is implemented within a small group of people and a wider range of users uses the old system. Using this approach it is easier to identify errors, bugs, and problems in the new system without affecting the old one. This method is suitable for organizations with several branches.

A **big bang** method is a deployment approach where all the new system modules are implemented at one go. Through this strategy, the entire enterprise will switch to the program at the same time, and all legacy systems will be retired. This deployment approach would also have the lowest total cost and shortest timeline since all end-user groups will go live at the same time. The big bang method can also be risky as every aspect of the system is not tested thoroughly.

For deploying the “**Smart Agro**” project **pilot** method will be the best choice because initially, the primary user (farmers) may fail to use the system at its full potential. For

deploying the system a specific date will be declared and the system will be deployed in presence of the stakeholders.

13.4. Training

When implementing any new system, training is necessary. Nonetheless, training is an important part of this project because the system's primary users (farmers) are largely illiterate in a country like Bangladesh. Training will help farmers to understand the new system and give them the motivation to learn new technologies. The training plan for this project is given below:

Sl.	User Role	Training modules	Duration (Minutes)	Comment
1	Farmer	<ol style="list-style-type: none">1. Manage inventory.2. Manage orders.3. Buy agricultural materials (seed, fertilizers, etc.).4. Check real-time weather updates.5. Chat system.6. Browse and view posts.7. Find people.8. Login and registration.	120	Farmers will be able to easily sell their products and communicate with agriculture officers and share their problems.

2	Retailer / Customer	1. Add products to the cart. 2. Checkout. 3. Chat system.	30	Retailers and customers will be able to buy products directly from the farmers.
3	Admins	1. Manage inventory. 2. Manage post / blog. 3. Manage users.	60	Admin can manage inventory, orders, posts, and users.
4	Agricultural officer	1. Manage post / blog 2. Chat system	30	Agricultural officers will be able to manage posts and communicate with farmers.

13.5. Data migration

The process of transferring data from one application to another, from one place to other, or from one format to other is known as data migration. Data migration usually occurs when the legacy systems are replaced by a new system that will use the same data set. In this project data migration is not an integral part because users of the system are not part of any specific organization and also this system is not based on any old or legacy systems. The system will be used from a fresh start.

14. Evaluation

After successfully developing and deploying the solution it is time to evaluate the product.

In this section, the solution will be evaluated based on different criteria.

14.1. Product evaluation

Product evaluation outlines how well the product is built and the overall performance of the system. There are different criteria for evaluating software products. In the sections below usability, sustainability, and maintainability of the system will be evaluated.

14.1.1. Usability

Usability study aims to identify how well users can learn and use the new system to accomplish their objectives. Usability is the consistency and quality of the user's experience while interacting with the system. Usability is combined of factors like memorability, ease of learning, efficiency, etc.

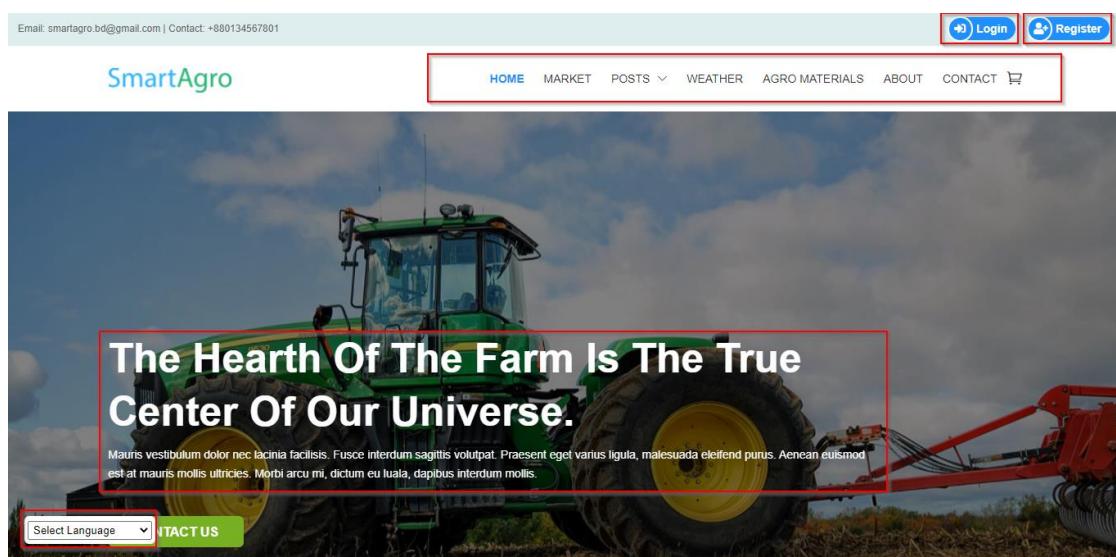


Figure 120: Home page user interface.

The “**Smart Agro**” system is developed keeping usability in mind. So that users can easily navigate and use the system. The website background colors and text colors are contrasting, therefore it is easier to read, font size is also kept to default standards and the links and buttons can be easily identified.

14.1.2. Sustainability

Sustainability is an important aspect to consider. Sustainability refers to the ability of a system to endure various domains. Sustainability allows companies to think about their actions in long-term environmental, socioeconomic, and human effects rather than short-term benefits like next quarter's earnings release. It persuades them to think of more than just the direct benefit or loss involved. The “**Smart Agro**” system is expected to be sustainable because there are not many software products available related to agriculture in Bangladesh. And this software is expected to mitigate some of the problems that rural farmers are facing. The feasibility study conducted in the previous section also suggests that the software will be feasible and eventually gain profits in few years.

14.1.3. Maintainability

Maintainability refers to the ability of a system or its features to be repaired within a defined time and environment. Shorter maintenance periods are associated with increased maintainability. In the “**Smart Agro**” system the features are developed in separate components. Repairing certain parts or features of the application will

not affect the rest of the systems and their functionalities. Therefore it will take less time and effort to fix the system and it can be said the system is maintainable.

15. Critical appraisal

This section includes the critical appraisal of the project. Where it will be identified that the previously identified objectives and functionalities are met.

15.1. Objectives met

The objectives that are met are listed below:

- Create an e-commerce platform for farmers, retailers, and consumers.
- Create an agricultural knowledge hub/center where farmers will be able to dive into modern agricultural knowledge.
- Provide latest agro news and weather updated through the system.
- Reduce the communication gap between the farmers, retailers, and agriculture officers.

15.2. Objectives that were partially met (why + possible course of action)

The objectives that are partially met are listed below:

- Implement functionality that would allow flawless communication between farmers to agriculture officers, retailers, and consumers.

Why these objectives could partially be met:

These objectives have been partially touched due to the lack of time and other resources. As this is an individual academic project managing time and resources was very difficult.

The possible course of action:

Proper time management and resource allocation could be done to ensure that the objective is met.

15.3. Objectives not met (why + possible course of action)

Most of the objectives are fully or partially met. The objectives not met are given below:

- Allow farmers to generate tallies for better visualization and comparison of their yield and income.
- The system should suggest and encourage farmers to grow crops best suited for that region in upcoming seasons.

Why these objectives could not be touched?

These objectives have been partially touched due to the lack of time and other resources. As this is an individual academic project managing time and resources was very difficult.

The possible course of action

Proper time management and resource allocation could be done to ensure that the objective is met.

15.4. Features that were touched

The feature that was touched is outlined below:

- User authentication and profile update
- User management
- Knowledge center
- Inventory management.
- Add to cart.
- Order products.
- Manage posts.
- Regular weather update.
- Ask questions or queries.

15.5. Features that were partially touched (why + possible course of action)

The feature that was partially touched are outlined below:

- **Chat system:** In the developed system the chat module includes only text-based communication. Audio or video call could not be added to the system.

Why partially touched: To implement an audio or video chat system paid services will be required. It can also be built from scratch but that would require writing lots of code and would be time-consuming.

Possible action: The possible action would be buying a service like “Twilio” to built the audio and video chat system easily. Otherwise building the entire audio or video call system would not be possible within the given time limit.

- **Human resource management:** the human resource management module is partially touched. Farm owners can create workers under them and assign tasks to them. But these tasks cannot be updated, modified, or deleted.

Why partially touched: Due to the lack of time and planning this feature could not be completely implemented.

Possible action: Proper planning and time management could be done to complete this feature.

15.6. Features that were not touched (why + possible course of action)

The features that could not be touched are listed below:

- Farm or field data management.
- Product rating and review.
- Plant disease or insect detection.
- Crops suggestion for the next season based on user location.

Why these features could not be touched?

These features could not be implemented because they would require more time, human effort, budget, and other resources. As this is an individual academic project all these resources are very limited, therefore these features are not implemented.

The possible course of action:

These features could be implemented if the resources would be increased a bit more, especially the time. Legitimate analysis, research, and planning could be done to attempt to complete these features. This feature can also be implemented in further development through iterations.

15.7. Strength of the system

The strength of the system is outlined below:

- The system is user-friendly and easy to learn and use.
- The website can be browsed in different languages it will be helpful for native speakers.
- Rural farmers will be able to easily find and communicate with agricultural officers.
- Easy inventory management and add to cart functionality.
- The account setup process is fairly simple and easy.

15.8. The weakness of the system

The weakness of the system is outlined below:

- The dashboard might be tricky to handle for some users.
- No payment system is implemented.
- Product shipments cannot be managed.
- Only a text-based communication system is available no audio or video.

