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POLITECNICO DI MILANO

RASD: Requirement Analysis and Specification Document

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1 Introduction

Data-driven Predictive Farming, also known as *DREAM*, is a project presented by UNDP India and Healthsites initiative, promoted by Telangana's government. The aim of the project is to enhance the farm system and the entire food supply chain with an IT supporting application. This arises from modern challenges like climate change and the foreseen population growth that have underlined the critical issues of the modern system making necessary a complete overhaul.

1.1 Purpose

DREAM aims to support work categories involved into the farming industry by providing them relevant and up-to-date data about the farm activity's performance. The main stakeholders are: Telangana's policy makers, farmers and agronomists. The goal is to develop a data-driven application with the help of IT partners. Telangana's state already collect important data concerning wheather forecast, these data are publicly available with a live rainfall map on the official government website. Other data can be collected through humidity sensors deployed all over the territory and through the water irrigation system.

Agriculture has a main role in India's economy, more than half of the population depends on it and about a fifth is below the poverty line. Furthermore, as a significant increment in population is expected by 2050 (*UN's* esteem), food demand is going to significantly increase. Telangana needs an efficient application to increase the general productivity of the farm system.

The user base is expected to include a large part of Telangana's population, bringing together people with different knowledge backgrounds, such as people directly working in the agriculture field up to political figures.

1.1.1 Goals

Shared goals

1. (G1) Make crops weather-resilient across the State

The aim of every stakeholder of the project is to grow more resilient crops to raise the productivity. This means more product to sell for the farmers as well as, for the policy makers and agronomists, more supply on the market to satisfy the increasing demand of the population.

2. **(G2) Reach out to farmers in need of help**

Farmers that struggle with their cultivation wish to be helped and turn around their business in a positive way, since their income depend on that. At the same time, given the forseen food supply demand, policy makers and agronomists strive for reaching the maximum potential of every suppliers.

Telangana's policy makers

1. **(G3) Identification of well-performing farmers**

Main goal of the policy makers is to identify farmers that are resilient to meteorological adverse events. This can be done comparing the productivity ratio defined as the produced amount per product in adverse condition over the amount in standard conditions. This farmers will receive special incentives and will be asked to help other farmers with useful practices.

2. **(G4) Identification of bad-performing farmers**

Identify farmers that are performing badly in order to seek the help for them to get back on track. In fact, they are the ones that need to be helped by the well-performing farmers.

3. **(G5) Visualize the results of steering initiatives**

Visualize and evaluate the results produced by the steering initiatives from agronomists and good farmers in order to assess which are resulting useful and actually improving the food production system, so that those practices can be applied on a larger scale.

Farmers

1. **(G6) Visualize relevant data for the business**

Visualize important data like weather forecast and personalized suggestion about specific crops or fertilizers. All data are based on location and type of production.

2. **(G7) Keep track of the production**

Insert data about their production to identify trends of their own doings, especially bad ones undermining their revenue. Register every type of problem they're experiencing for further inspection with the help of experts in the field.

3. **(G8) Request for help/suggestion**

Farmers can request help with a text message that will be sent directly to the agronomists responsible of the area to better their practice both in critical conditions and for improvement purposes. Thanks to this, the farmers are not required to know directly the contact of one of the agronomists, because the system will provide the contacts of the area they need automatically.

4. **(G9) Create and participate in discussions concerning the agriculture field**

Create forums to discuss with the other farmers. This feature shall allow a farmer-user to choose the name of a new topic they wish to introduce in the forum and to join all already open discussions. The purpose of this is to ease the cultivation-related knowledge spreading from which every farmer would benefit.

Agronomists

1. **(G10) Receive requests for help/suggestion all in one place**

Here the agronomist can manage all the incoming request for help or suggestion and will have an higher chance of intervening promptly in critical situations before it's too late. In fact, having just one place in which all the requests that need attention are cumulated makes easier for them to not miss them, rather than losing them because of the different means they could come from and in a cluttered way.

2. **(G11) Visualize area stats**

Keep track of the area general performance through a list of best-performing farmers and visualize data about whether forecast.

3. **(G12) Easy daily planning procedure**

The daily plan consists in a list of farms to be visited during the day. Since, by regulations, every farm must be visited at least twice a year, with particular attention to the under-performing ones that should be visited more often, agronomists wish to be suggested of which are the farms that are due to be visited or the ones that have not been visited yet during the year.

1.2 Scope

Phenomena controlled by the Machine

ID	Phenomenom	Shared
M1	Check username and password	No
M2	Analysis of best practices	No
M3	Analysis of weather data	No
M4	Visualize data concerning weather, land, performance	Yes
M5	User is given statistic data	Yes
M6	User is notified of unread requests for help or suggestions	Yes
M7	User is suggested about which farms need to be visited	Yes
M8	User is presented with news that might be relevant to their business	Yes

Phenomena controlled by the World

ID	Phenomenom	Shared
W1	User logs in	Yes
W2	User queries for the best performing farmers	Yes
W3	User queries for statistic data from humidity sensors	Yes
W4	User shares best practice	Yes
W5	User sends a request for help to an agronomist	Yes
W6	Collect land data from sensor	Yes
W7	User creates topic in forum	Yes
W8	User joins a discussion in forum	Yes
W9	User inserts post on the forum	Yes
W10	User updates daily plan	Yes
W11	User confirms daily plan	Yes
W12	User pays a visit to a farm	No
W13	User receives a visit in his/her own farm	No
W14	User accesses mail area	Yes
W15	User reads request for help	Yes
W16	User replies to request for help	Yes
W17	User checks weather forecast	Yes
W18	User checks news about crop	Yes

1.3 Definitions, acronyms, abbreviations

Definitions

- **Telangana:** Indian state promoting the *DREAM* project
- **User:** either Policy Makers, Farmers or Agronomists that will use the app
- **Production:** in this particular document, it's any type of edible result coming from crop
- **Forum:** online spot enabling users to meet and exchange ideas, share tips, express concerns and arise issues related to topics that comply to the purpose of the forum itself
- **Agronomist:** scientist in the agriculture field. Their main professional role is to make sure of the well-being of crops and recommend solutions to farmers in need of help with their cultivations
- **Policy Maker:** political figure responsible or involved in formulating policies, specifically food chain supply policies in this document
- **Farmer:** workers that own or manage a farm with the intention of selling at least a part of their own production
- **Daily plan:** a schedule of the activities to be done during the day, each of them planned out with their own starting time and location

Acronyms

- **DREAM:** *Data-driven predictive farming* project
- **PDPA:** Personal Data Protection Act
- **RASD:** Requirement Analysis and Specification Document

1.4 Revision history

1.5 Reference documents

- Specification document: "Assignment RDD AY 2021-2022"

- Alloy documentation: <https://alloytools.org/documentation.html>
- UML documentation: <https://www.uml-diagrams.org/>
- BPMN documentation: <https://www.bpmn.org/>
- Paper: "The World and the Machine" by M. Jackson and P. Zave

1.6 Document structure

- **Section 1** gives an introduction about the problem to tackle and about which functionalities will be implemented in the final product in order to comply to the users' needs.
- **Section 2** contains the overall description of the whole project, presenting it in a more formal way through class diagrams which will show the main flows and expected interactions between the user and the system. Furthermore, there will be presented: the so-called *actors* divided into the different types of user that will populate the application; the expected functionalities and the domain assumptions taken in consideration throughout the whole project, from the specification phase to the actual developing phase. To exemplify all the above, typical scenarios will be provided.
- **Section 3** delves deeply into the technical aspects of the topics presented in *Section 2*, in order to be extremely clear in setting the bounds between what the application must implement and what not. It will show functional and non-functional requirements. The former will be presented through some use-cases as meaningful examples; while the latter will be disclosed by analysing performance, design choices and software system features that the project shall have.
- **Section 4** presents the Alloy code briefly explaining the purpose of it in modeling the given problem.

2 Overall Description

2.1 Product perspective

DREAM is a system that offers the functionalities described in the *Product Functions (2.2)* section. It manages to use some external interfaces, for more details refers to the *Software Interfaces (3.1.3)* section. We can see below an high-level class diagram that shows the basic structure of the system.

2.1.1 Scenarios

1. Aanya has just passed her test to become a policy maker, so she decides to download and install DREAM in order to visualize the data concerning her job.
 - She opens the app and click on the "Sign Up" button
 - She inserts all her data in order to fill every mandatory field and presses the "Confirm" button
 - The system verifies that the e-mail isn't already present in the database. Since there isn't an entry for her e-mail yet, it allows the registration and shows a confirmation message to Aanya's mailbox
 - She checks her mailbox in order to verify that the procedure ended successfully
2. Apu is an expert policy maker, he wants to know what are the latest data regarding soil humidity and water irrigation.
 - He takes his phone and logs in DREAM app
 - He presses the "watch data" button
 - The system retrives data from a database and shows him the soil moisture and the consumed liters of water by the irrigation system thorughtout graphs that computes the average quantities across the Country in a span of 1 year
 - He wishes to have more detailed information about the soil humidity and the water irrigation in Adilabad district since he read an alaarming report about that region, so he choses it from the menu, setting the time span at 2 weeks

- The system gives him new graphs reporting only data about soil humidity and water used for irrigation retrieved by Adilabad's sensors in the last 2 weeks
 - He analyzes them and decides that he will talk about it later with a colleague, then he returns to the home page
3. Pajeet is one of the main policy makers in the state of Telangana. He wants to distribute special incentives to the best farmers and to do this he decides to open the app and visualize the data.
- He opens the app on his device. Since he's already registered, he logs in
 - The system shows the homepage for a policy maker user
 - He visualizes the ranking of the well-performing farmers
 - He clicks on the name of a farmer
 - Now the system shows the profile of the selected farmer
 - Here the policy maker can find useful contact information such as phone number (if it has been given by the farmer) and email
 - He takes note of the desirable contact information and closes the app
4. Chandran is an old farmer that has been cultivating mais for all his life. He has recently decided to move out from his previous field in order to give it to his son, Aakesh. Aakesh has already his own land near his dad's one, so he wants to add the new gifted area to his DREAM account. Furthermore, he found out that wheat is more productive and more bug-resistant than mais, so he also wants to change the crop type for both the lands from mais to wheat.
- He logs in DREAM app
 - He presses the profile edit button in order to change his area and crop type
 - He change the two value by inserting a new area and a new crop type
 - He confirm by pressing the confirm button

5. Sahil is a farmer that would like to share some best-practices about a particular product that he has cultivated during the last year. He decides to open a new discussion on the forum.
 - He opens the app on his device. Since he's already registered, he logs in
 - The system shows the homepage for a farmer user
 - He clicks on the "Forum" and access the forum section
 - Now he clicks on the "Create new topic" where he can select the name of the discussion
 - Finally he posts a new message in the discussion and leaves the device to go check it out later to see if someone has joined his topic and replied to him
6. Damayanti is a farmer that would like to improve the productivity of his farm. To do so he decides to consult the section regarding the suggestions on specific crops to plant or specific fertilizers to use.
 - He opens the app on his device, if he is already registered he logs in
 - The system shows the homepage for a farmer user
 - He clicks on the "News" and access the news section
 - Here he visualizes suggestions based on his type of production and on his location
 - If he is not satisfied, then he clicks on the "Request for help" to send a message to an agronomist of the area, which the app presents to him, and type his requests for suggestions
 - Otherwise, he takes note from the article he read
 - He closes the app
7. Chakrika is a young farmer. She decided to insert the data regarding last week production.
 - She sat in front of her computer and logs in DREAM
 - The system shows her the farmers home page

- She presses the "insert production data" button
 - She insert the total quantity of rice harvested last week
 - She checks the inserted data and finally press the confirmation button
 - The system sends her back to the home page
8. Shaleena is an agronomist responsible of Mahbubnagar, one of the biggest region in Telangana. She wants to compose the daily plan to decides which farms to visit today and for this reason she decides to open the app.
- She opens the app on his device, if she is already registered she logs in
 - The system shows the homepage for an agronomist user
 - She clicks on the "Daily plan" and access the new section
 - She can add the farms she wants to visit to the daily plan by choosing them from the list of available ones
 - Now the system shows the addresses and the date of the last visit of the selected farms
 - She takes note of the addresses of the farms to visit and close the app
9. Chaitanya is an agronomist that after a hard day of work wants to update the daily plan on the app. At the end of the day she realizes that she has visited three farms instead of the two indicated in the daily plan.
- She opens the app on his device, if she is already registered she logs in
 - The system shows the homepage for an agronomist user
 - She clicks on the "Daily plan" and access the new section
 - Here she can visualize the daily plan
 - She can click on the "Add" or on the "Remove"
 - In case of "Add" the system would redirect her to the list of available ones, in case of "Remove" she can delete a farm from the list simply by clicking on the cross at the right

- She clicks on the "Confirm" to validate the daily plan
 - The system returns to the homepage
 - Finally she close the app
10. Pradeep is an agronomist who wants to take care about help requests before going to work.
- He opens the app on his device, if he is already registered he logs in
 - The system shows the homepage for an agronomist user
 - He clicks on the "Mail box" and access the new section
 - Here he visualizes a list of help requests
 - By clicking on a help request he can visualize the request and answer
 - He do this for every help request until they are finished
 - Finally he closes the app and begins his working day
11. Sonya is an agronomist that want to check who are the best farmers of her responsibility area.
- She take her IT device and log in the system
 - She can already see who are the top farmers of the area
 - She press the widget and look deeply the ranking
 - She press the home button to return to home page

2.1.2 Class diagram

A UML class diagram describes the main entities in the system. Three types of actors can access the system: farmers, policy makers and agronomists. During the sign-up, they all create a user account with basic information such as username, password and e-mail. At this point, users are requested to choose what type of account to create. It is crucial that phisycal users register themselves accordingly to their job to ensure that the system works properly. Furthermore, this choice affects the next steps in the registration phase; for example, to complete the registration, farmers need to specify the

address of their farm and what type of crop they grow, whereas agronomists must declare their area of responsibility.

The system provides several functionalities tailored for the type of user, one of these is the forum for the farmers. When the farmers select the forum section, they are presented with the topics that are already active. For each topic, the discussion that has evolved through time can be seen: it's composed by the original post and its replies from other users. From here, the user can join an already ongoing discussion or create a new one generating a new topic and post the first message for it.

Another functionality is the *daily plan* feature for the agronomists. A daily plan is a list of farms that an agronomist has decided to visit on a particular day of the year, it has a date and a status flag that indicates whether the plan has already been confirmed or not. The schedule can be planned from the day before the actual visit and be confirmed until 23:59 of the visiting day. If the agronomist fills the plan and doesn't confirm it before the time limit expires, then the system will automatically assume that the schedule has been followed and will archive it at the end of the day. For the planner, agronomists have access to the list of farmers currently in their area of responsibility.

Finally, there are various types of data that can be visualized and analyzed by the users depending on the type of their account. There are four types of data:

- **Soil humidity sensors data**

Acquired by the sensors distributed all over the territory, they report values that represent the soil moisture level of the land they cover.

