RASD

POLITECNICO DI MILANO 1863

Title: DREAM - Data-dRiven PrEdictive FArMing in Telangana

Description: Based on the project document from teachers

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1. INTRODUCTION

This document contains an analysis of the system starting from a general description of the main goals, functionalities and scenarios. Then it describes the functional and nonfunctional requirements that the system should fulfill, the use cases and their relative sequence diagrams that show the main interactions in the system.

1.1 Purpose

1.1.1 Description

Agriculture plays a key role in India's economy. Many rural households depend on it for their living. The agricultural workforce, mostly composed of farmers with few resources, lives below poverty thresholds. The sector is facing infrastructural issues due to the increasing demand of food and due to the climate changes. This calls for a complete renovation of the entire mechanism that brings food from farms to houses and the development of a resilient production chain. Covid19 and the consequent supply chain issues highlighted even more the necessity of this refurbishment.

For this purpose, Telangana's Government comes into play with the aim of developing anticipatory governance models for food systems using digital public goods and community-centric approaches to strengthen data-driven policy making in the state. Primarily, Telangana decided to cooperate with IT providers to obtain and elaborate environmental, social and production data. Such data are given as input to DREAM, the application to be developed.

The main goals to be achieved with this application can be summarized in providing appropriate support for all the professionals involved in Telangana agricultural sector. The main actors involved are policy makers, farmers and agronomists. A detailed and complete list of the goals is provided in the next part of this section.

1.1.2 Goals

Goals	Description
Policy Makers related goals	
G1.1	Provide policy makers with data about farmers' production performances.
G1.2	Allow policy makers to identify farmers with best performances, especially the ones that faced adverse weather conditions.
G1.3	Allow policy makers to identify farmers with worst performances.
G1.4	Allow policy makers to identify whether agronomist initiatives increase farmers' production performances.

Farmers related goals	
G2.1	Provide quantitative data to each farmer based on location and type of production.
G2.2	Allow farmers to open discussions between them in the forum.
G2.3	Allow farmers to participate in forum discussions already opened.
G2.4	Allow farmers to send help requests to other farmers in the same area and the responsible agronomist.
G2.5	Allow farmers to send requests for suggestions to other farmers in the same area and the responsible agronomist.
G2.6	Allow farmers to receive help requests from their peers in the same area.
G2.7	Allow farmers to receive suggestion requests from their peers in the same area.
G2.8	Allow farmers to reply to help requests they received.
G2.9	Allow farmers to reply to suggestion requests they received.
G2.10	Allow farmers to insert their production data in the system.
G2.11	Allow farmers to insert into the system data about any problem they face.
Agronomists related goals	
G3.1	Allow agronomists to select their area of influence.
G3.2	Allow agronomists to receive help requests from farmers in their area.
G3.3	Allow agronomists to receive suggestion requests from farmers in their area.
G3.4	Allow agronomists to reply to help requests from farmers in their area.
G3.5	Allow agronomists to reply to suggestion requests from farmers in their area.
G3.6	Allow agronomists to get weather forecasts of their area of influence.
G3.7	Allow agronomists to get the list of farmers ordered according to best or worst performances in the area.
G3.8	Provide agronomists with a daily plan of the farms to be visited.
G3.9	Allow agronomists to update their daily plan.
G3.10	Allow agronomists to confirm the execution of the daily plan.
G3.11	Allow agronomists to specify the deviations from the original plan at the

	end of each day.
Other goals	
G4.1	Allow the DREAM system to acquire data concerning meteorological short-term and long-term forecasts.
G4.2	Allow the DREAM system to acquire data measured by the water irrigation systems.
G4.3	Allow the DREAM system to acquire soil humidity data obtained by sensors.

1.2 Scope

In this section, the phenomena related to the machine, which is the software to be developed, and to the world which is the real environment in which DREAMS will be used are enumerated. A phenomenon can be shared if it is controlled by the world and observed by the machine or vice versa.