15.9. Future development

The system features are developed in separate components. Therefore upgrade and maintenance can be easily done without affecting the usable parts of the system. In further developments, more features can be added to the system. A list of possible features that I want to implement and their importance is outlined below.

- **Farm of field data management:**

This feature will enable farmers to record their farm data digitally in the system. So that they can visualize the condition of their field and wealth in a better way. At the end of the season, farmers will be able to generate reports from the data they have stored.

- **Add audio or video call to the system:**

Adding audio and video call features to the system is very important because it will enable a more fluent communication system between the users. It will help reduce the communication gap.

- **Plant disease or insect detection:**

Plant disease and insect detection is also a very critical feature to implement.

It would enable farmers to upload disease or insect-infected leaves and the system will automatically detect the disease or insect and suggest a precaution.

If the system fails to respond the agricultural offices can come up for help. In this way, farmers will be able to mitigate disease or insects before they spread.

- **Crops suggestion for the next season based on user location:**

Crop suggestion can be a very useful feature to implement. The system will get the user's current location and analyze the best crops that grow in that region based on previous records. This will provide the novice or new farmer an idea of what crop is best to harvest in the upcoming season.

16. Lessons learned

In this chapter, there will be a discussion about the learnings from this project. This section is done during the project closing phase. The project mainly focusses on the agricultural sector, there were a lot of new things to learn and gain experience from. There were some problems faced during this project. Those problems and the solution made are discussed below.

16.1. What have I learned?

The solution is developed using a development methodology that allowed the development to be carried out in a sequential and structured way. Each development stage brought up a new experience or lessons to learn. Some of the important lesson learned are discussed below:

- The business process around the agricultural market is understood to some extent. Through critical analysis and requirement gathering, the knowledge about the agricultural marketing process was understood, from crop harvesting to consumer's plate.
- While doing the project different methodologies were studied and a custom development methodology was created. This allowed me to have a detailed understanding of the different stages of the development process and how they are linked.
- Learning new technologies was the best part of this project. Some new technologies were used to develop this project, which was unknown to me. I have learned a new frontend framework (VueJs) and had worked with channels

and sockets using pusher js. Moreover, my overall programming and problem-solving skill have developed immensely while doing the project. These silks and knowledge will be helpful for me in the future.

- Generally, I am an introverted person. Initially, it was very difficult for me to communicate with people while taking interviews or in questionnaire sessions. But as time passed by I have learned to cope up with the situation and my communication and collaboration skills have gradually improved.
- This project also helped me to improve my analytical skills. As I had to do extensive research on the topic and think outside the box from different angles, this nourished me to become a better thinker.

16.2. What problems I have faced?

During the project development processes many problems were faced some of the vital problems are discussed below:

- While gathering requirements I face most of the problems. Due to the Covid19 pandemic situation and lockdown, I was not able to reach the stakeholders and conduct face-to-face interviews and meetups.
- As this is an academic project all the tasks are done by a single person. For this reason, assuming the time boxes and properly managing the time was a difficult task. At the end of the project, there was likely to be a shortage of time and a chance of project failure.

- There were some errors in the development phase while coding. While coding I have faced some problems in building some features and there were lots of errors in the system.
- A system features required paid services to be used and due to lack of time and advanced knowledge properly implementing all the features was not possible.

16.3. What solutions occurred?

The solution to the problems faced are discussed below:

- Due to the problem in gathering requirements and Covid19, I have focused more on the online-based resources available and have also connected with the stakeholder online and by phone call.
- To manage the time shortage I had to also work on off days and left the less important features for further development, to complete the project on time.
- I took help from online sources like YouTube, Stake Overflow, W3 School, etc. to solve the problem related to coding. Few problems were solved after a quick discussion with my fellow teachers.
- The core features were developed with the available resource and skills. But with the help of paid services and advanced skills, the end solution could have been much better.

17. Conclusion

17.1. Project summary

“Smart Agro” - A Web-based farming assistant app to help the farmers in their daily activities and aid in better decision making. The proposed solution is dedicated to the farmers that will help them to access probable weather condition market price and enable them to directly communicate with retailers, consumers, and agricultural officers. The system will give them better profitability for the products they sell. Farmers will be able to get information about modern farming techniques by listening to or reading articles.

Most of the necessary/core required features of the solution have been developed within the time limit. An adequate amount of analysis, planning, implementation, and testing was conducted to ensure project success. The project took about three months to be completed. All the project steps performed in doing the project have been recorded in this document.

17.2. Goals of the project

17.2.1. Fulfilled goals of the project

The fulfilled goals of the project are listed below:

- Develop an e-commerce platform for farmers so they can sell products directly to retailers/consumers.

- Remove middlemen who feed on the profit that the farmers are expected to get.
- Ensure easier and effective communication of rural farmers with agriculture officers.
- Allows farmers to get more accurate weather predictions.
- Reduce communication and information gap in rural farmers with the aid of ICT.

17.2.2. Goals that are not fulfilled

The not fulfilled goals are listed below:

- Allow farmers to mark their field on the map for more effective farm data management.
- Farmers will be able to add works under them and assign tasks to the workers.
- Allows farmers to detect disease and insects using the system.

17.3. The success of the project

According to my opinion, the project has been successfully implemented. Although all the features are not completed but most of the core system requirements are met. The finished system will improve the overall existing agricultural marketing model and the livelihood of rural farmers. The project aim and most of the project goals/objectives

are fulfilled. Therefore it can be said that this project is completed successfully. Using the system the farmers will be able to generate a better income and gain more profit which will improve their way of living.

17.4. What has been done in the documentation? (Stages / activities / plans)

This documentation consists of different sections of my research work. This is the backbone of my research, it consists of analysis, research, literature review planning, testing implementation, etc.

- The **Initial Study** contains the project proposal, background of the project, identifying project scope and challenges.
- The **Literature Review** chapter contains a discussion on the problem domain and problem solution based on various research papers, journals, and articles. And a recommended approach to mitigate the problem is also provided.
- The **Product Research** chapter contains critical analysis and comparison between the three leading existing solutions along with the weighted scoring model and the recommended approach.
- The **Issues** chapter contains a detailed discussion on the legal, social, ethical, and professional issues.
- The **Methodology** chapter contains a discussion on various most used methodologies and a recommendation with the justification of the methodology that was used to develop this project.

- In the **Planning** chapter planning for the project was done. This includes test plan, quality management plan, risk management, and change management plan.
- In the **Feasibility** chapter, feasibility studies were conducted to find if this project is worthy of investing time and money.
- In the **Requirement analysis** chapter, all the project requirements are identified, logged, and prioritized using the MoSCoW prioritization rule.
- In the **Engineering** chapter, the new system design and architecture will be provided. This includes the Use Case, Class diagram, ERD, sequence diagram, etc. of the new system.
- In the **Development** chapter, the core module is coded and developed in iterations. The modules and iteration processes are recorded here.
- In the **Testing** chapter, the system is tested following the test plan. Several tests are performed and the test results are recorded in this part.
- In the **Deployment** chapter, the deployment process that was followed to deploy the system is discussed.
- In the **Critical Appraisal and Evaluation** chapter, the system is evaluated and the objectives that have been met and the objectives that have not been met are outlined.
- In the **Lesson Learned** chapter, the knowledge, skills, and experiences that I have gained are discussed.

17.5. My experience

In the end, I would like to say I had a great time doing this project. I was able to meet new people from different fields like farmers, agriculture offices, buyers, etc. It was a great experience working and communicating with different types of people and I was able to learn many things from them. I hope that these experiences will help me grow better in my professional and personal life.

17.6. Future implications

In the future, I would like to work more on this project and improve it further. I plan to create a mobile app version of the solution for greater accessibility. Currently, the website is accessible through mobile, tab, laptop, computers, etc. I have a plan to implement satellite imagery so that farmers can visualize their land through the app and have greater control over their agricultural land.

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[provides-opportunities-challenges](#)

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19. Appendices

19.1. Appendix A – Project proposal

Introduction.

The agriculture sector is the economic backbone for many countries and occupies a large portion of the total GDP. The growing population of the world is estimated to reach 10 billion by 2050. Therefore the agriculture sector needs technological advancement that any country can adapt to.

The proposed solution is a Farming Assistant Web Application named (AgroTechBD). It is a web-based database-driven application that will provide a platform for the farmers to directly connect to the seller or retailer so that they can buy products at a lower cost. Farmers will be able to predict crop yield, detect disease or insect early, manage their farming data, get regular weather updates, and can communicate with plant or veterinary doctors.

Tech giants like IBM and Microsoft have developed drones, farming robots, and other IoT, Machine learning, big data, and AI-based solution to enhance the agriculture sector. But these technologies are not affordable for many countries due to the expense and lack of technological advancement. Some of the popular software-based agriculture solutions are Agrivi, AgDNA, AgroSense, and Sentera. (Immanuel, 2017) Although these solutions are pretty popular, further research can be conducted to develop this solution furthermore and fill out the missing gaps in research.

1. Research aim and objectives.

Aim: The main aim of this research is to develop a web-based farming assistant app that will be able to help the farmers manage and keep track of their daily farming activities and will aid in better decision making.

Objectives:

- ❖ **Objective 1:** Extensive research/investigation on similar products to exploit the weakness or gaps in the existing solutions.
- ❖ **Objective 2:** Analyze the system requirement specification for managing the farming.
- ❖ **Objective 3:** Research the usability and design specification of the product.
- ❖ **Objective 4:** Develop / code a useable product/solution.
- ❖ **Objective 5:** Generate test plan and test and evaluate the developed solution.
- ❖ **Objective 6:** Generate the project research report.