- **Weather forecast data**

Meteorological short-term and long-term forecast acquired by Telangana's government and displayed on their official website. They are comprehensive of temperature, rainfall probability and quantity, direction and strength of the wind and air humidity.

- **Water irrigation data**

Acquired by the water irrigation system installed in the farms, the only significant value is the amount of water used by the system during the day.

- **Production data**

Provided by the farmers, this type of data is displayed as a table that

maps the type of cultivated product to the sown amount and the respective harvested quantity.

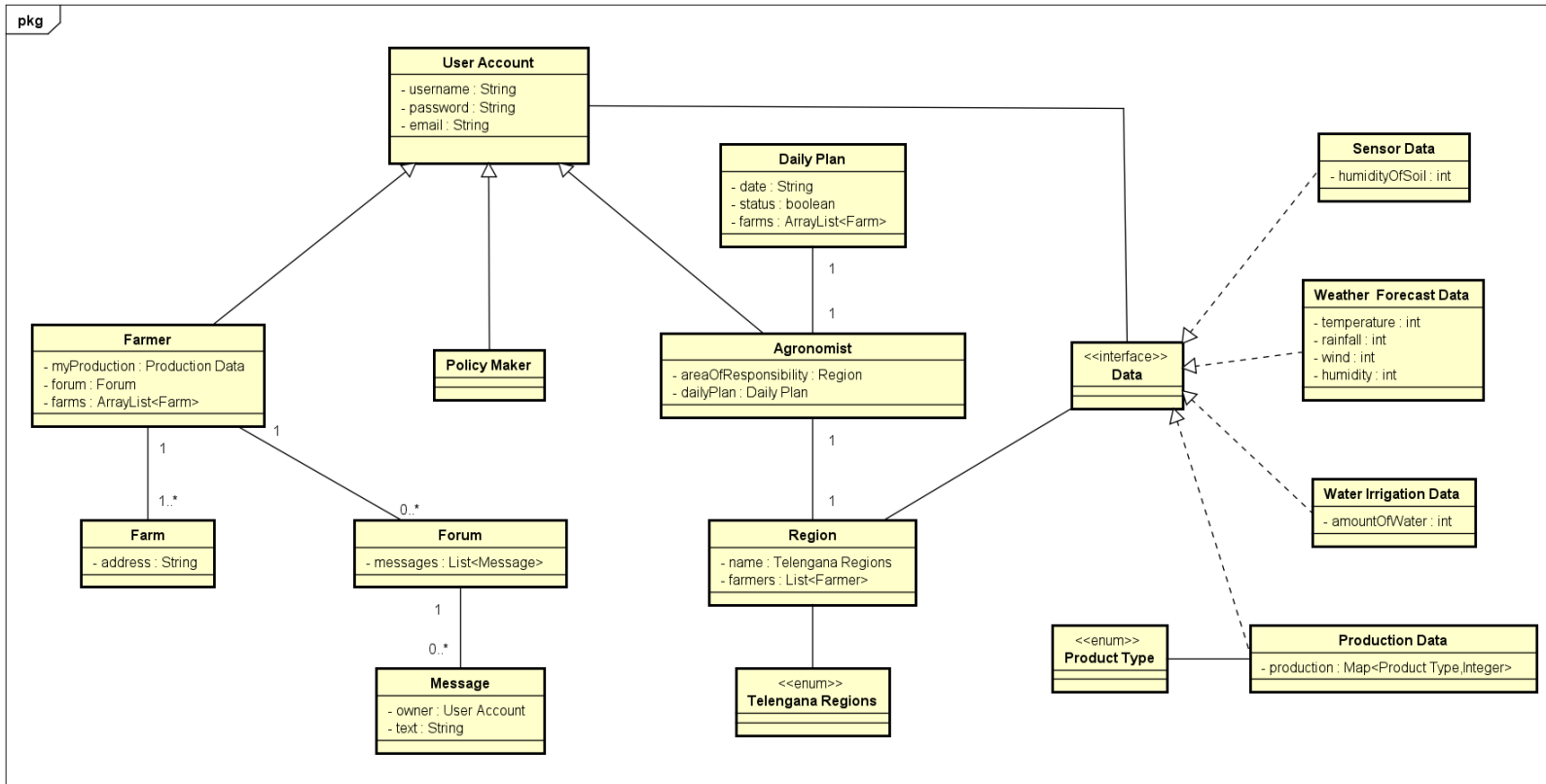


Figure 1: High-level UML

2.2 Product functions

2.2.1 Sign-up and shared functions

- **Sign-up:** let the user sign-up thorough an email and a password, creating a profile tailored for the user's job. Specify the area in which they live and what type of cultivation they manage.

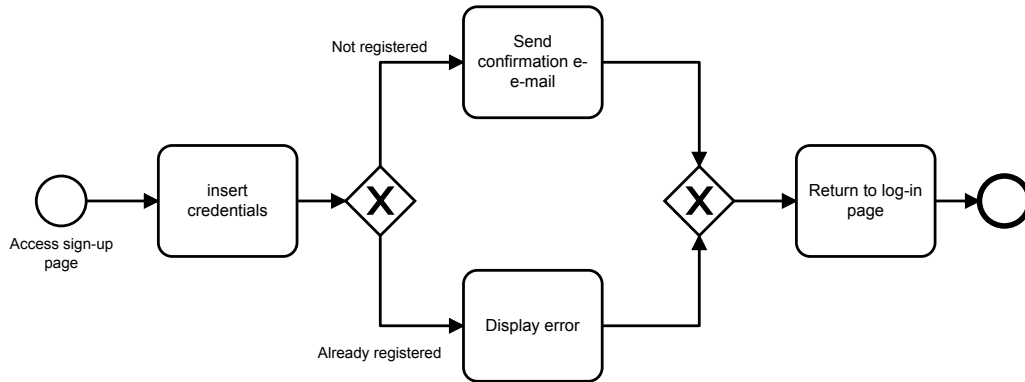


Figure 2: Sign Up BPMN

2.2.2 Policy makers functions

- **Visualize relevant data and initiative:** let the policy makers know a variety of data like the performances of the farmers by grouping them in a rank to know who are the farmers that are performing well and who are the worst one mainly based upon the production data provided by them. Policy makers can also visualize the steering initiatives presented by the agronomist in a specific subsection of their application.

2.2.3 Farmers functions

- **Profile edit:** allow the farmers to change their profile in order to upgrade information like:

Area: allow to change the area where farmers have their plantation;

Crop type: allow to change the type of the crop they're cultivating;

Username and password: allow to change their username and password.

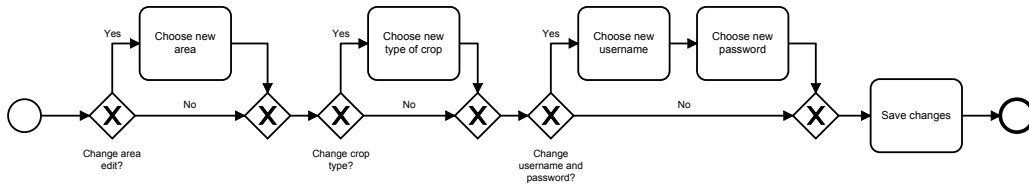


Figure 3: Profile edit BPMN

- **Getting information about the agriculture field:** allow farmers to visualize news relevant to their business interests such as: wheather forecast for the day or for the next few days, articles posted on major online farming magazines that are related to their own crop type and specific fertilizers for their needs.
- **Agronomists Interactions:** allow farmers to send messages to the agronomist.
- **Building a useful community on the forum:** allow farmers to create a new topic or reply to a message in the dedicated forum.

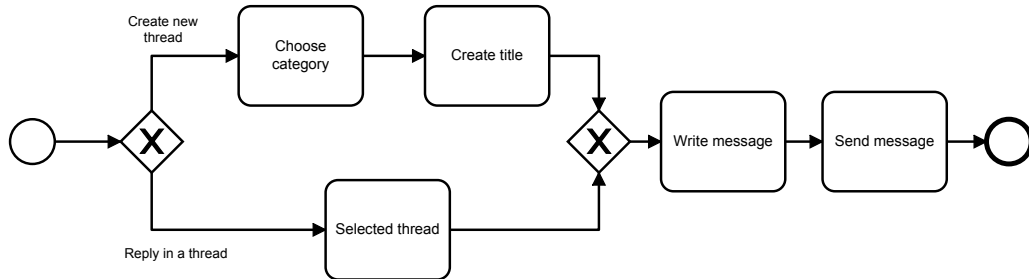


Figure 4: Forum BPMN

2.2.4 Agronomists functions

- **Area functions:** allow the agronomists to insert their responsibility area and visualize related data like wheather forecast or the rank of the farmers in that region.
- **Manage farmers requests:** agronomists reply to farmers' requests for help or suggestion.
- **Manage daily plan:** allow the agronomist to make their daily plan by registering the scheduled visits to the farmers. At the end of the day an agronomist must confirm if they were able to complete the plan or specify the deviations occurred during the day.

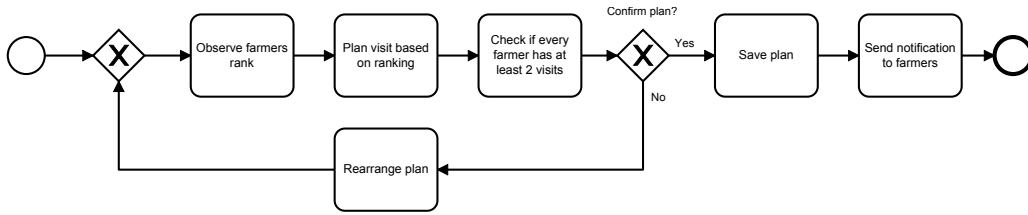


Figure 5: Daily plan BPMN

2.3 User characteristics

The application has been thought for the three different user categories that follows:

- **Policy makers** are government's employees that are in charge of analysing the general agriculture trends among all the districts in Telangana, then promote based state-wide policies to better the whole food system. Their main goal is not only to secure the current provision, but also to identify now the best practices that will lead to a flourishing food production in the future. By doing so, the plan is to grow more resilient and profitable crops and prepare the lands to face future menaces, for instance the climate that is getting more hostile or the

foreseen increment of the food demand. As a consequence, they want to be notified about the best performing farmers in order to contact them and get more insight from them about their procedures, with the aim to acquire best practises to be shared and applied on a larger scale. At the same time, they need to know who, on the other hand, is performing particularly badly, so that they can be given the help they need to better their results, since obtaining the foresaid goal requires the structure to run smoothly in all its parts. Policy makers also need a feedback system that let them be aware of the true impact *a posteriori* of the initiatives carried out by the agronomists in collaboration with the knowledge and practice of the best farmers.

- **Farmers** are interested in functionalities that will help with their day-to-day life at work, so they would like to receive in one place all the information about the weather to plan before hand the work day and useful data, like suggestions and news about the specific crop they cultivate, if some crop's illness is spreading in their area and how to treat it, which fertilizers boost the plant's production, etc. Moreover, they should insert data about their own production and ask for help to a regional agronomist through the app if it's needed. Being part of a larger community of people that share the same purpose (such as being more productive) brings more knowledge in general, so it's easier for the farmers to get in touch with their colleagues that grow the same crops and might have faced the same challenges they do through the in-app forum. The feature allows them to enlarge their pool of acquaintances and brings them together online, even though they might be kilometers away from each other.
- **Agronomists** are the experts in the agriculture field, so the main function needed for them is the possibility of helping out the farmers that reach out to them. Each agronomist is in charge of a specific geographical area in Telangana, in order to be efficiently present on the territory in a fair and useful way according to the actual helping demand. In fact, they visit each farm spread among their area at least twice a year. That said, agronomists would like some functionalities that help them planning out their trips on the field in an simple yet flexible way. Furthermore, they would like to be notified of the farms' performace, especially the ones scoring poor results in order to plan

their visits more often for those, depending on the problem they facing. Nonetheless, in order to make a complete and exhaustive report about the area productivity for the central government, they are also interested into acknowledging the top performing farms.

2.4 Assumptions, dependencies and constraints

- D1: Agronomists actually stick to the scheduled daily plan
- D2: Agronomists correct their schedule at the end of the day if deviations occur
- D3: Each user registers according to their role and always feeds correct information to the app
- D4: The internet connection works properly
- D5: The sensors measuring humidity level of the soil work properly, with at most an error of 1%
- D6: Weather forecasts are accurate up to a 80% for the short-term and up to 60% on the long-term
- D7: Water irrigation system send the information accurately, with an error of at most 1%
- D8: Agronomists always reply to farmers requests of help
- D9: Farmers periodically insert data about their crop status and resulting production
- D10: Data inserted by the Farmers sticks to the reality of the produced quantity.
- D11: Agronomists periodically report their initiatives to the central government.
- D12: Users own an IT device to connect to the application
- D13: Devices external to the system (e.g. humidity sensors, water irrigation systems, weather stations) are active and working properly for 99.9% of the year

- D14: A user register only once, choosing just one type of account accordingly to their real job

3 Specific Requirements

3.1 External Interface Requirements

3.1.1 User Interfaces

The system should interface with users through devices which must be connected to the Internet. Everyone that needs to use this service would connect to it through a web browser from an existing domain, for example: dream.com. It must be easy to use as it will have to be used from different kind of people, sometimes with a not great affinity with technologies.

3.1.2 Hardware Interfaces

The system "as it is" does not provide specific hardware equipment in order to access to web site. To use all functionalities it's required to have an IT devices connected to the internet, eventually a user can decide to use GPS to insert his own location and only proper devices with GPS equipment can do this.

Soil data, obtained from sensors, are collect by someone else and will be added by the policy makers, also this not requires any special kind of hardware.

3.1.3 Software Interfaces

In order to use the system it's required the use of a web browser, on that will run the application.

System will also use some important interfaces in order to accomplish its functionalities.

First is an external API to access maps which will use the position acquired by the user settings to return an interactive map with a marker on that exact position.

Second API service used is the one of the DBMS system which will be adopted in order to query the internal database.

Another API will be use to access the external database containing data regarding the sensor data and the other external data that the system need.

3.1.4 Communication Interfaces

Internet connection is mandatory in order to access to every formation that the system will display. Users that want full functionalities have to have a GPS system on their device in order to guarantee a certain level of precision in the localization phase.