1.2.1 World phenomena

World Phenomena	Description
WP1	Telangana government collects data about meteorological short-term and long-term forecasts.
WP2	Farmers collect data about the type of products they are producing.
WP3	Farmers collect data about the amount of product of each type they are producing.
WP4	Water irrigation systems collect the amount of water used by each farmer.
WP5	Sensors placed throughout the whole territory, collect data concerning the humidity of the soil.
WP6	Agronomists collect data from farms they visit.
WP6	Agronomists perform initiatives.
WP7	Policy makers judge agronomist initiatives.
WP8	The farmers performing well with respect to production are rewarded with special incentives.
WP9	Farmers in the same area share suggestions with each other.
WP10	Farmers in the same area help each other.

WP11	Agronomists give suggestions to farmers in their area.
WP12	Agronomists help farmers in their area.
WP13	Farmers have discussions with other farmers on agriculture related topics.

1.2.2 Shared phenomena

Shared Phenomena	Description	Control
Shared phenomena connected with Policy makers		
SP1.1	The system shows to policy makers data relevant to farmers and their production.	Machine Controlled
SP1.2	The system shows to policy makers an entire overview of farmers production performances.	Machine Controlled
SP1.3	Policy makers evaluate agronomist initiatives.	World controlled
Shared phenomena connected with Farmers		
SP2.1	Farmers insert in the system data about their production.	World Controlled
SP2.2	Farmers insert in the system data about any problem they face.	World Controlled
SP2.3	Farmers insert in the system requests for help.	World Controlled
SP2.4	Farmers insert in the system requests for suggestions.	World Controlled
SP2.5	Farmers answer requests for suggestions that they received.	World controlled
SP2.6	Farmers answer help requests that they received.	World controlled
SP2.7	Farmers create discussion posts.	World Controlled
SP2.8	The system shows farmers data relevant for their own production.	Machine Controlled
Shared phenomena connected with Agronomists		

SP3.1	Agronomists insert the area they are responsible for.	World Controlled
SP3.2	Agronomists receive requests for help from farmers in their area.	Machine Controlled
SP3.3	Agronomists receive requests for suggestions from farmers in their area.	Machine Controlled
SP3.4	Agronomists answer requests for help they received.	World Controlled
SP3.5	Agronomists answer requests for suggestions they received.	World controlled
SP3.6	The system shows an agronomist a daily plan to visit farms in his area.	Machine Controlled
SP3.7	Agronomists update the daily plan to visit farms in his area.	World Controlled
SP3.8	The system shows to agronomists data concerning weather forecasts in his area.	Machine Controlled
SP3.9	The system shows agronomists data about farmers' performances in their area.	Machine Controlled
SP3.10	Agronomists confirm the execution of their daily plan.	World Controlled
SP3.11	Agronomists register deviations from their original daily plan.	World Controlled

1.2.3 Machine phenomena

Machine Phenomena	Description
MP1	The system computes the production performances of farmers.
MP2	The system generates daily plans for agronomists so that they visit every farm in their area at least twice every year.
MP3	For each farm, the system maintains a counter for every visit in the current year.
MP4	The system updates the visit count to zero within 24

	hours from the beginning of the new year.

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

Terms	Definition
Farmer	A person who owns or manages a farm.
Policy maker	A person responsible for or involved in formulating policies.
Agronomist	An expert in the science of soil management and crop production.
Weather Forecast	An analysis of the state of the weather in an area with an assessment of likely developments.
Information	Facts provided or learned about something or someone.
Daily Plan	It is the mapping of one's daily activities.
Visit	Go to see and spend time with someone socially.
Initiative	An act or strategy intended to resolve a difficulty or improve a situation; a fresh approach to something.
Best practices	Professional procedures that are accepted or prescribed as being correct or most effective.
Problem	A matter or situation regarded as unwelcome or harmful and needing to be dealt with and overcome.
Discussion Forum	A web page where users can post comments about a particular issue or topic and reply to other users' postings.
Sensor	A device which detects or measures a physical property and records or otherwise responds to it.
Peer	A person that belongs to the same category.