Summary of objective, methods, deliverables, and duration

Objective	Method	Deliverable	Duration
Objective 1	<ul style="list-style-type: none">• Survey• Questionnaires• Observation• SWAT analysis.	<ul style="list-style-type: none">• Literature review.• Product research• Identify legal, social, ethical, and professional issues.	2 weeks
Objective 2	<ul style="list-style-type: none">• Brainstorming• Observation	<ul style="list-style-type: none">• Identify the functional and non-functional requirements.• Define system scope and boundaries.	1 week

	<ul style="list-style-type: none"> • Unified Modeling Language (UML) 	<ul style="list-style-type: none"> • Feasibility study. • Use Case 	
Objective 3	<ul style="list-style-type: none"> • Unified Modeling Language (UML) • Object-oriented model 	<ul style="list-style-type: none"> • Data design (ERD, Class diagram) • Architecture Design (DFD, Rich picture, Activity diagram, Sequence diagram) • Interface design (UI, UX designs, Prototype) • Procedural design (Algorithm design) 	2 week
Objective 4	<ul style="list-style-type: none"> • Object-oriented model 	<ul style="list-style-type: none"> • Database • Develop system modules • Integrate system modules • Perform initial testing • Review 	5 weeks
Objective 5	<ul style="list-style-type: none"> • White box testing. 	<ul style="list-style-type: none"> • Test strategy and Test plan • Test design • Test execution (white-box testing) • Generate test report 	1 week
Objective 6		<ul style="list-style-type: none"> • Reflection of the whole project in a written document. 	3 week

2. Research approach.

To meet the project goal, proper research needs to be done. For gathering information about the problem, some techniques were followed which are surveys, questionnaires observation, and SWAT analysis. By using these techniques I was able to find the flaws and gaps in the existing solutions and was able to complete the literature review, product research, and feasibility study of this project. This will take about two weeks to be completed.

To analyze the system requirement and identify the system scope and boundaries, observation, and brainstorming techniques were used. The analysis part will take about ten days to complete.

To create the system design specification Unified Modeling Language (UML), an Object-oriented model was used. The design part will produce data design, architecture design, interface design, and procedural design. The design part will take 2 weeks to complete.

After the design part, the actual solution development process starts, and here the database and website were developed following the object-oriented model. This will take about 6 weeks to complete.

During the test and evaluation part first, a test plan and test design are created. Then the test is executed using the white-box testing and a test report is generated. This will take about a week.

3. Planning.

In the planning stage, the entire project is divided into several small tasks (milestones), by applying a work breakdown structure (WBS). The entire project will take about three months to complete. The Gantt chart provided below shows the work breakdown for this project.

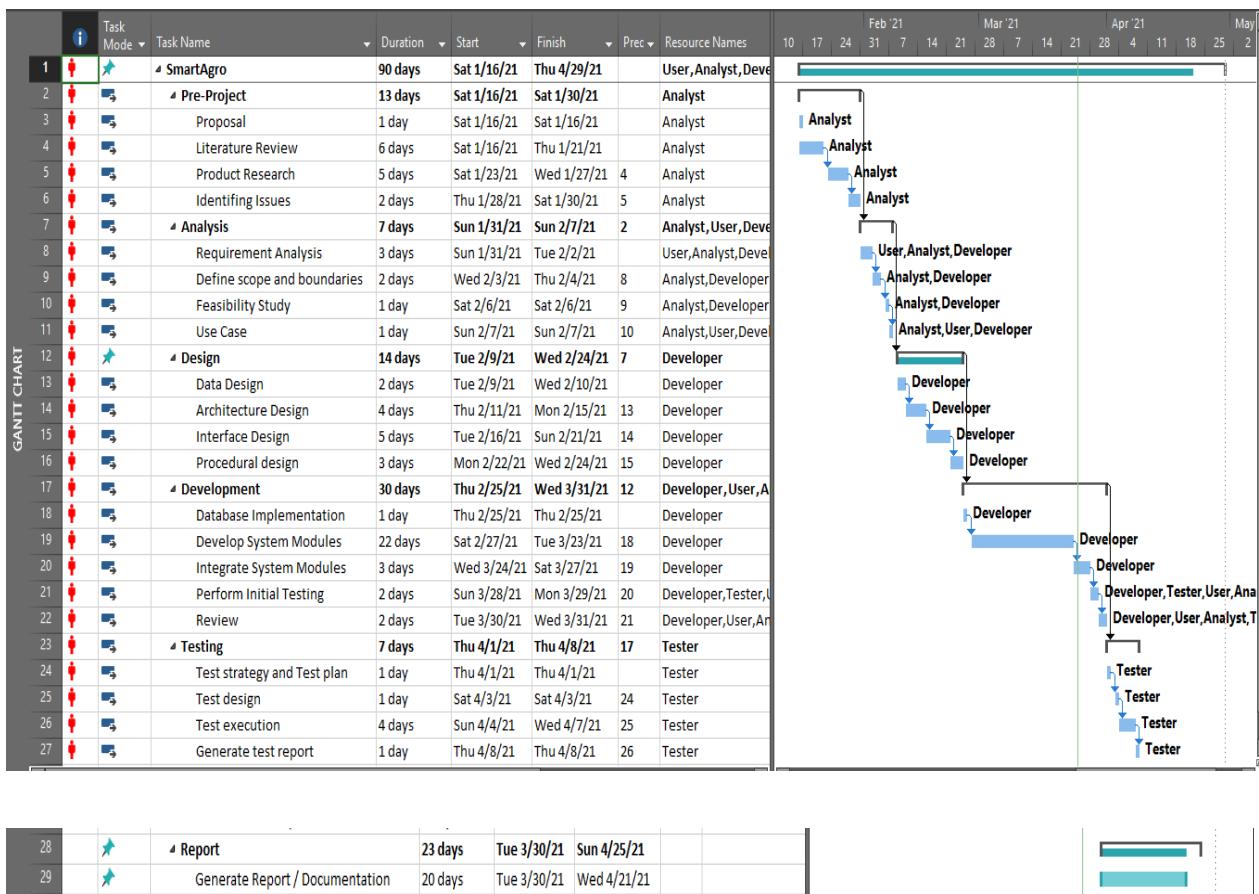


Figure 121: Gantt chart

4. Legal, Social, Ethical, and Professional Issues and Consideration.

While developing software or application it is necessary to consider Legal, Social, Ethical, and Professional Issues. These issues include data security, presentation of incorrect data, misusing of user data, etc. Farmers should not be presented with the wrong data.

19.2. Appendix B – Breakdown of cost-benefit analysis

A breakdown of the cost-benefit analysis is given below:

No.	Cost Area	1 st year (\$)	2 nd year (\$)	3 rd year (\$)	4 th year (\$)	5 th year (\$)
1	Hardware	972.67	-	-	-	-
2	Software	348.99	-	-	-	-
3	Domain & Hosting	99.95	80.99	80.99	80.99	80.99
4	Additional cost of development	306.78	-	-	-	-
5	Employee Salary	2000	1500	2200	2500	3600
6	Office Rent	3200	3200	3200	3200	4000
7	Office utility	578.6	592.3	541.8	570.0	616.4
8	Office Internet	172.5	172.5	172.5	172.5	172.5
9	Training	160	-	56	56	110
10	Government taxes	200	200	200	200	200
11	Delivery vehicle cost	540	960	1370	1500	1800
12	Maintenance	100	108	120	134	150
Total		8679.49	6813.79	7942.29	8413.49	10729.89

Cost-benefit analysis:

The approximate revenue of five years are shown in the table below:

	1 st year (\$)	2 nd year (\$)	3 rd year (\$)	4 th year (\$)	5 th year (\$)

Cost	8679	6814	7942	8413	10730
Benefit	2610	6964	9728	11179	14690
Revenue	- \$6069	\$150	\$1786	\$2766	\$3960

Calculate net present value (NPV).

The net present value (NPV) calculation is shown below:

First, the present value (PV) of the cash inflow of each year will be found.

Formula for finding the present value of revenue: $PV = FV / (1+r)^n$

Where, FV = future value, PV = present value, r=cost of capital, n=year number.

2nd year: $PV = 150 / (1.10)^3 = 112.7$

3rd year: $PV = 1786 / (1.10)^3 = 1341.85$

4th year: $PV = 2766 / (1.10)^4 = 2078.14$

5th year: $PV = 3960 / (1.10)^5 = 2975.2$

$$\text{NPV} = -6069 + 112.7 + 1341.85 + 2078.14 + 2975.2 = 438.89$$

By calculating the net present value (NPV) for five years a positive value of **\$438.89** is found. It suggests that the combined PV of all cash inflows exceeds the PV of cash outflow by \$438.89. This project is an acceptable one since it adds \$438.89 to the value of the company. Therefore it can be concluded that this is a good investment.

19.3. Appendix C – Requirement analysis

19.3.1. Description of each interview

Interview session with farmers:

Q: Would you mind introducing yourself?

Manik: My name is Shri Ashok Banker, and I'd like to introduce myself. I live in a remote Madhya Pradesh village. I am 55 years old and have finished 5th-grade school. We are two brothers who own 40 hectares of land between us. Farming is our primary source of income, and our whole family is reliant on it.

Q: What precautions did you take to keep insect infestations under control?

Habibur Rahman: Since cotton and chili were grown in this region, the infestation was more serious. Nevertheless, I was still aware of it, and timely spraying with Hesitation, Permethrin, Dithane-M-45, and Copper-oxychloride effectively contained almost all pests.