3.2 Functional Requirements

3.2.1 List of Requirements

ID	Requirement
R1	The system must allow only registered and logged-in users to use the app.
R2	If the IT device is equipped with GPS technology, then the system must suggest the users the area in which they are during the registration phase. In any case, the final decision will be up to the registering user.
R3	The system must allow the users to change their location.
R4	The system must allow Policy Makers to see up-to-date statistic data, accordingly to the database, about water irrigation systems and soil humidity sensors.
R5	The system must give Policy Makers and Agronomists up-to-date ranking of the best and worst performing farmers.
R6	The system must use a fair and scientific score to rank the Farmers in order to represent the real situation.
R7	The system must let Farmers insert their production information every day

R8	The system must suggest a list of agronomists appointed to the area of the Farmer requesting professional help.
R9	The system must notify Agronomists of unresolved requests of help from Farmers.
R10	The system must show weather forecasts relevant to the area concerning the Farmer or the Agronomist.
R11	The system must present news concerning crop only if relevant to the Farmer's own crop type.
R12	If users are experimenting connectivity issues, the system must inform them to try later.
R13	The system must allow every user registered as Farmer to access the forum, to create new discussions and to post replies to already existing ones.
R14	The system must suggest to the Agronomists which farms to visit (among the ones in their area of competence) while planning the Daily Plan based upon the last visit day following a FIFO policy. Exceptions to the FIFO policy are the farms under-performing, which shall have higher priority.
R15	The system must allow the Agronomists to add a new schedule for the day each day.
R16	The system must allow the Agronomists to update their schedule during the day and to confirm the execution before the end of the day. If the user doesn't confirm before 23:59, the system must register the already uploaded schedule as definitive.
R17	The system must allow Policy Makers to retrieve all agronomists' steering initiative reports uploaded to the database.

3.2.2 Mapping

G1	Make crops weather-resilient across the State
D5	The sensors measuring humidity level of the soil work properly
D7	Water irrigation system sends the information accurately, with an error of at most 1%
R1	The system can be used only by registered and logged-in users.
R4	The system must allow Policy Makers to see up-to-date statistic data, accordingly to the database, about water irrigation system and soil humidity sensors.

G2	Reach out to farmers in need of help
D3	Each user registers according to their role and always feeds correct information to the app
D4	The internet connection works properly
D8	Agronomists always reply to farmers requests of help
R1	The system must allow only registered and logged-in users to use the app.
R8	The system must suggest a list of agronomists appointed to the area of the Farmer requesting professional help.
R12	If users are experimenting connectivity issues, the system must inform them to try later.

G3	Identification of well-performing farmers
D9	Farmers periodically insert data about their crop status and resulting production
D10	Data inserted by the Farmers sticks to the reality of the produced quantity.
R1	The system must allow only registered and logged-in users to use the app.
R5	The system must give Policy Makers and Agronomists up-to-date ranking of the best and worst performing farmers.
R6	The system must use a fair and scientific score to rank the Farmers in order to represent the real situation.
R7	The system must let Farmers insert their production information every day.
R12	If users are experimenting connectivity issues, the system must inform them to try later.

G4	Identification of under-performing farmers
D3	Each user registers according to their role and always feeds correct information to the app.
D9	Farmers periodically insert data about their crop status and resulting production
D10	Data inserted by the Farmers sticks to the reality of the produced quantity.
R1	The system must allow only registered and logged-in users to use the app.
R5	The system must give Policy Makers and Agronomists up-to-date ranking of the best and worst performing farmers.
R6	The system must use a fair and scientific score to rank the Farmers in order to represent the real situation.
R7	The system must let Farmers insert their production information every day.
R12	If users are experimenting connectivity issues, the system must inform them to try later.

G5	Visualize the results of steering initiatives
D5	Each user registers according to their role and always feeds correct information to the app.
D11	Agronomists periodically report their initiatives to the central government.
R1	The system must allow only registered and logged-in users to use the app.
R12	If users are experimenting connectivity issues, the system must inform them to try later.
R17	The system must allow Policy Makers to retrieve all agronomists' steering initiative reports uploaded to the database.

G6	Visualize relevant data for the business
D3	Each user registers according to their role and always feeds correct information to the app.
D6	Weather forecasts are accurate up to a 80% for the short-term and up to 60% on the long-term.
R1	The system must allow only registered and logged-in users to use the app.
R10	The system must show weather forecasts relevant to the area concerning the Farmer or the Agronomists.
R11	The system must present news concerning crop only if relevant to the Farmer's own crop type.
R12	If users are experimenting connectivity issues, the system must inform them to try later.

G7	Keep track of the production
D3	Each user registers according to their role and always feeds correct information to the app
D9	Farmers periodically insert data about their crop status and resulting production.
D10	Data inserted by the Farmers sticks to the reality of the produced quantity
R7	The system must let Farmers insert their production information every day.
R12	If users are experimenting connectivity issues, the system must inform them to try later.

G8	Request for help/suggestion
D3	Each user registers according to their role and always feeds correct information to the app.
D4	The internet connection works properly.
D8	Agronomists always reply to farmers' requests of help.
R1	The system must allow only registered and logged-in users to use the app.
R8	The system must suggest a list of agronomists appointed to the area of the Farmer requesting professional help.
R9	The system must notify Agronomists of unresolved requests for help from Farmers.
R12	If users are experimenting connectivity issues, the system must inform them to try later.

G9	Create and participate in discussions concerning the agriculture field
D3	Each user registers according to their role and always feeds correct information to the app.
D4	The internet connection works properly.
R1	The system must allow only registered and logged-in users to use the app.
R12	If users are experimenting connectivity issues, the system must inform them to try later.
R13	The system must allow every user registered as Farmer to access the forum, to create new discussions and to post replies to already existing ones.

G10	Receive requests for help/suggestion all in one place
D3	Each user registers according to their role and always feeds correct information to the app
D4	The internet connection works properly.
R1	The system must allow only registered and logged-in users to use the app.
R	The system must suggest a list of agronomists appointed to the area of the Farmer requesting professional help.
R9	The system must notify Agronomists of unresolved requests for help from the Farmers.

G11	Visualize area stats
D3	Each user registers according to their role and always feeds correct information to the app
D4	The internet connection works properly.
D9	Farmers periodically insert data about their crop status and resulting production.
D10	Data inserted by the Farmers sticks to the reality of the produced quantity
R1	The system must allow only registered and logged-in users to use the app.
R5	The system must give Policy Makers and Agronomists up-to-date ranking of the best and worst performing Farmers.
R6	The system must use a fair and scientific score to rank the Farmers in order to represent the real situation.
R10	The system must show weather forecasts relevant to the area concerning the Farmer or the Agronomist.
R12	If users are experimenting connectivity issues, the system must inform them to try later.

G12	Easy daily planning procedure
D3	Each user registers according to their role and always feeds correct information to the app
D4	The internet connection works properly.
D1	Agronomists actually stick to the scheduled daily plan.
D2	Agronomists correct their schedule at the end of the day if deviations occur.
R1	The system must allow only registered and logged-in users to use the app.
R12	If users are experimenting connectivity issues, the system must inform them to try later.
R14	The system must suggest to the Agronomists which farms to visit while planning the Daily Plan based upon the last visit day following a FIFO policy. Exceptions to the FIFO policy are the farms under-performing, which shall have higher priority.
R15	The system must allow the Agronomists to add a new schedule for the day each day.
R16	The system must allow the Agronomists to update their schedule during the day and to confirm the execution before the end of the day. If the user doesn't confirm before 23:59, the system must register the already uploaded schedule as definitive.

3.2.3 Use Cases

3.2.3.1 Use Cases Diagram

- Policy Makers



Figure 6: Policy Maker - Use Case Diagram

- Farmers

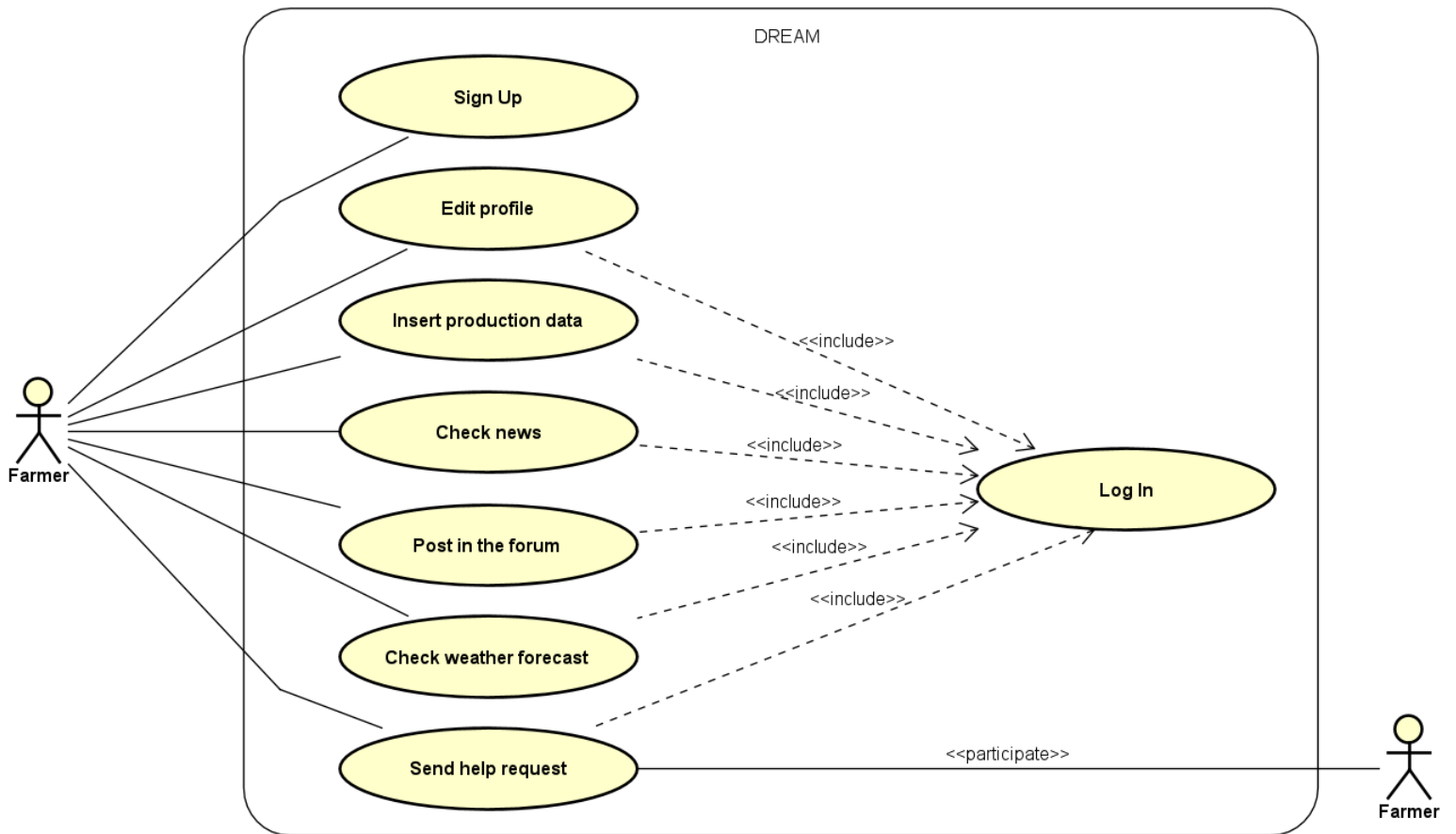


Figure 7: Farmer - Use Case Diagram

- Agronomists

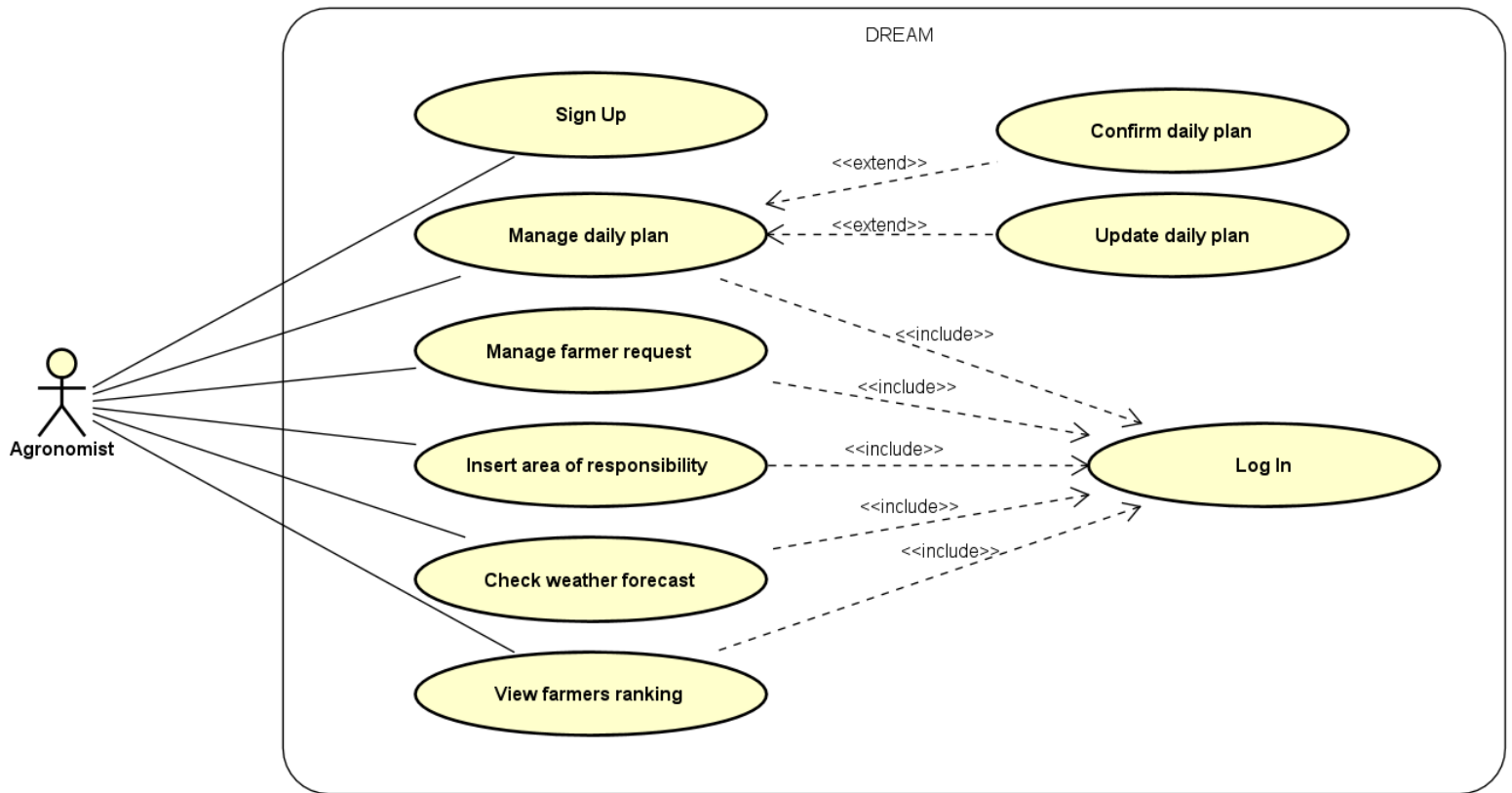


Figure 8: Agronomist - Use Case Diagram

3.2.3.2 Use Cases Description

- Shared Use Cases

Sign Up

Use Case	Sign Up
Actor	Policy Maker, Farmer, Agronomist
Entry condition	User want to register in the system
Flow of events	<ol style="list-style-type: none">1. User press the sign up button2. User select its username, password and role
Exit condition	The system shows a confirmation message to the user
Exceptions	<ol style="list-style-type: none">1. If the user insert an already taken username2. If the user press the cancel button3. Internet connection isn't working