Q: What is the current market condition of the products that you produce?

Habibur Rahman: The current market condition is very fragile. Product prices are very low and it's difficult if live a decent life and educate our children.

Q: Why do you think you are not able to get the proper value of products?

Habibur Rahman: Look we usually sell our products to the local middlemen and they do no give us the proper value of products that we are expected to get. On the other hand, they are selling products at a high price.

19.3.2. Requirement analysis summary

Questionaries' session.

User type	Question	Answer
Farmer	What is the current market condition of the products that you produce?	
	Why do you think you are not able to get the proper value of your products?	A. Middle mane ()
	What are the problems you are facing in the crop production process?	
	According to your opinion, what can be improved about the farming business?	
	What changes in the market can be beneficial to you and other farmers?	

19.3.3. Requirement catalog

Chat system:

Source:	Sign Off:	Priority:	Requirement ID:
Admin	All Users	Should have	R13
Functional requirement: Chat system.			
Users will be able to communicate between them using a chat system.			
Non-Functional requirements: A user must not be able to see messages of other users.			
Criteria	Target value	Acceptable range	
Limit per day	4000	5000	
Comments: Users must be able to communicate efficiently.			

Weather update:

Source:	Sign Off:	Priority:	Requirement ID:
Admin	All Users	Must have	R14
Functional requirement: Real-time weather update			
The user will be able to get real-time weather updates.			
Non-Functional requirements: Weather updated should be accurate.			
Criteria:	Target value	Acceptable range	
Limit per day	600	1000	

Comments: The user should be able to get a weather update.

Manage products:

Source:	Sign Off:	Priority:	Requirement ID:
Admin	All Farmers	Should have	R14
Functional requirement: Manage farmers. Farmers should be able to manage products.			
Non-Functional requirements: Farmers should be able to manage products.			
Criteria		Target value	Acceptable range
Limit per day		300	500
Comments: Farmers should be able to manage products.			

19.4. Appendix D – Use case descriptions

19.5. Appendix F – Screenshots of the final product (feature by feature)

All the screenshot of the features are given below:

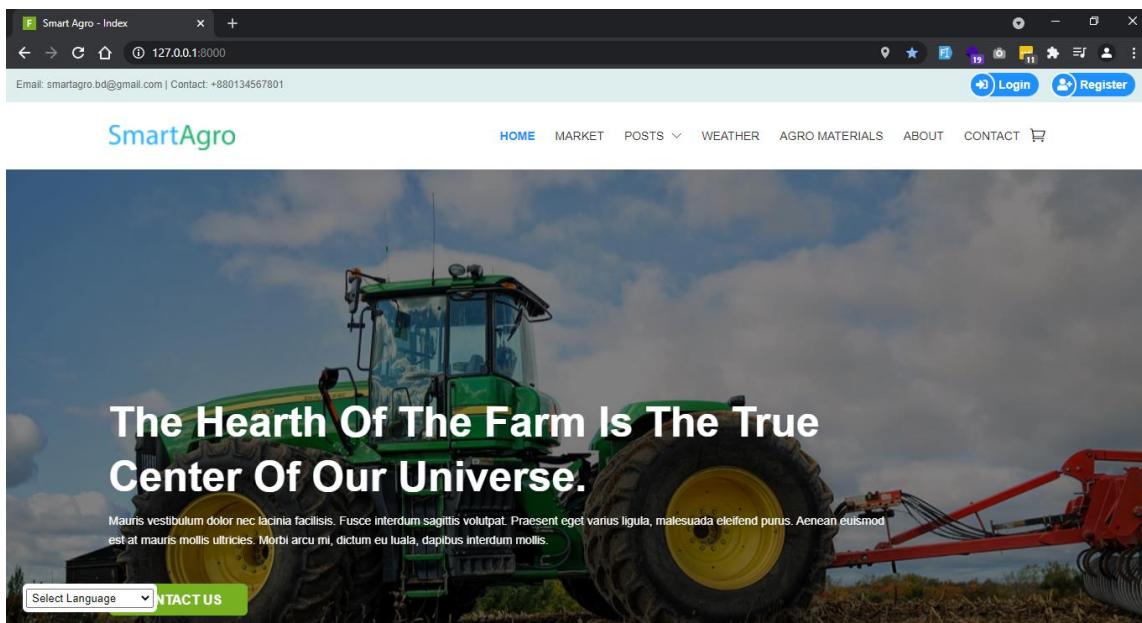


Figure 122: Home page.

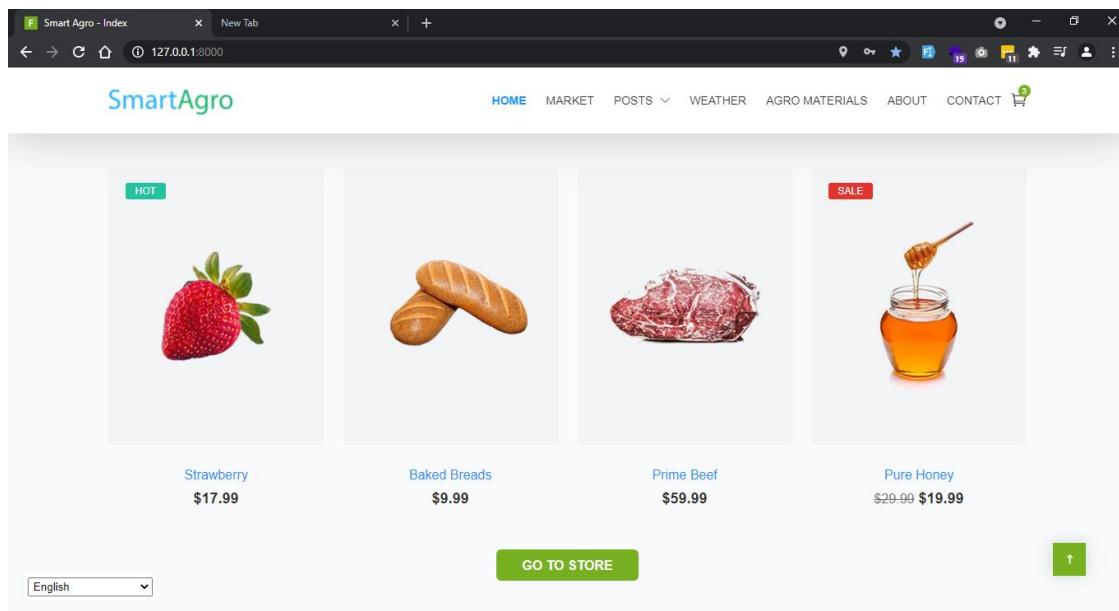


Figure 123: Product view home page.

SmartAgro - Market x +

127.0.0.1:8000/market

SmartAgro

HOME MARKET POSTS WEATHER AGRO MATERIALS ABOUT CONTACT Cart

Showing 1–14 of 14 results

Catagories

All

- Crop (3)
 - Sugarcane (1)
 - Rice (1)
 - Wheat (0)
 - Corn (1)
- Fruit (7)
 - Mango (2)
 - Lychee (3)
 - Jackfruit (1)
 - Banana (0)
 - Vegetables (0)
 - Potato (0)
 - Tomato (0)

Search: Product name, category, location Clear

Guava	Mango	Indian cow
40 TK / kg Stock: 196 kg	56 TK / kg Stock: 114 kg	285000 TK / piece Stock: 1 piece

Select Language ▼

Figure 124: Market place.

Smart Agro - Blogs x +

127.0.0.1:8000/blogs

SmartAgro

HOME MARKET POSTS WEATHER AGRO MATERIALS ABOUT CONTACT Cart

BLOG

Home blog

Post on 05-01-2021 / Nahid Ferdous

Requirements for zinc rich rice.

Search

Select Language ▼

Categories

All

Figure 125: Blog page.

Email: smartagro.bd@gmail.com | Contact: +880134567891 

SmartAgro

HOME MARKET POSTS ▾ WEATHER AGRO MATERIALS ABOUT CONTACT 



BLOG

 Home  blog 

Post on 05-01-2021 / Nahid Ferdous

Requirements for zinc rich rice.



Requirements for zinc rich rice

Although Bangladesh has succeeded in achieving food security, there is a huge deficit in nutrition security. To ensure nutritional security, the government has continued its efforts to fill the deficit by feeding vitamin A tablets under its national nutrition program. In addition to vitamins, zinc is one of the most important micronutrients in the human body.

The objective of the HarvestPlus program in Bangladesh is to innovate, release high yielding rice varieties rich in zinc or zinc, increase the acceptance of these varieties among small and marginal farmers and eliminate zinc deficiency in women and children by encouraging them to eat zinc rich rice.

The need for zinc in the human body

- ✓ Boys and girls are not shortened by eating zinc rich foods.
- ✓ Children develop physically and intellectually. Hunger relieves depression.
- ✓ Increases immunity
- ✓ কিশোরী মেয়ে ও পর্যবেক্ষণ মাঝের জিনেকের অভাব থলে শারীরিক দুর্বলতা দেখা দেখে গর্ভের বাচ্চার সামৃদ্ধ ক্ষতিগ্রস্ত হয়।
- ✓ পৌষ্ণিক শিশুদের ৩-৫ মিলিলিট্র ও মহিলাদের ৮-৯ মিলিলিট্র জিনেকের প্রয়োজন।

মানব দেহের একটি অত্যাৰম্ভীকৃত অনুপূর্ণি হল জিনেক। বালাদেশে খেচ বছরের কম বয়সে শক্তকরা ৪৪ ভাগ শিশু এবং ৫১ ভাগ মাইলতা জিনেকের অভাবে দুগ্ধে। ১৫-১৯ বছরের শক্তকরা ৪৪ ভাগ মাঝের এবং অভাবে থাপ্টি দেখে যায়। এর সমান সুতৰে নিয়ে (বায়োফার্মেসিন এবং মাহাত্ম্য) আমদের প্রধান বাদা ভাতে এর মধ্যে অধিক পরিমাণে জিনেক সম্পূর্ণ করে তাঁর নতুন জীবনে ধৰ্ম উত্তৃত্ব করা হয়েছে।

Zinc rice contains up to 24 mg of zinc per kg, which can meet up to 80% of your body's zinc needs. Note that despite the high zinc content, the taste and color of this rice does not change.

Zinc rice variety in Aman season

Brie paddy 72	Brie paddy 72
This rice ripens in just 100 days, so rabi crops can be cultivated in advance.	Lifespan is 125-130 days
Yield per hectare is 4.4-5 tons	Yield per hectare is 5.6-6 tons
The shape of the rice is long, slender and white in color, much like Brie.	The shape of the rice is long, thick and white in color.
Rice contains an average of 19.7 mg of zinc and 9 percent protein per kg.	Rice contains 22.6 mg of zinc per kg.
Paddy can also be cultivated in other seasons of the year.	The cultivation of this paddy requires less amount of urea fertilizer than the conventional variety.

Zinc rice varieties in the Boro season

Brie rice 74	Brie rice 74
Lifespan is 145-150 days	Lifespan is 148 days.
Yield per hectare is 7.5-6 tons.	Yield per hectare is 6.1-6.3 tons.
Rice is medium in size, thick and white in color.	Rice is medium in size, thick and white in color.
Rice contains 24 mg of zinc per kg.	Rice contains 24.2 mg of zinc and 8.3 percent protein per kg.
Cultivation method is similar to other Utsi Boro paddy. This variety is resistant to medium quality blast disease.	

Source: Harvest Plus, Bangladesh

Figure 126: Frontend read posts.

SmartAgro - Articles x

127.0.0.1:8000/articles/farming-practice

SmartAgro

HOME MARKET POSTS WEATHER AGRO MATERIALS ABOUT CONTACT

Farming Practices To Preserve Land & Water

Search

Categories

All

- Farming practice (8)
- Crop (2)
- Crop Care (0)
- Improved Rice Cultivation (0)
- Crop Storage (0)
- Crop Health & Nutrition (0)
- Planting (4)
- Beef Cattle Farming (0)
- Poultry Farming (0)
- Goat Farming (0)
- Soil Improvement Techniques (0)

Select Language



Farming practice for **MOP or potash fertilizer work, deficiency or deficiency symp...**
MOP or potash fertilizer work, deficiency or deficiency symptoms, harmful aspects of overuse MOP or muriate of potash contains 50% potassium. MOP fertilizer pro...

Farming practice for **Harmful aspects of urea fertilizer work, deficiency or sympt...**
The work of urea fertilizerUrea is a nitrogen-rich chemical fertilizer that is widely used in crop lands. Urea fertilizer contains 46% nitrogen. Urea fertilizer...

Figure 127: Farming practice articles page.

SmartAgro - Weather x

127.0.0.1:8000/weather

SmartAgro

HOME MARKET POSTS WEATHER AGRO MATERIALS ABOUT CONTACT

Weather Update

10:34:38, PM - 01 May 2021, Saturday

Your Location: Pantha Path, Dhaka, Bangladesh, 1205

Pantha Path, Dhanmondi R/A, BD

Location details: Building 4, Eastern Panthachaya, 152/2/G/1-2, Pantha Path, Dhanmondi R/A, Lalmatia, Dhaka, Dhaka District, Dhaka Division, 1205, Bangladesh

31°C Haze

Feels Like: 35.35m/s S
Wind speed: 2.06m/s S
Humidity: 62%
Pressure: 1009hPa

Today 8 day forecast

Sunrise: 05:24 am, Sunset: 06:26 pm
Dew Point: 22.86°C
Select Language: English: 4000
Wind speed: 2.06m/s S

Search

City Name: Eg: dhaka ...

Map Satellite



Figure 128: Weather update page.

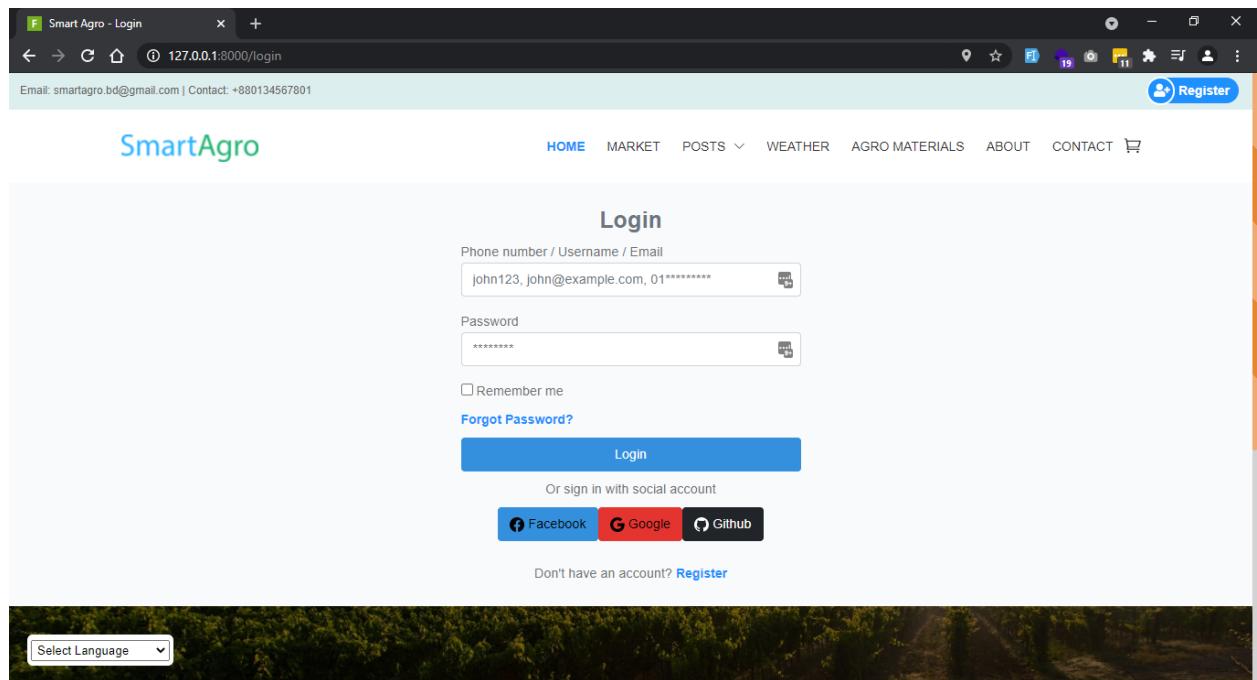
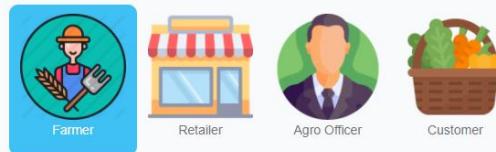


Figure 129: Login page.

Register

Who are you?



Fill the form

First Name (*) <input type="text" value="John"/>	Last Name (*) <input type="text" value="Doe"/>
Username (*) <input type="text" value="john123"/>	Email (*) <input type="text" value="example@gmail.com"/>
Password (*) <input type="password" value="*****"/>	Confirm Password (*) <input type="password" value="*****"/>
Mobile Number (*) <input type="text" value="01*****"/>	Postal Code <input type="text" value="1205"/>

Register

By creating an account you agree to our [terms of service](#)

Already have an account? [Login](#)

Lorem ipsum dolor sit amet, consecetur adipiscing elit. In act honcus risus atinier Pellentesque risus.

 120 Raymond Rd, New York
 info.deercreative@gmail.com
 +84 223 9000

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Return
Payments
Guide
News

Policies
FAQs
Careers
Partners
Standard
Brands

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18 Aug 2018
Beef retail prices hit a record
18 Aug 2018

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Select Language 

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About Produce Practice Products News Contact

Figure 130: Registration page.