Log In

Use Case	Log In
Actor	Policy Maker, Farmer, Agronomist
Entry condition	User want to log in the system
Flow of events	<ol style="list-style-type: none">1. User put its own username and password
Exit condition	The system correctly log in the system
Exceptions	<ol style="list-style-type: none">1. If the user insert a wrong username and password2. Internet connection isn't working

- Policy Makers

View Initiatives Reports

Use Case	View Initiatives Reports
Actor	Policy Maker
Entry condition	User wants to check the Steering Initiative proposed by agronomists
Flow of events	<ol style="list-style-type: none"> 1. User press the "View Initiatives Reports" button 2. System send to the user the steering initiative insert by the agronomist
Exit condition	User press the back button
Exceptions	

Check Soil Humidity Data

Use Case	Check Soil Humidity Data
Actor	Policy Maker
Entry condition	User wants to check the soil humidity data
Flow of events	<ol style="list-style-type: none"> 1. User press the "Check Sensors Data" button 2. User press the soil humidity data button 3. System retrieve soil humidity data and send them back to the user 4. System display the data
Exit condition	User press the "Home" button
Exceptions	

Check Water Irrigation Data

Use Case	Check Water Irrigation Data
Actor	Policy Maker
Entry condition	User wants to check the water irrigation data
Flow of events	<ol style="list-style-type: none">1. User press the "Check Sensors Data" button2. User press the water irrigation button3. System retrieve water irrigation data and send them back to the user4. System display the data
Exit condition	User press the "Home" button
Exceptions	

View Farmers Ranking

Use Case	View Farmers Ranking
Actor	Policy Maker
Entry condition	User wants to see the farmers ranking
Flow of events	<ol style="list-style-type: none">1. User press the best or the worst performing ranking2. System retrieve data on farmers ranking3. System show ranking data
Exit condition	User press the "Back" button
Exceptions	

View Specific Farmer Information (View Farmers Ranking)

Use Case	View Specific Farmer information (View Farmers Ranking)
Actor	Policy Maker
Entry condition	User wants to see the specific information of a farmer
Flow of events	<ol style="list-style-type: none">1. First three events are the same of the "View Farmers Ranking" use case2. User press on a farmer name3. System retrieve farmer data4. System display farmer data
Exit condition	User press "Back" button
Exceptions	

- Farmers

Profile Edit

Use Case	Profile Edit
Actor	Farmers
Entry condition	User wants to modify or update its profile
Flow of events	<ol style="list-style-type: none"> 1. User press the "Settings" button on its home page 2. User modify the interest data (username, password, crop type or area) 3. User press "Confirm" button
Exit condition	User receive a confirmation message
Exceptions	<ol style="list-style-type: none"> 1. User choose an already taken username 2. User choose the old password

Insert Production Data

Use Case	Insert Production Data
Actor	Farmers
Entry condition	User wants to insert the production data
Flow of events	<ol style="list-style-type: none"> 1. User press the "Insert Production Data" button 2. User insert data regarding its coulivation performance 3. User press "Confirm" button 4. System collect and analiyze data
Exit condition	User receive a confirmation message
Exceptions	<ol style="list-style-type: none"> 1. User insert data in a wrong manner 2. User press "Back" button

Check News

Use Case	Check News
Actor	Farmers
Entry condition	User want to check the news
Flow of events	<ol style="list-style-type: none">1. User press the news box2. The system retrive data regarding news
Exit condition	User press "Back" button
Exceptions	

Post in the Forum

Use Case	Post in the Forum
Actor	Farmers
Entry condition	User wants to post in the forum
Flow of events	<ol style="list-style-type: none">1. User press "Forum" button2. User choose a thread to reply in or the creation of new thread3. User write the text
Exit condition	User press "Post" button
Exceptions	<ol style="list-style-type: none">1. User exceed the maximum number of character

Check Weather Forecast

Use Case	Check Weather Forecast
Actor	Farmers
Entry condition	User wants to check weather forecast
Flow of events	<ol style="list-style-type: none">1. User press on the weather forecast widget
Exit condition	User press "Home" button
Exceptions	

Send an Help Request

Use Case	Send an Help Request
Actor	Farmers
Entry condition	User needs the agronomist help
Flow of events	<ol style="list-style-type: none">1. User press "Contact Agronomist" button2. User choose the object of its help request3. User write the message4. User send the request by pressing "Send request" button
Exit condition	The system shows a confirmation message to the user
Exceptions	<ol style="list-style-type: none">1. User doesn't fill every mandatory boxes

- Agronomist

Confirm Daily Plan

Use Case	Confirm Daily Plan
Actor	Agronomist
Entry condition	User want to confirm its daily plan
Flow of events	<ol style="list-style-type: none"> 1. Press the daily "Daily Plan" button 2. Choose the farmers that he want to visit during the day 3. Check if the farmers has at least two visit 4. Confirm the plan with the "Confirm" button
Exit condition	System display a confirmation message
Exceptions	<ol style="list-style-type: none"> 1. At the end of the year a farmer has less than two visit

Update Daily Plan

Use Case	Update Daily Plan
Actor	Agronomist
Entry condition	User want to update its daily plan
Flow of events	<ol style="list-style-type: none"> 1. Press the daily "Daily Plan" button 2. User press the "Modify" button 3. Choose the farmers to add or the ones to remove 4. Check if the farmers has at least two visit 5. Check if there are farmers to visit in the list 6. Confirm the plan with the "Confirm" button
Exit condition	System display a confirmation message
Exceptions	<ol style="list-style-type: none"> 1. At the end of the year a farmer has less than two visit

Manage Farmers Request

Use Case	Manage Farmers Request
Actor	Agronomist
Entry condition	User wants to reply to a farmer help request
Flow of events	<ol style="list-style-type: none">1. System displays the notification of an incoming message2. User press the inbox icon3. User insert the object4. User replys the request5. User send the message
Exit condition	System show the user a confirmation message
Exceptions	<ol style="list-style-type: none">1. Object field is empty2. Message field is empty3. User press the "Cancel" button

Insert responsibility Area

Use Case	Insert responsibility Area
Actor	Agronomist
Entry condition	User wants to insert its own coverage area
Flow of events	<ol style="list-style-type: none">1. User press the setings button2. User select the new responsibility area3. User press the "Confirm" button
Exit condition	
Exceptions	<ol style="list-style-type: none">1. User press the "Cancel" button2. User select an already taken area

Check Weather Forecast

Use Case	Check Weather Forecast
Actor	Agronomist
Entry condition	User wants to check the weather forecast in its responsibility area
Flow of events	<ol style="list-style-type: none">1. User press the wheather widget2. System retrive and display data
Exit condition	User press "Home" button
Exceptions	

View Farmers Area Ranking

Use Case	View Farmers Area Ranking
Actor	Agronomist
Entry condition	User wants to see the ranking of farmers in the area
Flow of events	<ol style="list-style-type: none">1. User press the ranking widget2. System retrives and displays data
Exit condition	User press "Home" button
Exceptions	

3.2.4 Sequence Diagrams

- Shared Sequence Diagrams

Sign Up

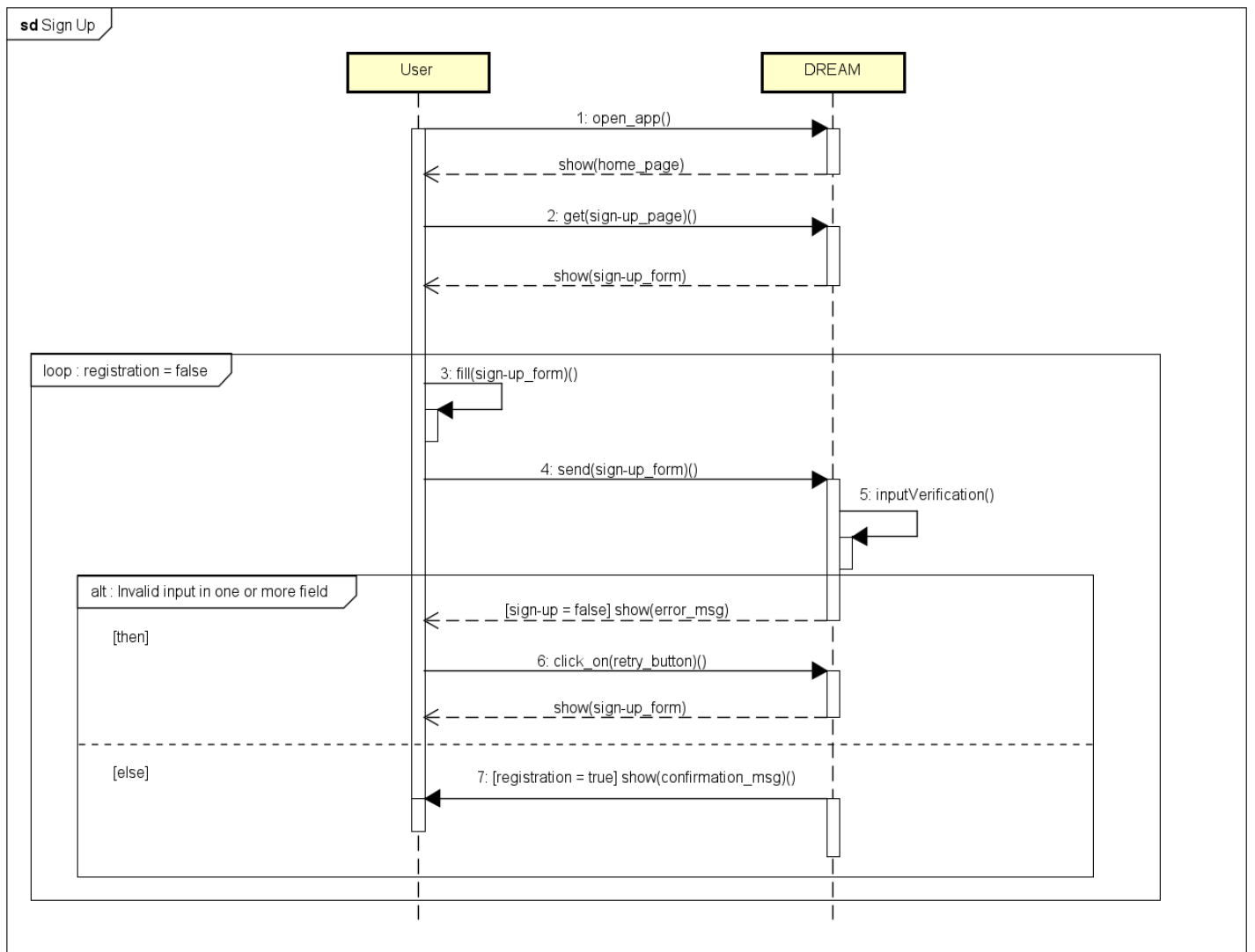


Figure 9: Shared Sequence Diagram - Sign Up Sequence Diagram

Log In

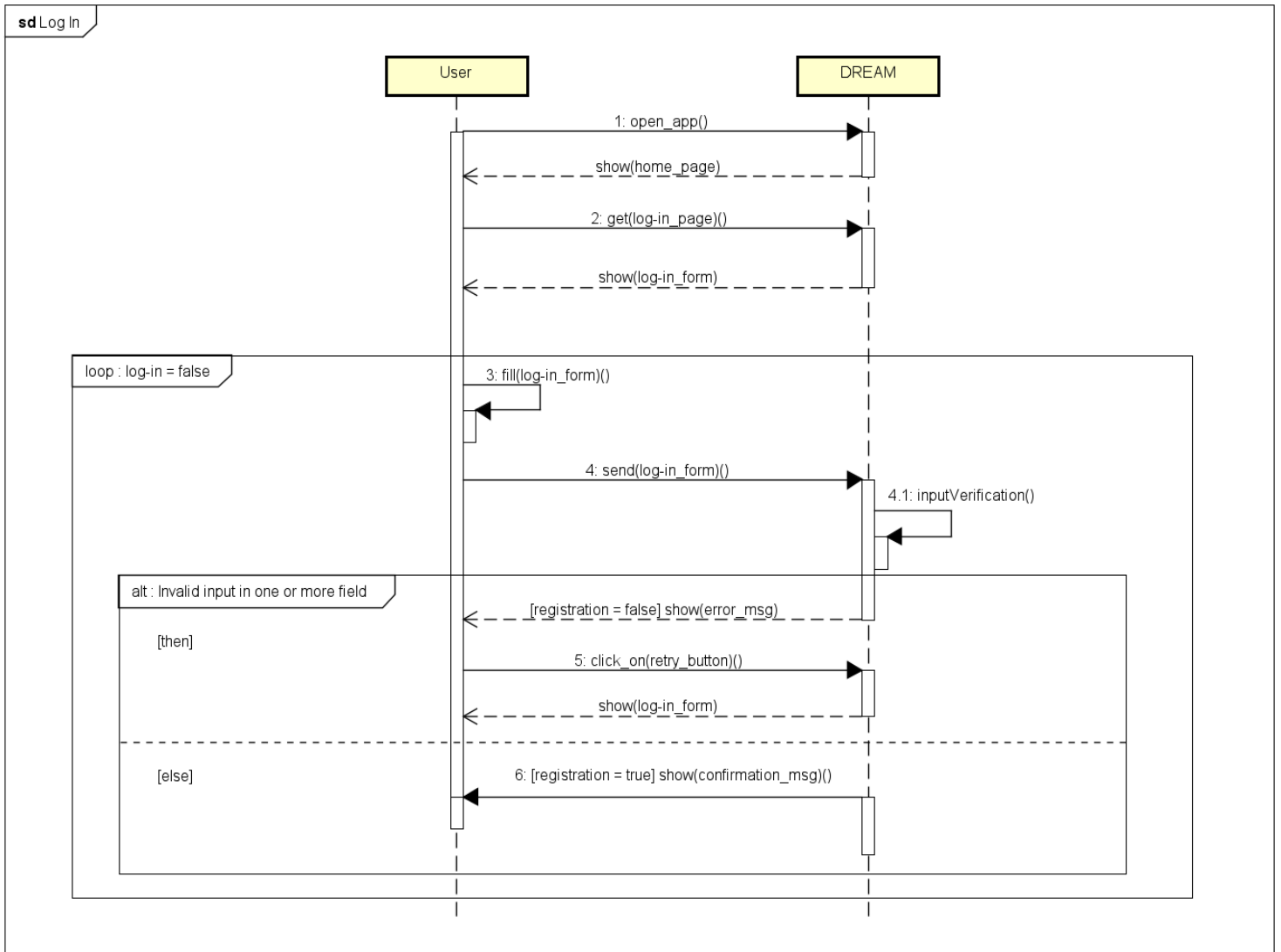


Figure 10: Shared Sequence Diagram - Log In Sequence Diagram

- PolicyMakers

View Initiative Report Sequence

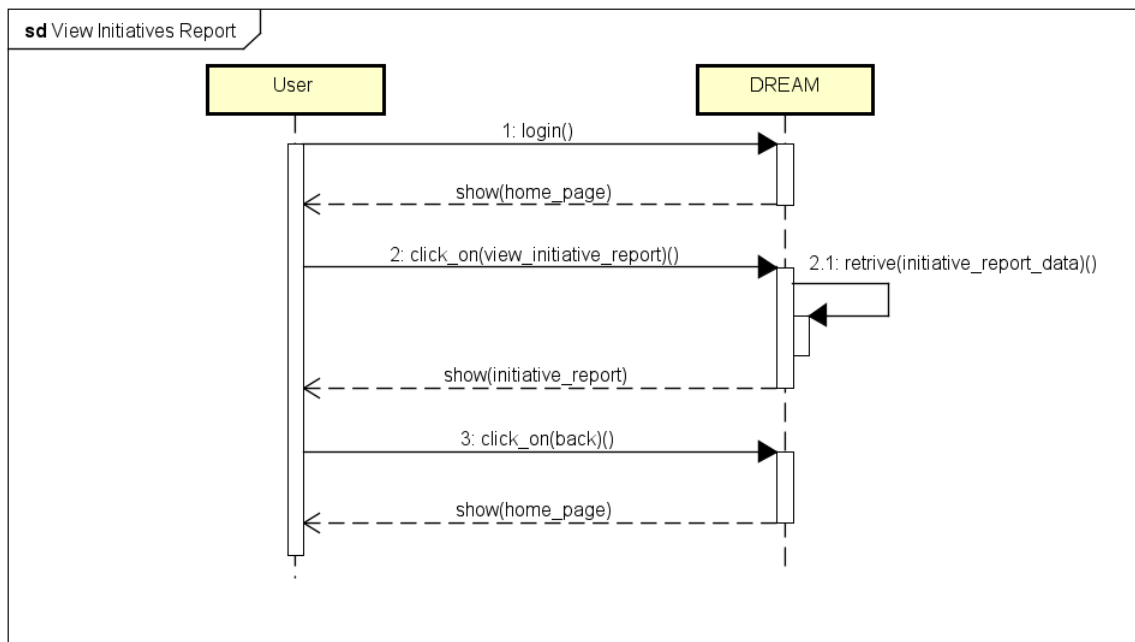


Figure 11: Policy Makers - View Initiative Report Sequence Diagram

Check Soil Humidity Data

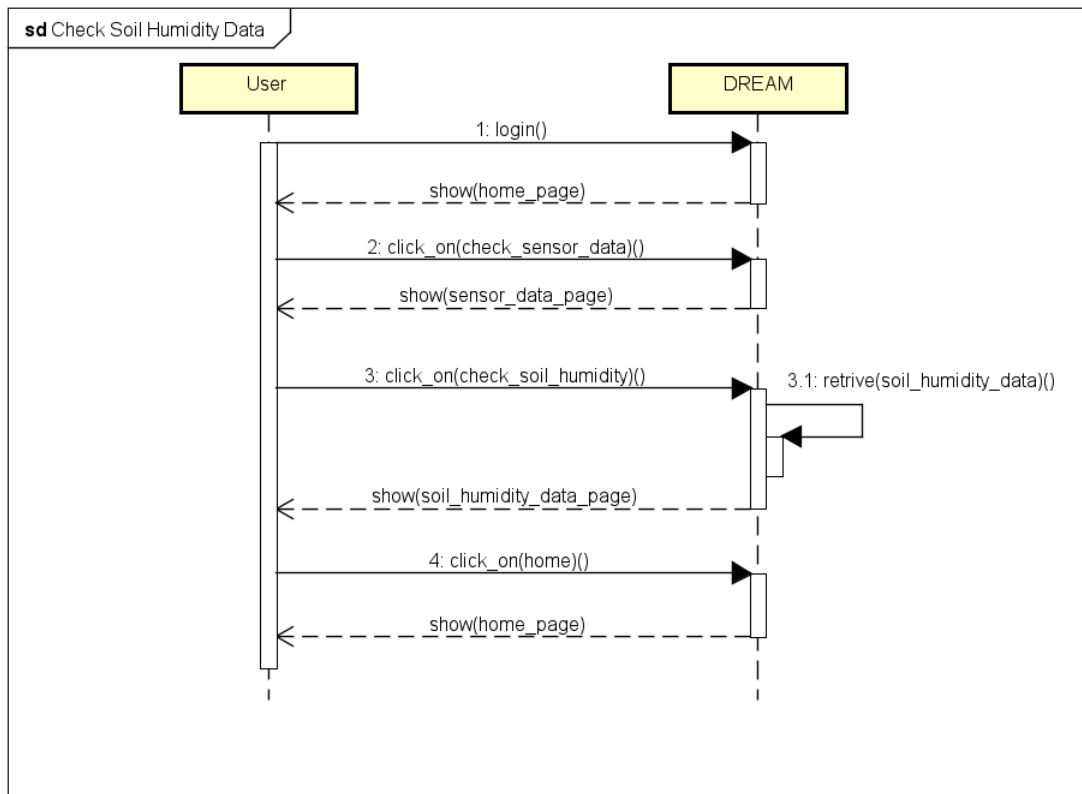


Figure 12: Policy Makers - Check Soil Humidity Data Sequence Diagram

Check Water Irrigation Data

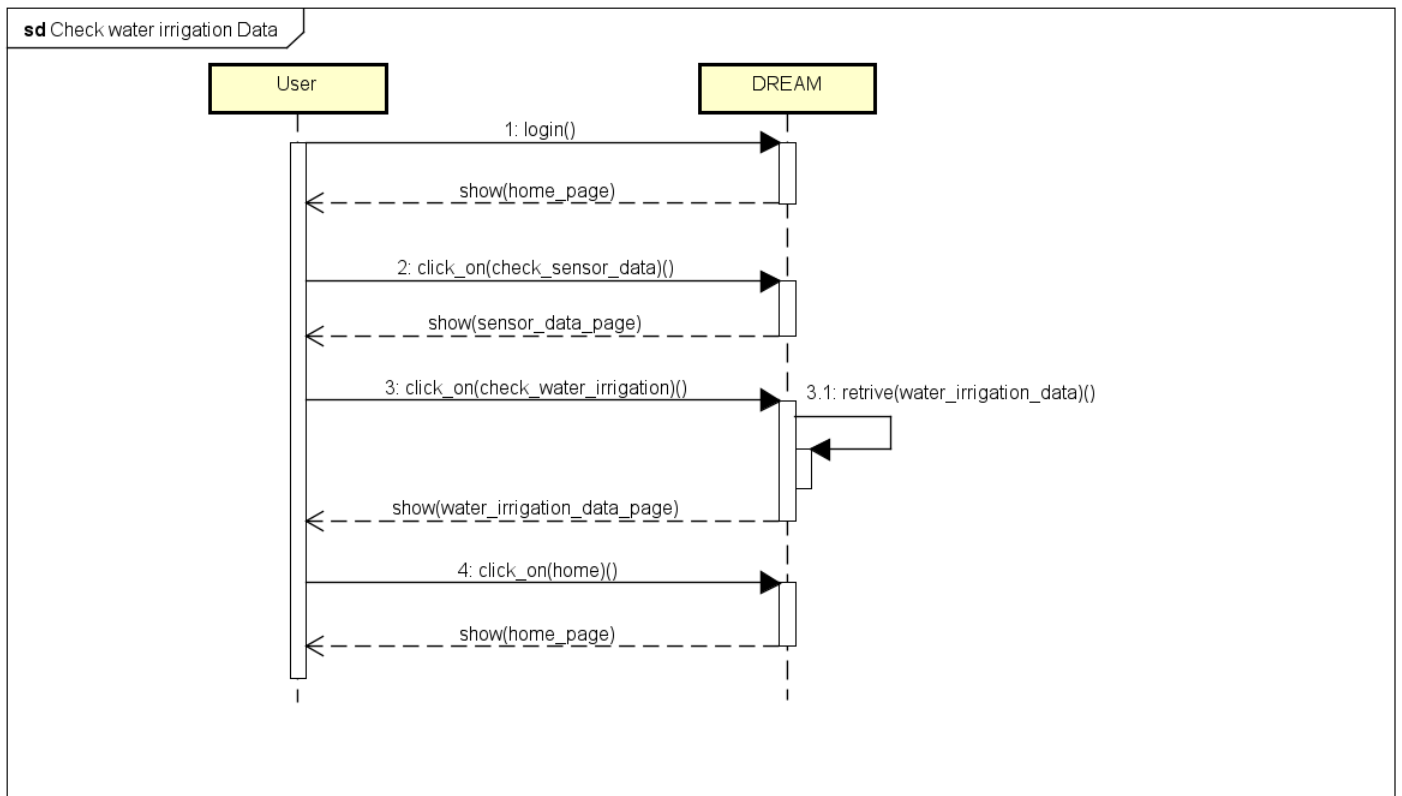


Figure 13: Policy Makers - Check Water Irrigation Data Sequence Diagram

View Farmers Ranking

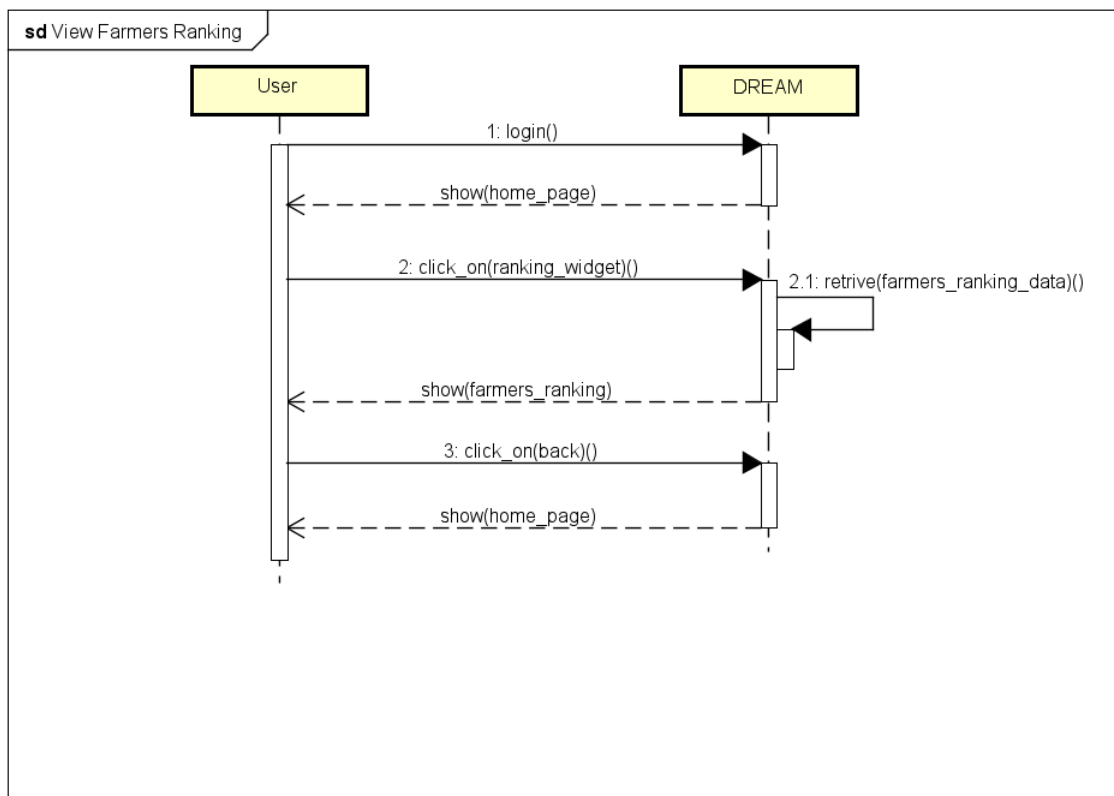


Figure 14: Policy Makers - View Farmers Ranking Sequence Diagram

View Specific Farmers information

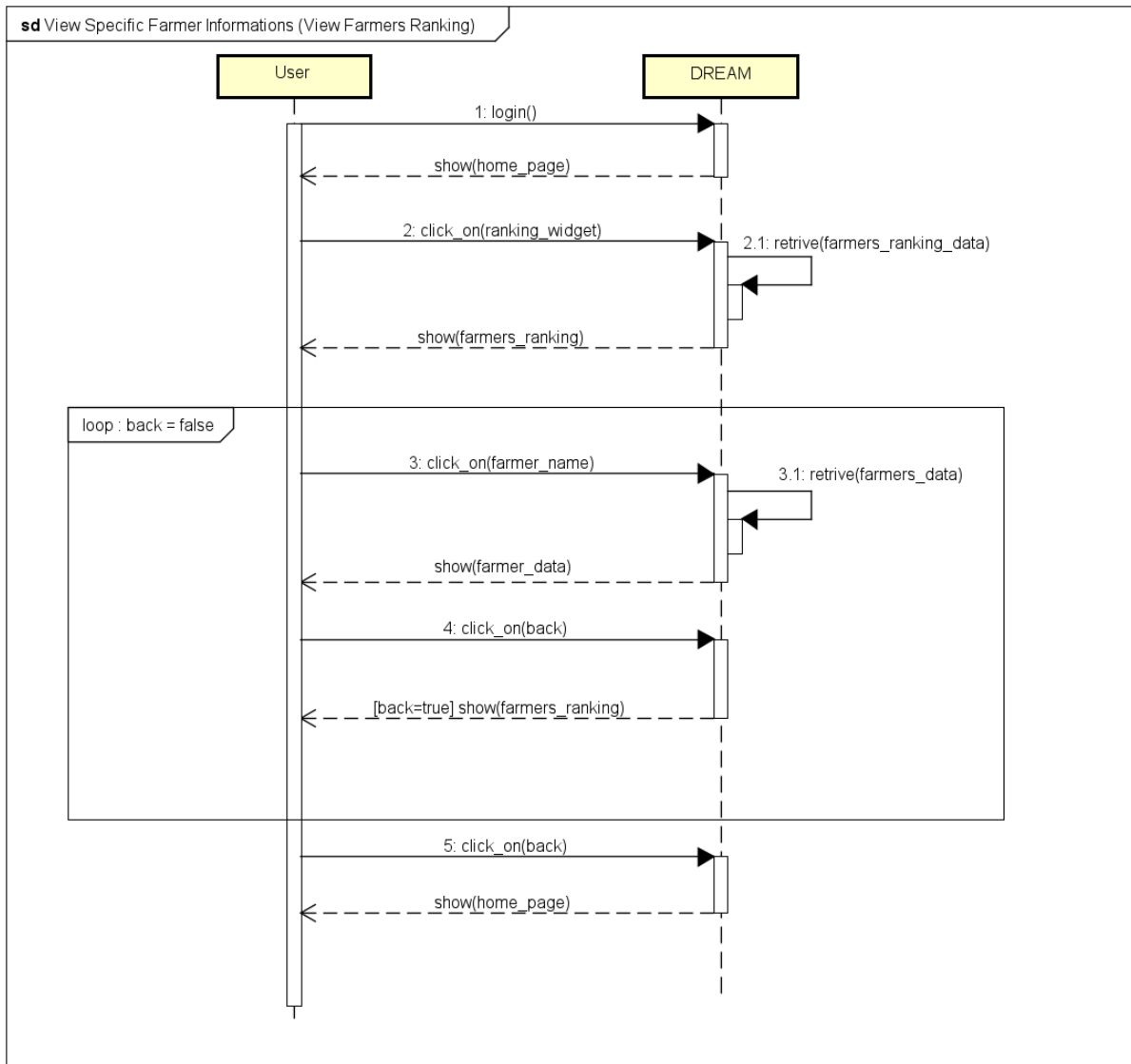


Figure 15: Policy Makers - View Specific Farmers information Sequence Diagram

- Farmers

Profile Edit

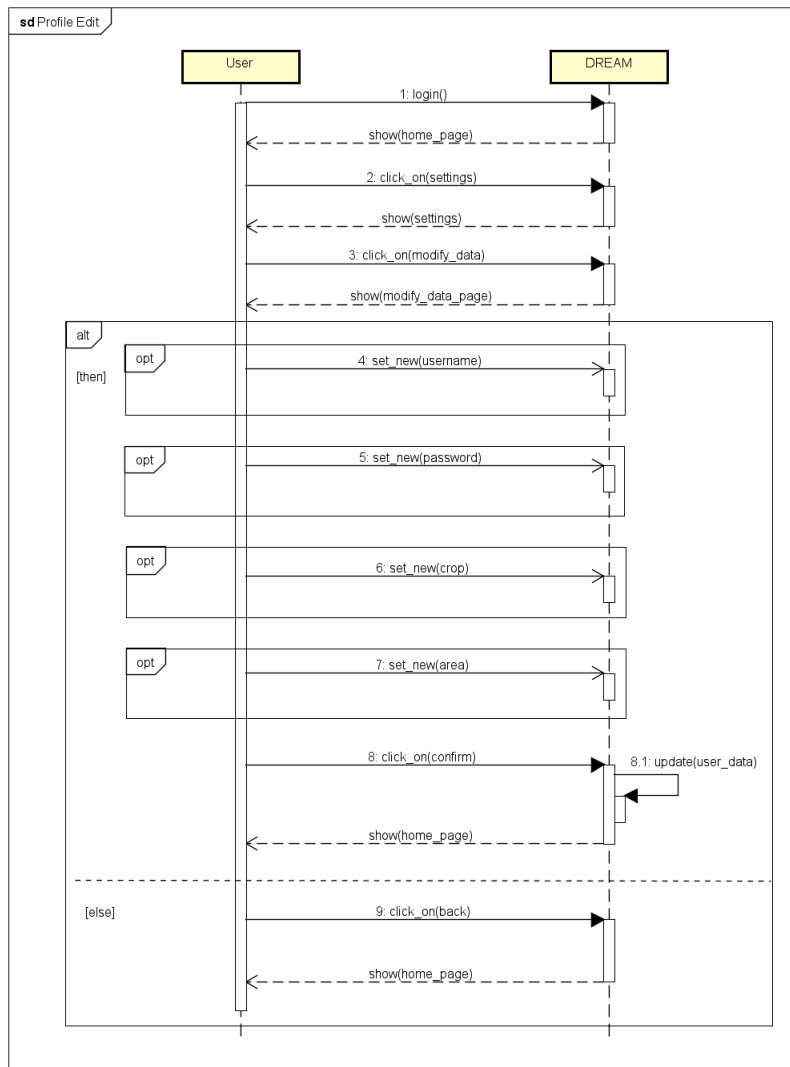


Figure 16: Farmers - Profile Edit Sequence Diagram

Insert Production Data

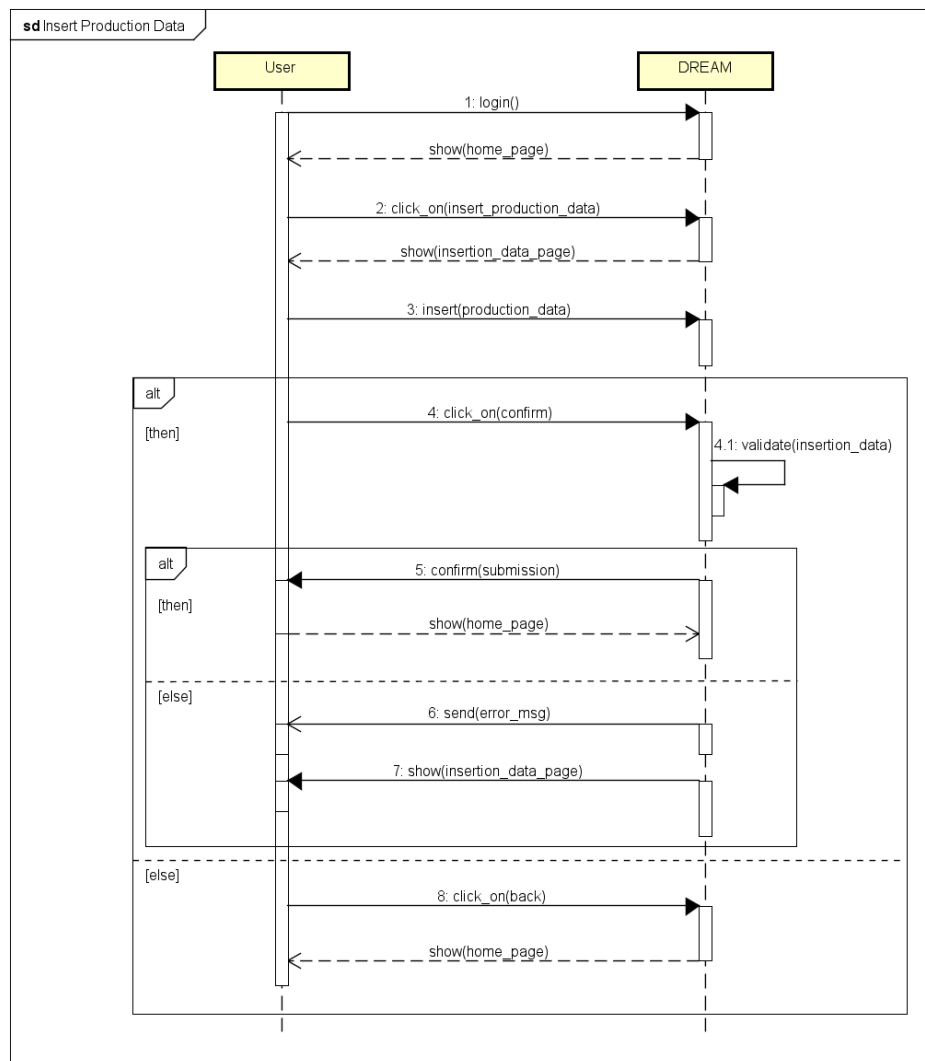


Figure 17: Farmers - Insert Production Data Sequence Diagram

Check News

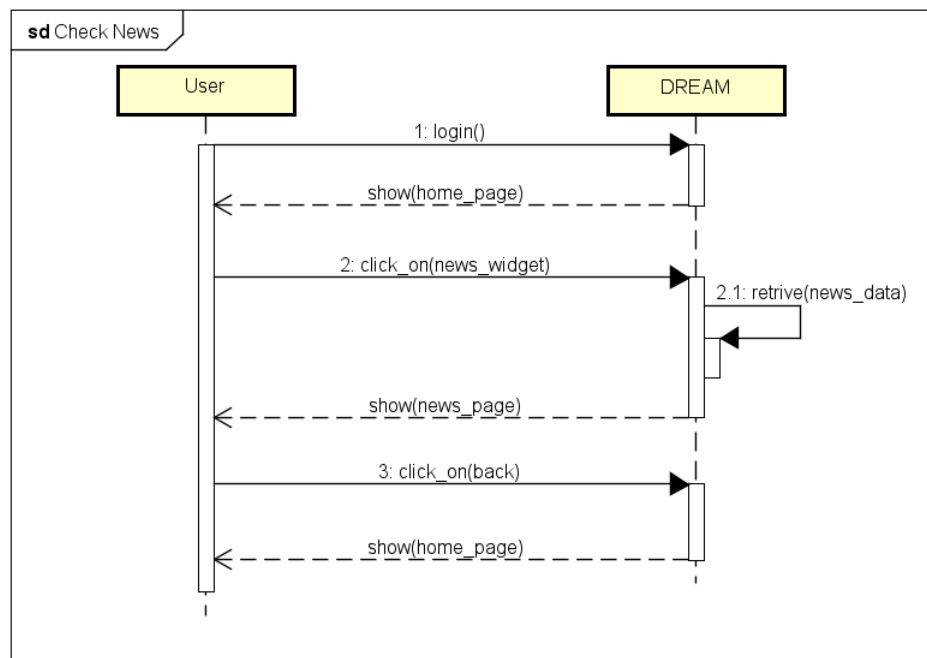


Figure 18: Farmers - Check News Sequence Diagram

Post in the Forum

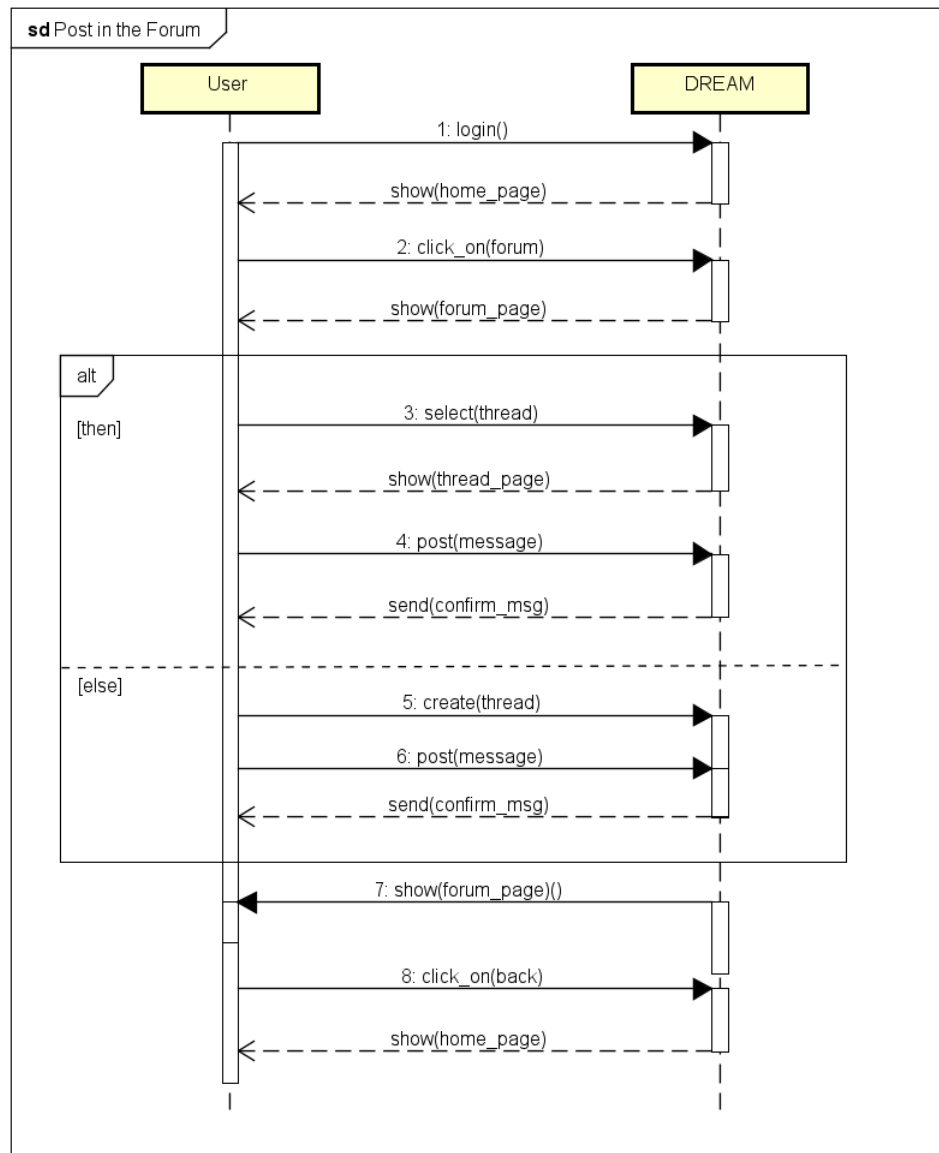


Figure 19: Farmers - Post in the Forum Sequence Diagram

Check Weather Forecast