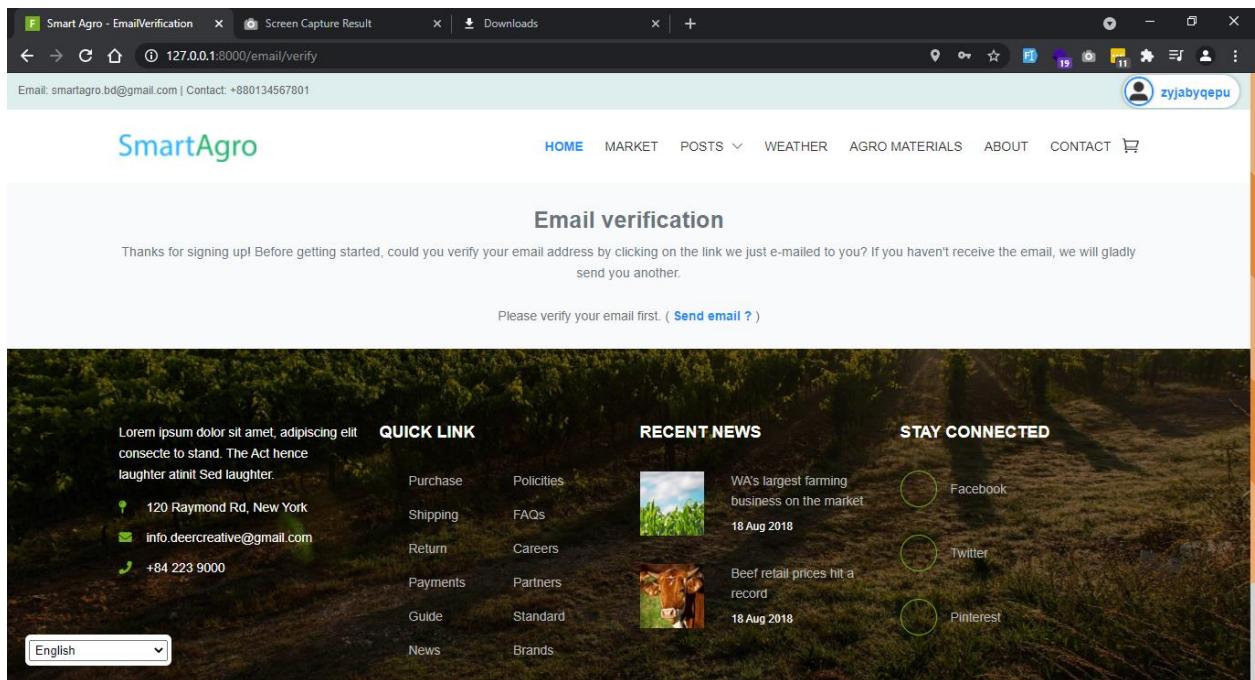


Figure 131: Email verification page.

The screenshot shows a web browser window with the URL 127.0.0.1:8000/dashboard/@admin123/profile. The page title is "Smart Agro - Index". The left sidebar contains a navigation menu with icons and labels: Dashboard, Manage post, Inventory, Manage Users, Chat, People, Help, Notifications, and Settings. The main content area shows a profile for "Admin Nahid" (developer, super admin,) located in New York, USA. The profile includes a "Edit Profile" button, a "Change Password" button, and a "Delete Account" button. Below the profile, there is a "Profile Info" section showing the email "admin@gmail.com". Under "Product List:", there are two entries: "Mango" (Seller: Admin Nahid) with a regular price of 35 Tk, retail price of 30 Tk, and stock of 1000 kg; and "Bombay Lychee" (Seller: Admin Nahid) with a regular price of 60 Tk, retail price of 50 Tk, and stock of 1000 kg. Both products have small images next to their names. The top right of the main content area shows a user profile icon with the name "S" and a gear icon for settings.

Figure 132: logged-in user profile.

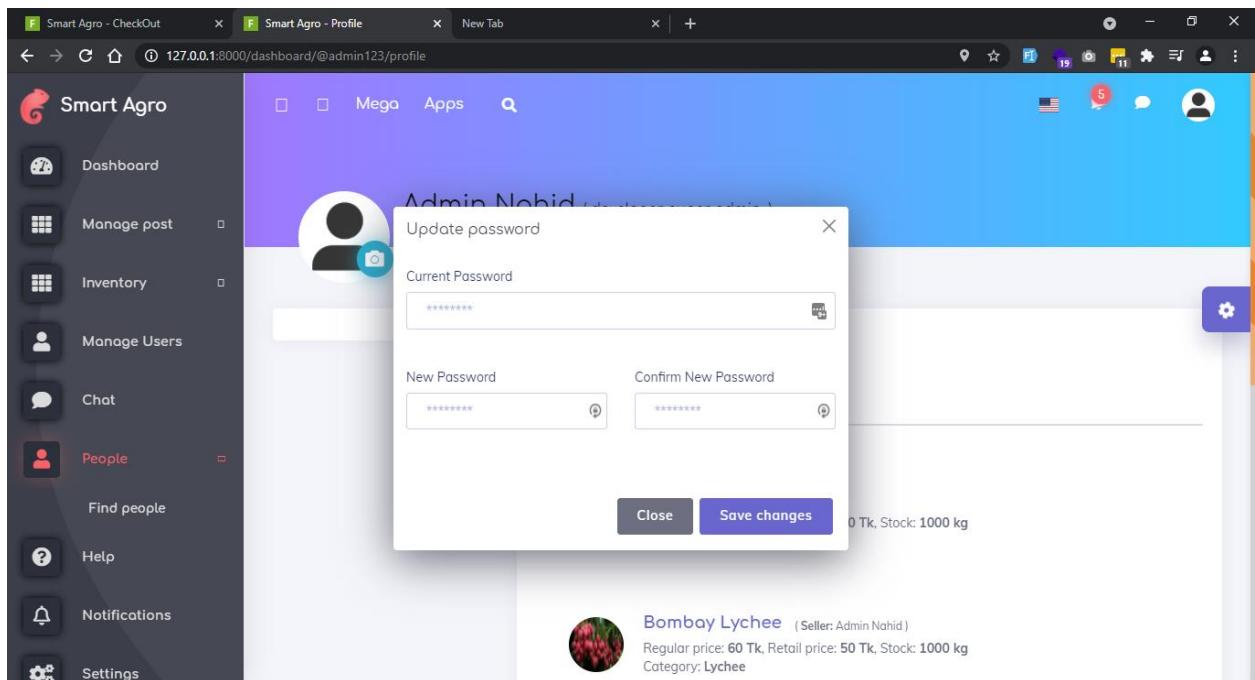


Figure 133: Update password.

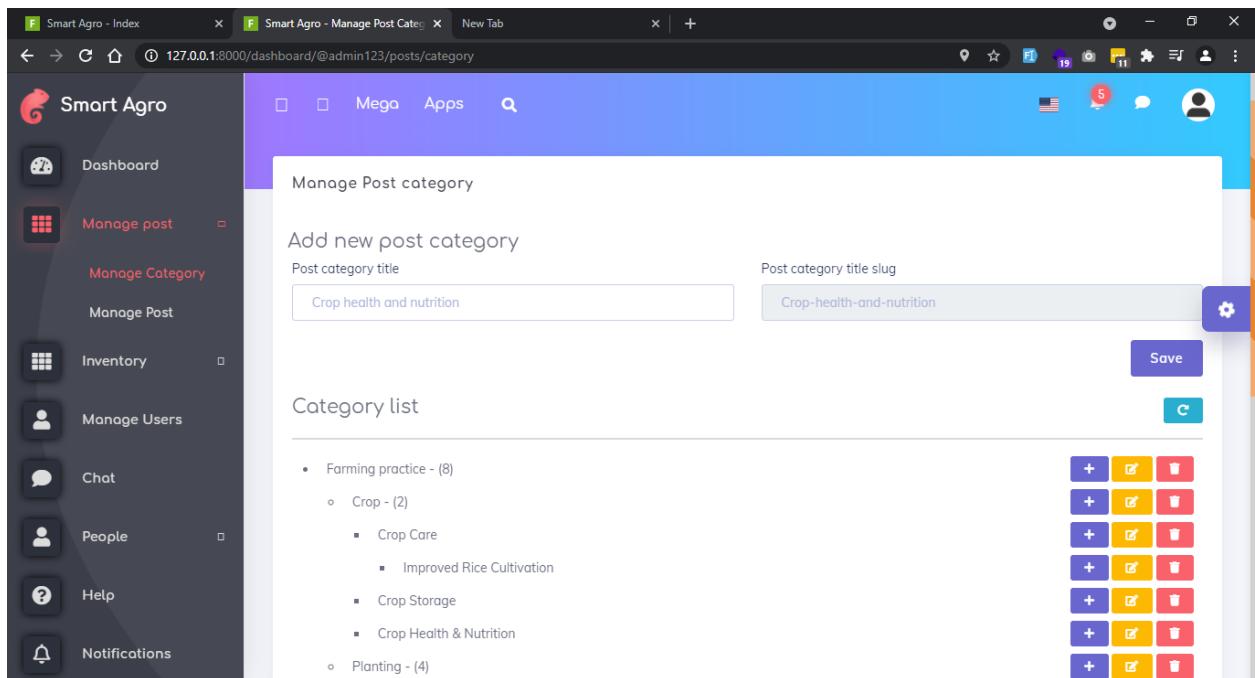


Figure 134: Manage post category.

The screenshot shows the 'Manage Posts' section of the Smart Agro application. The left sidebar has a dark theme with icons for Dashboard, Manage post (selected), Manage Category, Manage Post, Inventory, Manage Users, Chat, People, Help, and Notifications. The main area has a light blue header with 'Manage Posts' and a navigation bar with 'Dashboard - Layouts - Manage Posts'. Below is a table with two rows of posts.

Post Title	Category	Actions
5 Agritech startups enabling farmers to go all digital	POST TYPE: NEWS, STATUS: ACTIVE	Read More
MOP or potash fertilizer work, deficiency symptoms, harmful aspects of...	POST TYPE: FARMING-PRACTICE, STATUS: ACTIVE	Read More

Each row includes a small image, a detailed description, and edit/delete buttons.

Figure 135: Manage post.

The screenshot shows the 'Read Posts' section of the Smart Agro application. The left sidebar is identical to Figure 135. The main area shows a single post detail page for '5 Agritech startups enabling farmers to go all digital'.