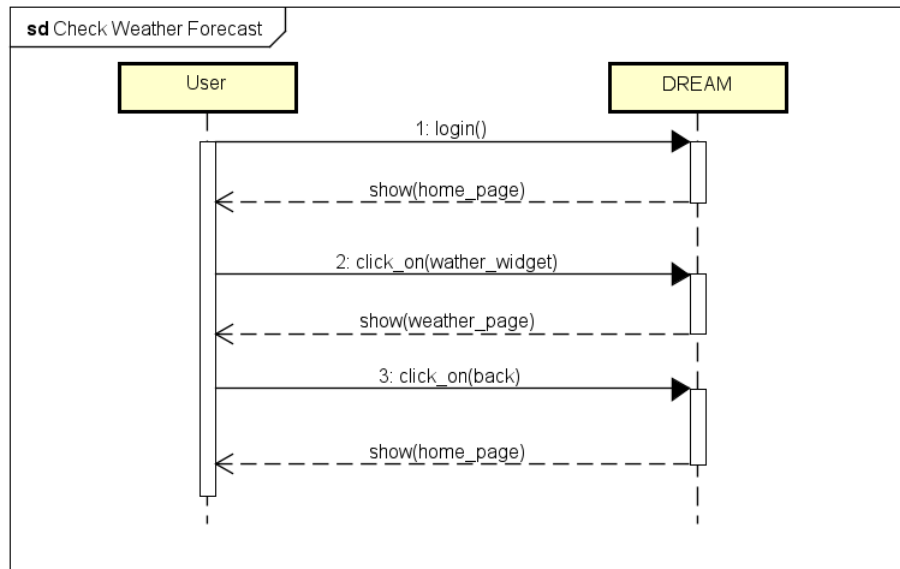


Figure 20: Farmers - Check Weather Forecast Sequence Diagram

Send Help Request

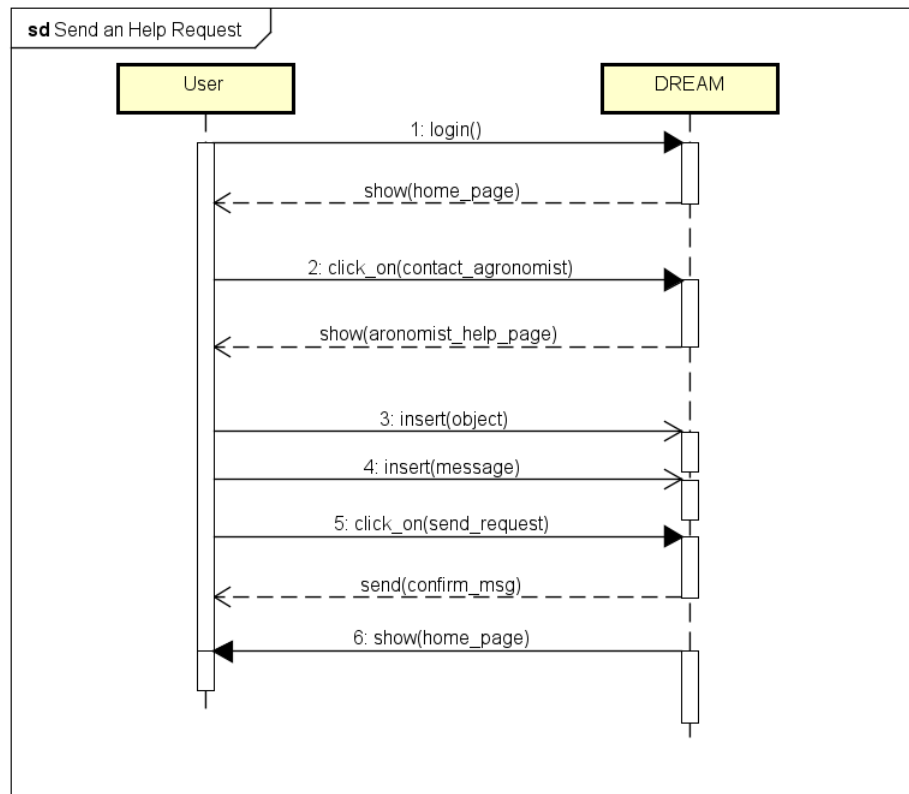


Figure 21: Farmers - Send Help Request Sequence Diagram

- Agronomists

Confirm Daily Plan

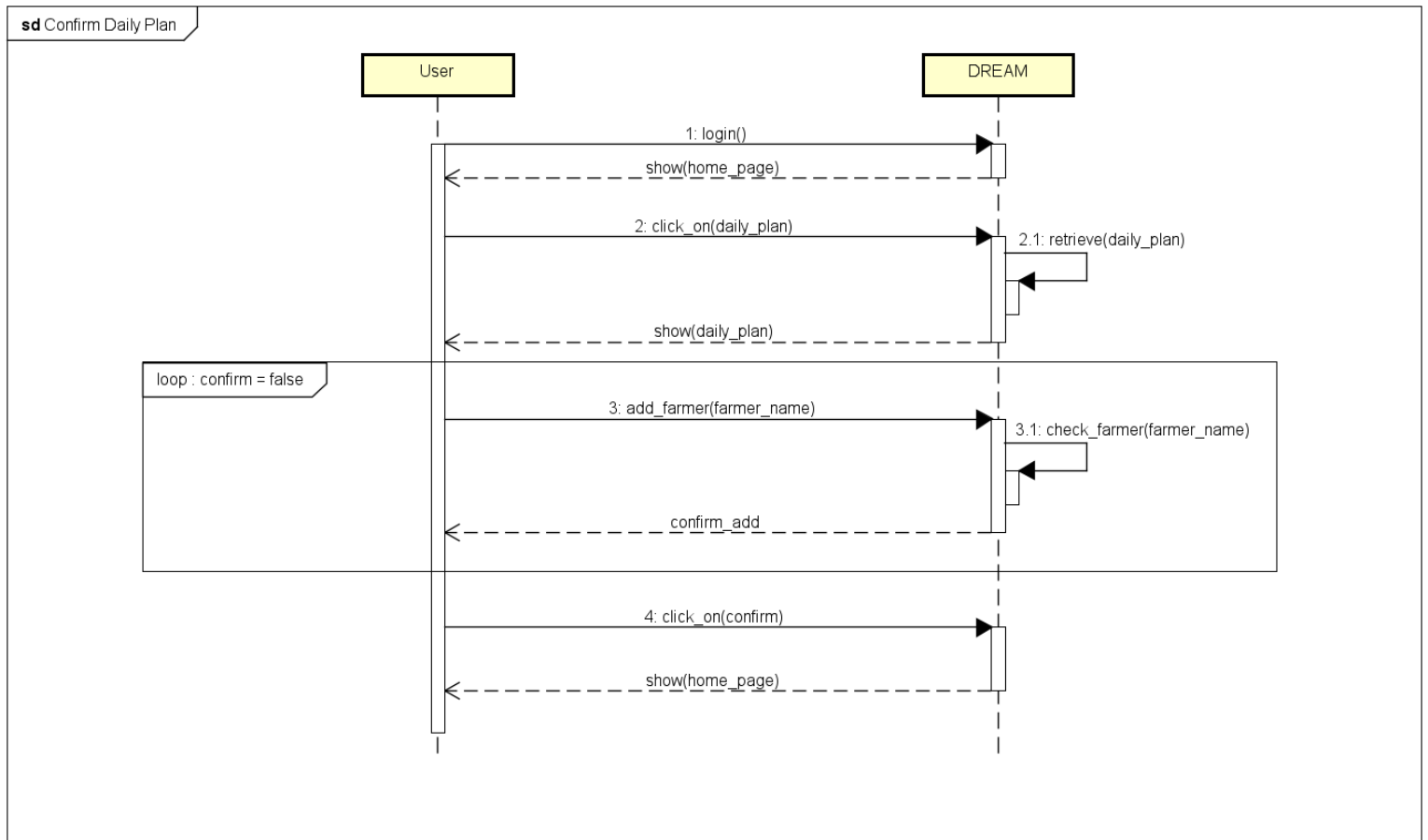


Figure 22: Agronomists - Confirm Daily Plan Sequence Diagram

Update Daily Plan

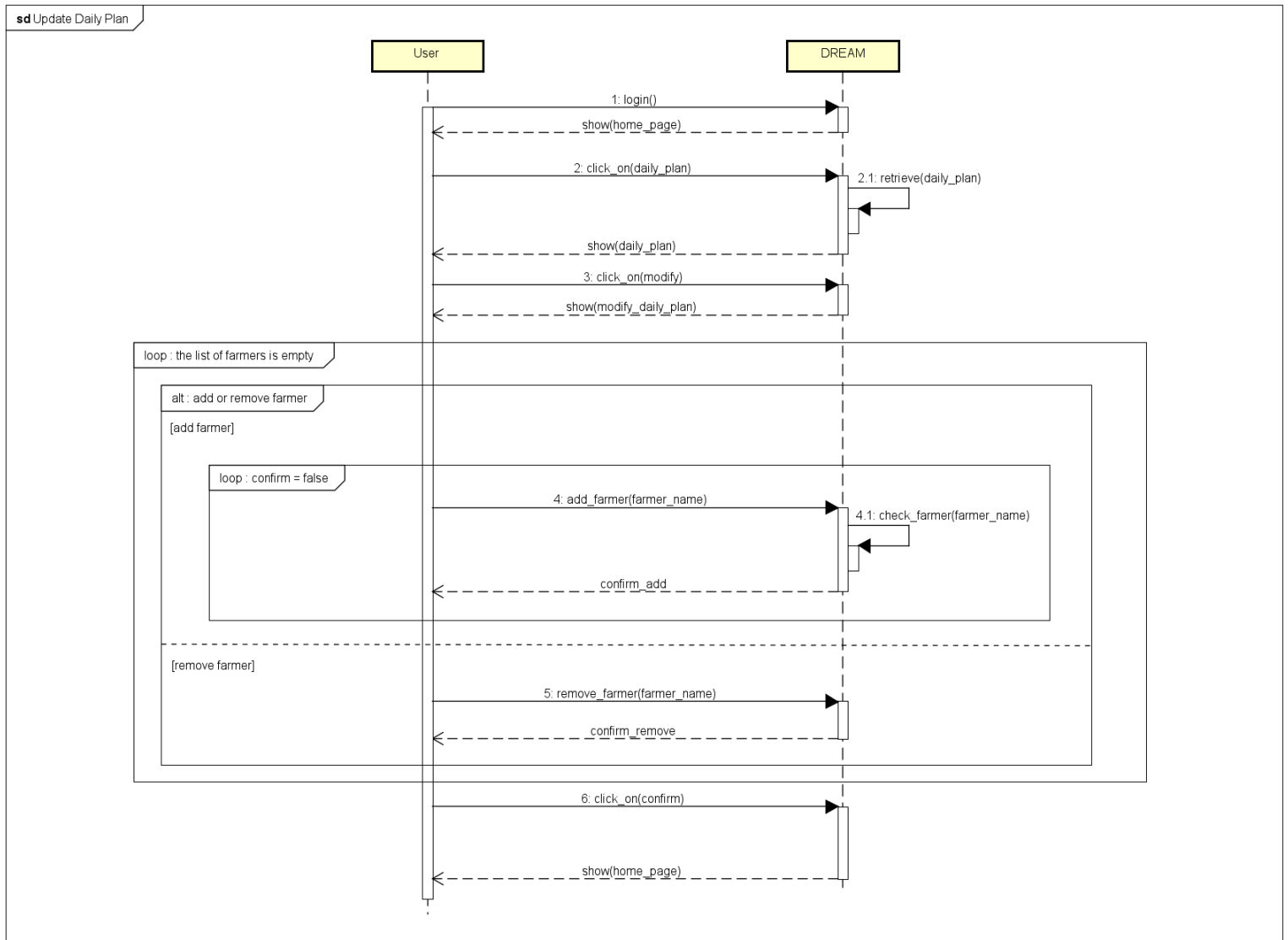


Figure 23: Agronomists - Update Daily Plan Sequence Diagram

Manage Farmers Request

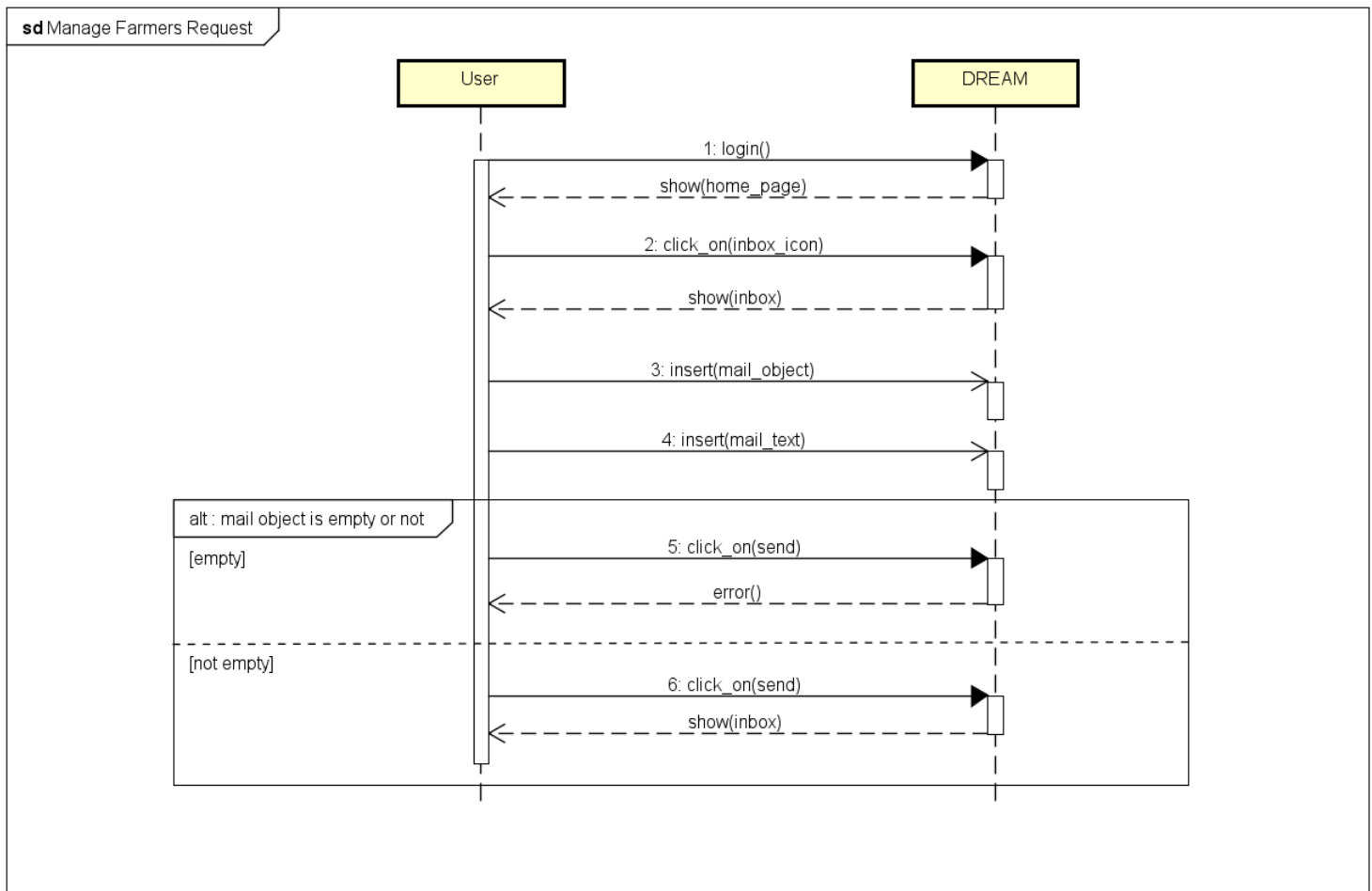


Figure 24: Agronomists - Manage Farmers Request Sequence Diagram

Insert Responsibility Area

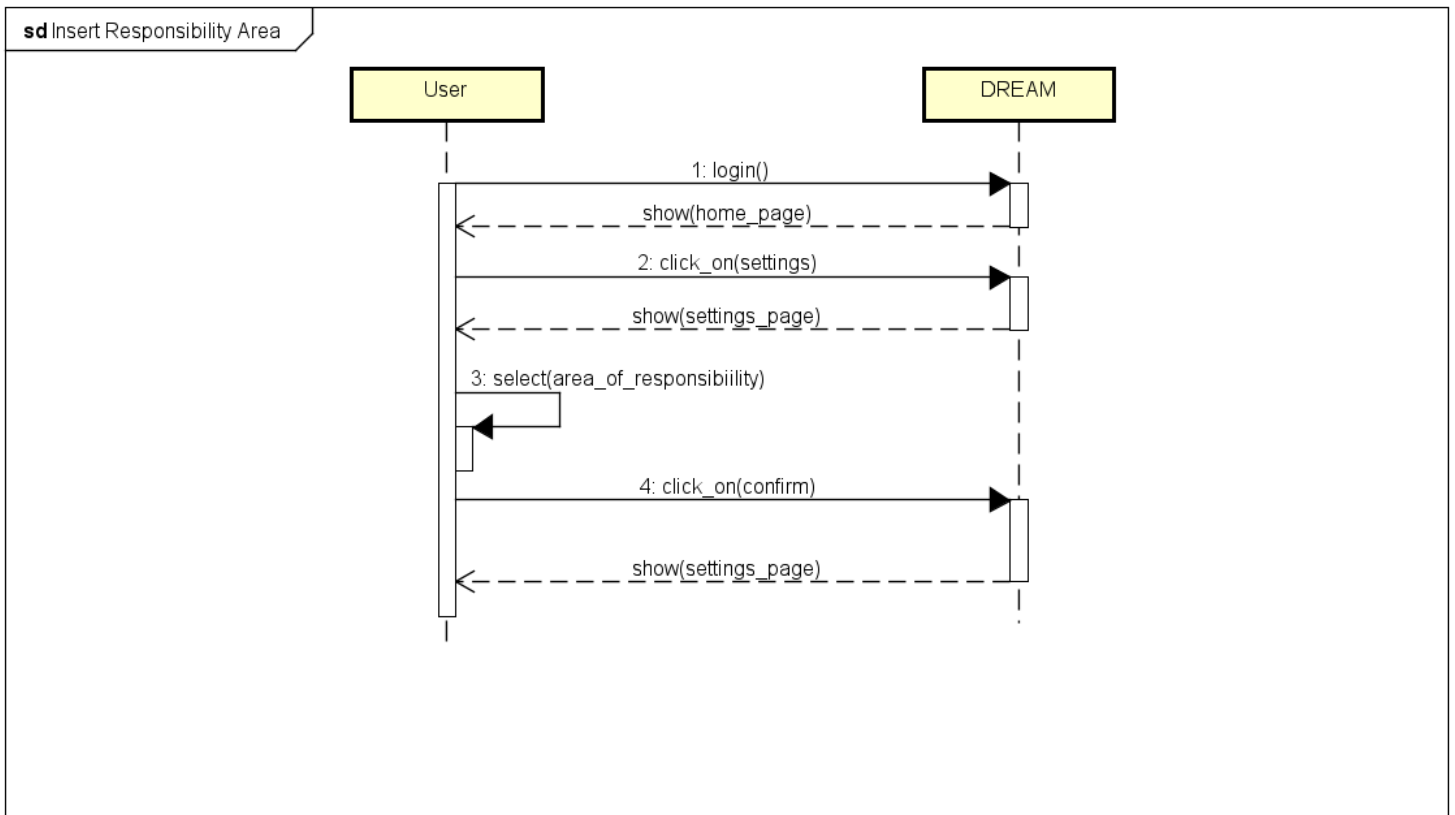


Figure 25: Agronomists - Insert responsibility Area Sequence Diagram

Check Weather Forecast

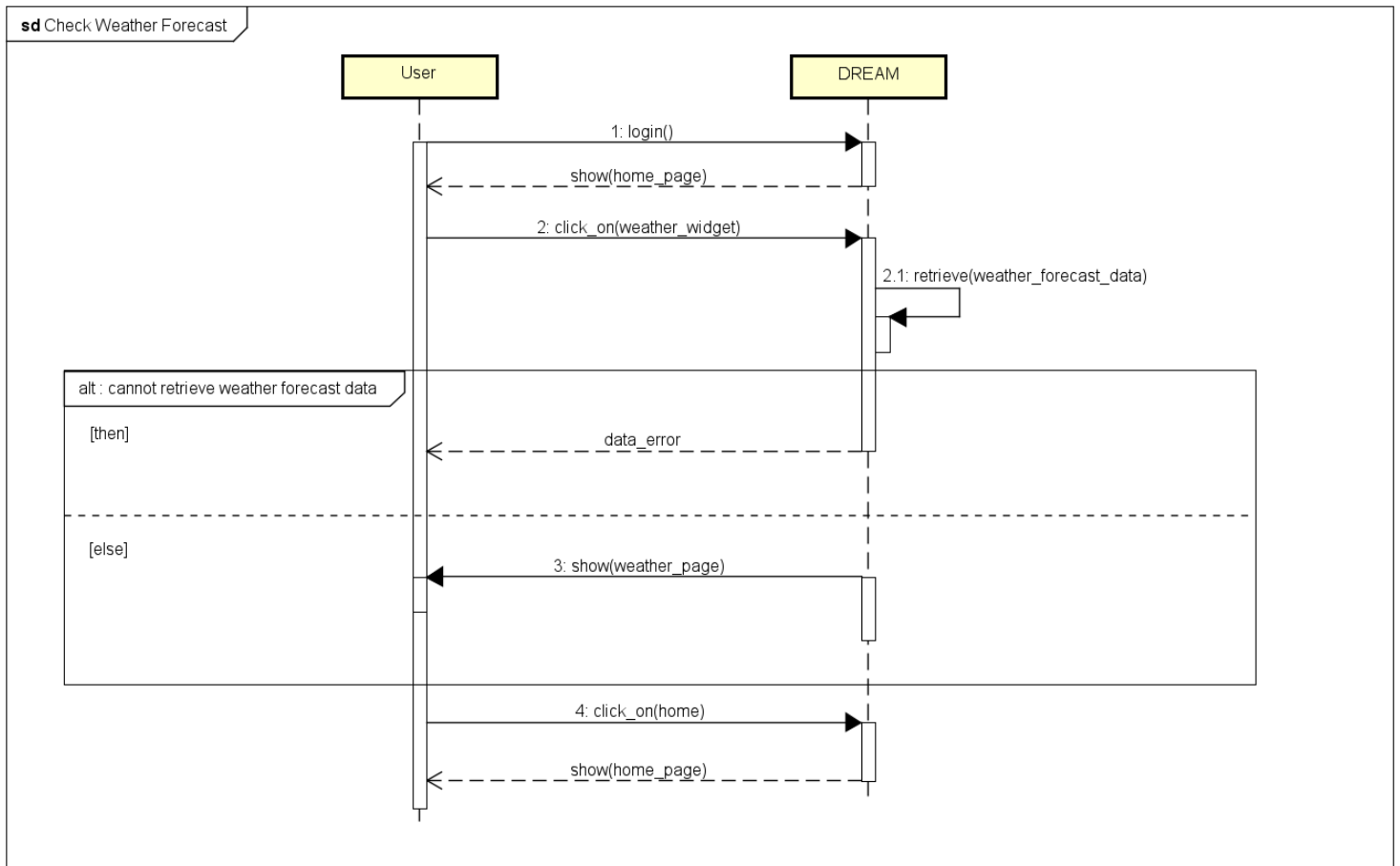


Figure 26: Agronomists - Check Weather Forecast Sequence Diagram

View Farmers Area Ranking

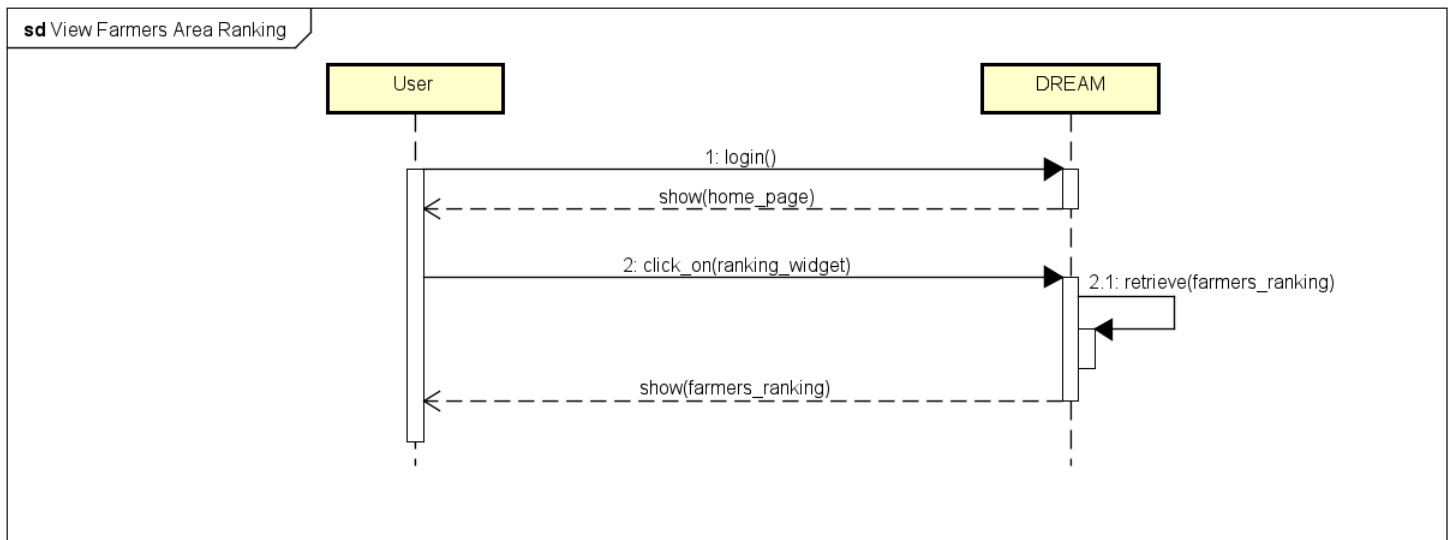


Figure 27: Agronomists - View Farmers Area Ranking Sequence Diagram

3.3 Performance Requirements

The majority of the user base will be represented by the farmers that cover the 58% of the entire population of Telengana. According to Unique Identification Aadhar India the Telengana population in 2021 is estimated to be 39.9 million. This means that the system is expected to be widely adopted with the registration of millions of users just in the first year. Also the average workload of the system is expected to be high, the goal is to guarantee the simultaneous connection of 200.000 individuals. A mid-term goal could be to improve the scalability of the system in order to guarantee an efficient service to all users. Finally the system should have a good response time, less than 3 seconds is reasonable.

3.4 Design Constraints

3.4.1 Standards compliance

DREAM's user data must be treated respecting the law according to the PDPA. All hardware devices distributed all over the territory (sensors) must comply the CE safety standards.

3.4.2 Hardware limitations

The software is designed to enhance the portability, in fact it is enough to have a device with a stable internet connection. In order to use the application correctly it is required to have a device equipped with GPS.

3.5 Software System Attributes

3.5.1 Reliability

To ensure data consistency the system must have a fully backup infrastructure, this allows to recover from general failures in the main system. The four components shown in the *Figure(29)* operate in parallel, this guarantees high reliability and the correct functioning of the overall system in the case of a single component failure. Finally all the components of the system must be characterized by the highest MTTF and by the lowest MTTR possible.

3.5.2 Availability

The system should be up almost 24/7 in order to allow users to use the application's services at any time. The peak of use is expected during the working hours, it means that it is better to do all the maintainance activities during the night hours.

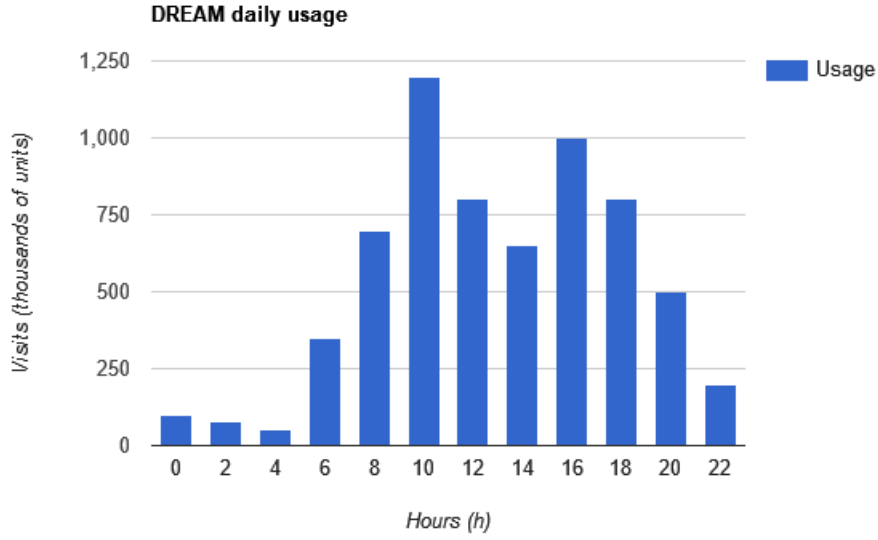


Figure 28: DREAM daily usage

Component	Availability	Downtime
Main System	99.999% (5-nines)	5 minutes/year
Government Website	99.9% (3-nines)	8.76 hours/year
Water Irrigation System	99.9% (3-nines)	8.76 hours/year
Humidity Sensors	99% (2-nines)	3.65 days/year
GPS	99.999% (5-nines)	5 minutes/year
Entire System	99.998%	10 minutes/year

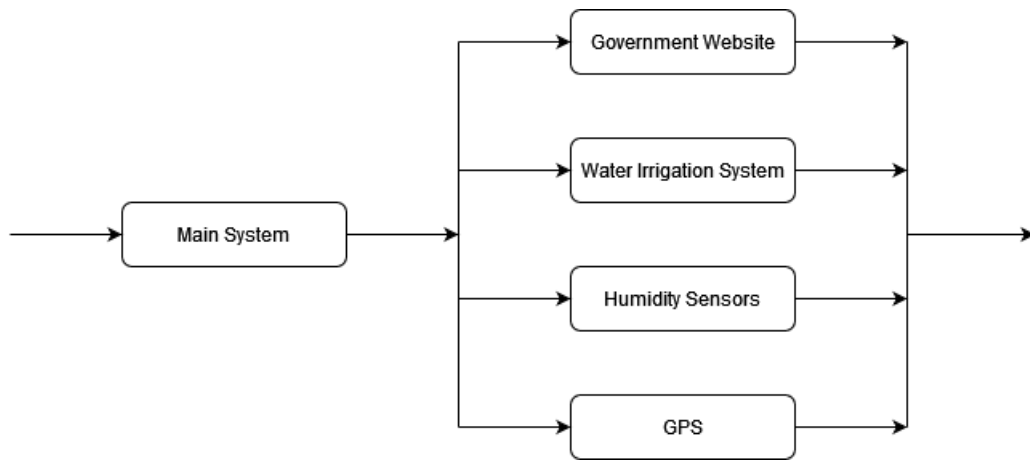


Figure 29: DREAM combined availability

3.5.3 Security

All the data stored by the system must be encrypted with a standard algorithm like the AES (Advanced Encryption Standard). The communications goes on a secure channel powered by the SSL protocol. In addition users can request a two-factor authentication (2FA) to improve the security of the personal account. All data should be stored in compliance with PDPA's regulation.

3.5.4 Maintainability

The maintainability is guaranteed by high standard of code, the use of design patterns will enhance this point and guarantee high reusability. The code must be extensively tested. The system must be extendible in order to support future updates. User's application will be regularly updated.

3.5.5 Portability

The system is designed to work on different operating systems like Windows, MacOS and Linux. All main browsers are supported.

4 Formal Analysis using Alloy

5 Effort Spent

Student	Time for S.1	S.2	S.3	S.4
Ottavia Belotti	2.5h	3h	4h	?
Alessio Braccini	2h	2h	6h	?
Riccardo Izzo	2h	2h	6h	?

6 References