News

5 Agritech startups enabling farmers to go all digital

Published at: 05-01-2021
Status Active
Author: Admin Nahid
Post type: news
Categories: Modern Technology |

Sustainable agricultural technology can transform the global food landscape. Agritech startup innovations are addressing some of the key challenges connected to agriculture and food production. Many agritech startups are working on various technologies that not only create a viable business but will also help improve farm income. The agriculture sector has come up as one of the fastest booming sectors. Infusion of technologies such as machine...

Figure 136: Read post page - dashboard.

Smart Agro

Add post

Post title:

Post title slug:

Author: Admin Nahid

Status: Active Inactive

Post type:

Select category:

- Farming practice
 - Crop
 - Crop Care
 - Improved Rice Cultivation
 - Crop Storage
 - Crop Health & Nutrition
 - Planting

Description:

Save Close

Figure 137: Add post form.

Smart Agro

Manage Product Category

Manage Product category

Add new product category

Product category title:

Product category title slug:

Save

Category list

• Crop	+		
◦ Sugarcane - (1)			
◦ Rice - (1)			
◦ Wheat			
◦ Corn - (1)			
• Fruit - (1)			

Figure 138: Manage product category.

The screenshot shows the 'Manage Product' page of the Smart Agro application. On the left, a dark sidebar menu includes 'Dashboard', 'Manage post', 'Inventory', 'Manage Category', 'Manage Product' (which is selected), 'Manage Orders', 'Manage Users', 'Chat', 'People', and 'Help'. The main content area has a blue header 'Manage Product' and a sub-header 'Dashboard - Layouts - Manage Product'. It features a search bar with 'Add Products' and 'Search' buttons. A table lists three products: 'Guava' (Seller: Rofiqui Haque), 'Mango' (Seller: Khwaja Salimullah), and 'Indian cow' (Seller: Rofiqui Haque). Each product row includes an 'Action' button.

Figure 139: Manage product page.

The screenshot shows the 'Market' page of the SmartAgro application. At the top, there's a navigation bar with links for HOME, MARKET, POSTS, WEATHER, AGRO MATERIALS, ABOUT, and CONTACT. A shopping cart icon indicates 3 items. The main content area is titled 'Cart' and displays a table of items:

#	Image	Item	Total stock	Quantity	Price	Action
0		Mango	114 kg	2 kg	+ - BDT 56.00	X
1		Guava	196 kg	1 kg	+ - BDT 40.00	X
2		Corn	996 piece	2 piece	+ - BDT 30.00	X
Total Amount				1	BDT 56.00	

Below the cart, there are sections for 'Price' (dropdown: English) and products: Sugarcane (50 TK / piece, Stock: 1000 piece), Corn (25 TK / piece, Stock: 996 piece), and Rice (50 TK / lbs, Stock: 4 lbs). A green 'Checkout' button is located at the bottom right of the cart area.

Figure 140: Add to cart.

SmartAgro

Checkout

#	Image	Item	Quantity	Price
0		Mango	2 kg	BDT 112.00
1		Guava	2 kg	BDT 80.00
2		Corn	2 piece	BDT 60.00
Total Amount			BDT 252.00	

Payment method
 Cash on delivery

Address
 Road 32, Dhanmondi Dhaka , Dhaka , Bangladesh

[Add new address](#)

[Confirm Order](#)

Figure 141: Checkout page.

Smart Agro

Manage Order

Manage Orders

Search Options
 Product name, category name, seller name, customer name, order id
 name, email or mobile number ...

Status

#	Product - seller	Total price	Status	Customer	Address	Actions
#0-00001	4 - Products	Tk 18616	pending	jahid_re	Road 32, Dhanmondi Dhaka	

Showing (1 - 1) from 1 orders

Current page: 1, Total page: 1

Figure 142: Manage orders page.

The screenshot shows the 'Manage Users' page of the Smart Agro application. On the left is a dark sidebar with icons for Inventory, Manage Users (selected), Chat, People, Help, Notifications, and Settings. The main area has a purple header with 'Smart Agro' and navigation tabs for Inventory, Manage Users, Apps, and a search bar. Below is a 'Manage Users' section with a 'Search Options' panel containing fields for Name, Email or Mobile number, Role (All), Status (All), and a 'Clear' button. A red button labeled 'Show removed user' is visible. A table lists four users:

#	Name	Username	Email	Mobile	Status	Role	Action
1	Mary Norton	zyjabyqepu	nosymnojy@mailinator.com	01934759838	active	farmer,	
2	Rofiq Farmer	rofiq_farmer	rofiqfarmer@gmail.com	01793845734	active	farmer,	
3	Khwaja Salimullah	salimullah_far	salimullah@gmail.com	01819945156	active	farmer,	
4	Nawab	Syed_far	sayed@gmail.com	01819905156	active	farmer,	

Figure 143: Manage user's page.

The screenshot shows the 'View Profile' page for a user named Khwaja Salimullah. The sidebar and header are identical to Figure 143. The main content area displays the user's profile picture, name (Khwaja Salimullah, farmer,), location (bangladesh , dinajpur), and a 'Message' button. Below is a 'Profile Info' section with details: Email: salimullah@gmail.com, Farmer type: Vegetables, Field area: 8, acres. A 'Product List:' section shows one item: Mango (Seller: Khwaja Salimullah). It includes a thumbnail of a mango, regular price (56 Tk), retail price (48 Tk), stock (114 kg), and category (Mango). At the bottom, it says 'Showing 1 of 1 from 1 products' and 'Current page: 1, Total page: 1'.

Figure 144: View user profile.

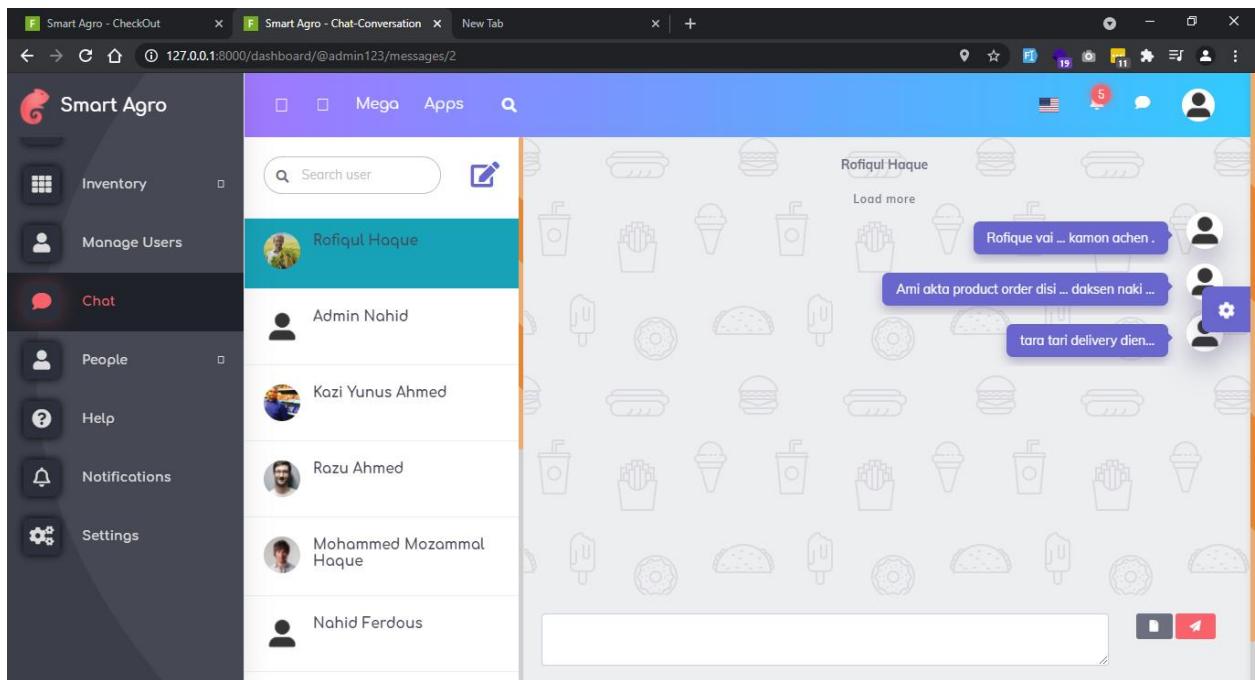


Figure 145: Chat system.

A screenshot of the 'Find People' feature in the Smart Agro dashboard. The sidebar shows 'Find people' selected under the 'People' category. The main area has a search bar and a table with columns: #, Name, Username, Email, Role, and Actions. The table contains four rows of data:

#	Name	Username	Email	Role	Actions
1	Khwaja Salimullah	salimullah_far	salimullah@gmail.com	farmer,	
2	Nawaab Syed Shamsul Huda	Syed_far	sayed@gmail.com	farmer,	
3	Customer Three	customer3	customer3@gmail.com	customer,	
4	Rupali Akhter	rupali_cu	rupali@gmail.com	customer,	

Figure 146: Find people.

19.6. Appendix G – Testing

- Unit test UT004

Test Case ID: UT001		Test Type: Unit	Tester: Nahid Ferdous
Test Title		Post image upload validation.	
Test Case Description		A post can have maximum 4 images.	
Execution steps		1. Upload images for a post.	
Test Browser: Chrome Browser		Test device OS: Windows	
SL.	Actions	Expected Result	Actual result
1	Upload image for a post	Error message is shown that tells a post can have maximum 4 images.	The result is as expected.

The screenshot shows a form for creating a post. The fields include:

- Post title
- Post title slug
- Author: Admin Nahid
- Status: Active (radio button selected)
- Post type: Select
- Image: An input field with a "Choose file..." button and a "Browse" button. This field is highlighted with a red box.
- Select category: A dropdown menu showing a tree structure:
 - Farming practice
 - Crop
 - Crop Care
 - Improved Rice Cultivation
 - Crop Storage
 - Crop Health & Nutrition
 - Planting
- Description: A rich text editor with a toolbar at the top.

At the bottom right are "Save" and "Close" buttons.

Figure 147: Browse button is clicked.

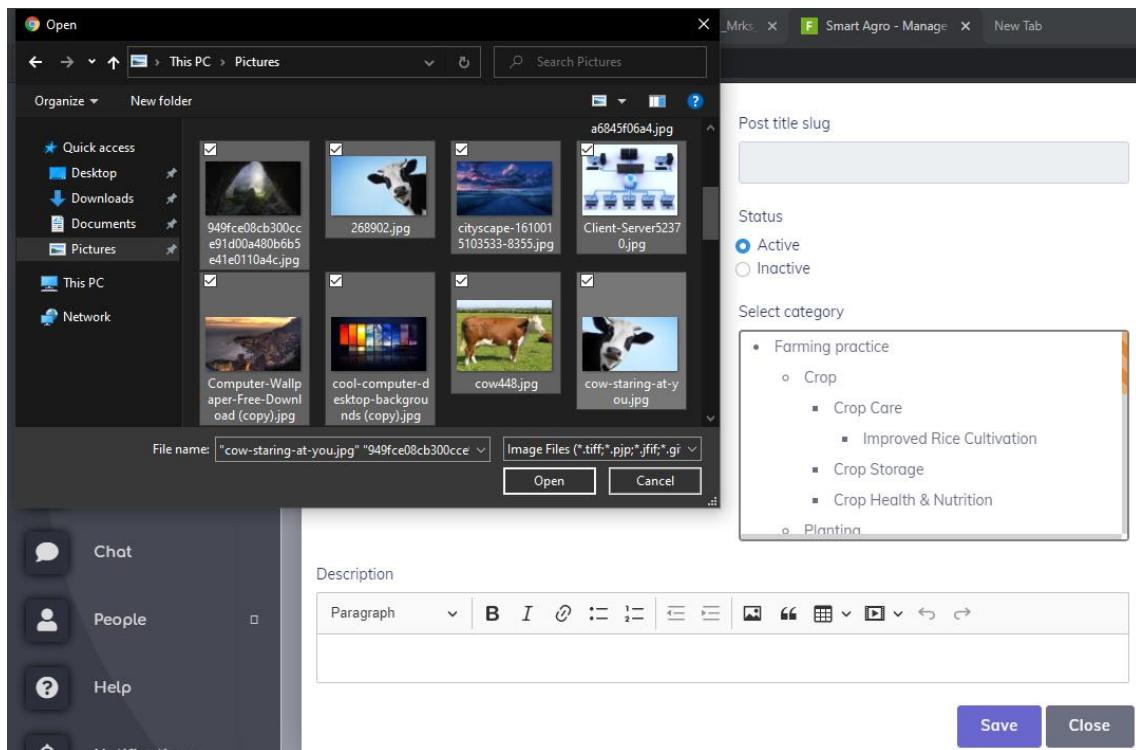


Figure 148: Selecting image.

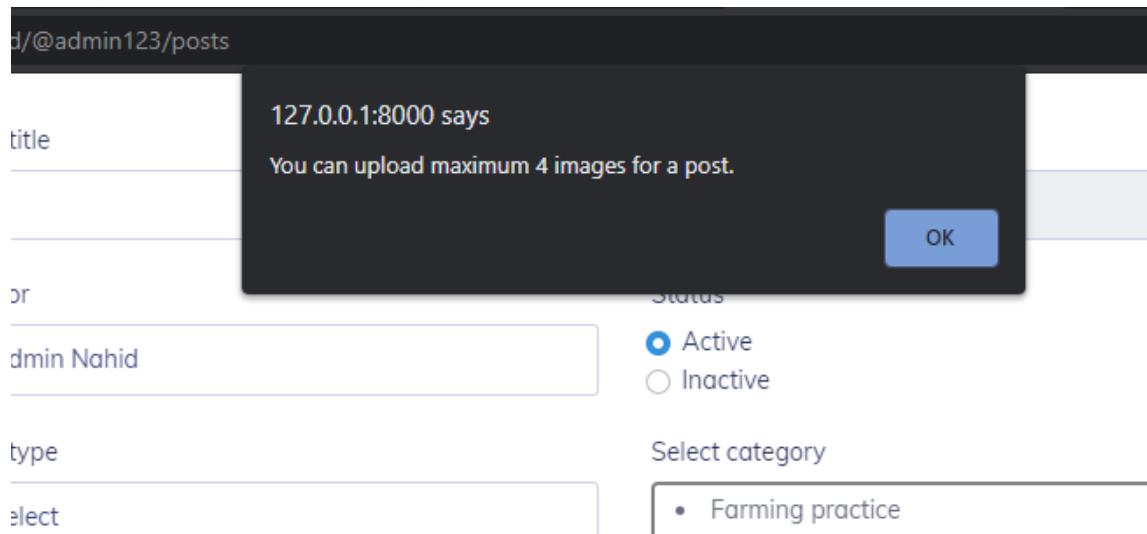


Figure 149: Error message is shown. Maximum 4 images.

- **Unit test UT005**

Test Case ID:	UT001	Test Type:	Unit	Tester:	Nahid Ferdous
Test Title	Product image upload validation.				
Test Case Description	A product can have maximum 4 images.				
Execution steps	1. Upload images for a product.				
Test Browser:	Chrome Browser	Test device OS:	Windows		
SL.	Actions	Expected Result	Actual result		
1	Upload image for a product.	Error message is shown that tells a product can have maximum 4 images	The result is as expected.		

- **Module test MT004**

Test Case ID:	MT004	Test Type:	Module	Tester:	Nahid Ferdous
Test Title	Search user.				
Test Case Description	Users should be able to search other users.				
Execution steps	1. Search users using the search field.				
Test Browser:	Chrome Browser	Test device OS:	Windows		
SL.	Actions	Expected Result	Actual result		
1	Search users using the search field.	Search user results shown.	The result is as expected.		

Search Options

Name, Email or Mobile number

Role

Status

Clear

Show removed user

#	Name	Username	Email	Mobile	Status	Role	Actions
	Mary Norton	zyjabyqepu	nosymynojo@mailinator.com	01934759838	active	farmer,	
	Rofiq Farmer	rofiq_farmer	rofiqfarmer@gmail.com	01793845734	active	farmer,	
	Khwaja Salimullah	salimullah_far	salimullah@gmail.com	01819945156	active	farmer,	
	Nawaab Syed Shamsul Huda	Syed_far	sayed@gmail.com	01819905156	active	farmer,	

Figure 150: Searching user using their role.

Manage Users

Search Options

Name, Email or Mobile number

Role

Status

Clear

Show removed user

#	Name	Username	Email	Mobile	Status	Role	Actions
	Khwaja Salimullah	salimullah_far	salimullah@gmail.com	01819945156	active	farmer,	

Showing (1 - 1) from 1 users

Current page: 1, Total page: 1

Figure 151: Searching users using their name and role.

- **Module test MT005**

Test Case ID: MT004		Test Type: Module	Tester: Nahid Ferdous
Test Title	Search products.		
Test Case Description	Users should be able to search products they want to buy.		
Execution steps	1. Search users using the search field.		
Test Browser:	Chrome Browser	Test device OS:	Windows
SL.	Actions	Expected Result	Actual result
1	Type product name in the search fields	Searched products are shown.	The result is as expected.

The screenshot shows the SmartAgro website interface. At the top, there's a navigation bar with links for HOME, MARKET, POSTS, WEATHER, AGRO MATERIALS, ABOUT, CONTACT, and a shopping cart icon. Below the navigation, there's a search bar with the query 'mango'. To the left, a sidebar titled 'Catagories' lists categories like All, Crop (3), and Fruit (7). Under Crop, there are sub-categories: Sugarcane (1), Rice (1), Wheat (0), and Corn (1). Under Fruit, there are sub-categories: Mango (2), Lychee (3), Jackfruit (1), and Banana (0). Under Vegetables, there are sub-categories: Potato (0), Tomato (0), and Cabbage (0). A dropdown menu for language is also visible. The main content area displays search results for mangoes. It shows two items: one labeled 'Mango' with a price of 48 TK / kg and stock of 114 kg, and another labeled 'Mango' with a price of 30 TK / kg and stock of 1000 kg. Each item has a small image, a 'View' button, and a 'Buy' button.

Figure 152: Searching for products.

Catagories

- All
- [Crop \(3\)](#)
 - [Sugarcane \(1\)](#)
 - [Rice \(1\)](#)
 - [Wheat \(0\)](#)
 - [Corn \(1\)](#)
- [Fruit \(7\)](#)
 - [Mango \(2\)](#)
 - [Lychee \(3\)](#)
 - [Jackfruit \(1\)](#)
 - [Banana \(0\)](#)
 - [Vegetables \(0\)](#)
 - [Potato \(0\)](#)
 - [Tomato \(0\)](#)

Search: Product name, category, location [Clear](#)

Category: Crop



Sugarcane
50 TK / piece
Stock: 1000 piece

Corn
25 TK / piece
Stock: 996 piece

Rice
50 TK / lbs
Stock: 4 lbs

Language [▼](#)

[Up](#)

Figure 153: Searching products by category.