1.3.2 Acronyms

Acronyms	Description
DREAM	**D**ata-d**R**iven Pr**E**dictive F**A**r**M**ing in Telangana
RASD	Requirements Analysis and Specification Document

UML	Unified Modeling Language
IEEE	Institute of Electrical and Electronics Engineers
API	Application Programming Interface

1.3.3 Abbreviations

Abbreviations	Description
S2B	Software to be
PC	Computer
IT	Information technologies
e.g.	Exempli gratia
w.r.t.	With reference to
MP	Machine Phenomena
G	Goal
SP	Shared Phenomena
WP	World Phenomena
R	Requirements
D	Domain
NB	Note well
Webapp	Web Application

1.4 Revision history

Version	Date	Description
0.0	7/11/2021	Project opening.
1.0	19/12/2021	First release.
1.1	20/12/2021	Graphical Interfaces review.
1.2	21/12/2021	Alloy review.
1.3	22/12/2021	Fixed typos.

1.5 Reference Documents

- Slides of the lectures
- Specification document “01.Assignment RDD AY 2021-2022”
- ISO/IEC/IEEE 29148-2018 - International Standard - Systems and software engineering - Life Cycle Process - Requirements Engineering
- Telangana website: Telangana State Development Planning Society
- Community paper: *Artificial Intelligence for Agriculture Innovation*

1.6 Document Structure

The document is divided into six parts.

- **INTRODUCTION**: It gives an overview on the purpose and scope of the document, defining the main goals and phenomena and the definitions, acronyms, and abbreviations of the most used terms. It also contains the revision history and the reference documents to better underline how it has been developed.
- **OVERALL DESCRIPTION**: It contains scenarios and further details on the shared phenomena given through class diagrams and state charts. Moreover, it describes the major functions of the application and their constraints.There is also information about users and their main characteristics in order to clarify their needs. Finally, the domain assumptions that can be deducted from the assignment are included.
- **SPECIFIC REQUIREMENTS**: It includes more details on all the aspects in section 2 which can be useful for the development team. It represents the core of the document as it contains the functional and non-functional requirements, described through the definition of the use cases and their associated sequence/activity diagrams.There are also described the requirements on the external interfaces and the design constraints.
- **FORMAL ANALYSIS USING ALLOY**: It consists of the model designed using Alloy and the corresponding metamodel generated from the code, in order to formally describe the application.
- **EFFORT SPENT**: It includes information about the number of hours each group member has worked for the development of the document.

2. OVERALL DESCRIPTION

2.1 Product perspective

The system will be developed from scratch.

2.1.1 Scenarios

1. **(Policy Maker): The power of data**

Dinesh Neelam is an elected policy maker from Telangana. To perform his job properly he requires to collect all data on the agricultural sector of the state. He was used to getting some data from the country and collecting the rest by himself but everything changed with the advent of the DREAM application. The system presents him in his home page a thorough overview of all data about the agricultural sector of Telangana. Data is not only well grouped in tables but also pre digested and the good things do not stop here, Dinesh is given from the system the possibility to filter and manipulate data to obtain the view he needs to compute all his tasks for the Telangana government.

2. **(Farmers): Production production production**

Naresh Padawan is a hardworking and energetic farmer who is very committed to his job. He is very proud of his production performances and knowing that Telangana offers special incentives to farmers that are achieving good results, Naresh is looking forward to communicating to Telangana his production data. He has two possibilities: contacting the supervision authority or using the DREAM application. Naresh opts for the latter because he wants to remain updated with new technologies and he likes DREAM functionalities. After logging in, he can finally reach, with just a few and easy steps, the form to insert his production performances data.

3. **(Farmers): Help!!!**

Vipan Rai is a farmer with a medium sized plot of land. Recent harvests have seen a gradual reduction in the yield of wheat per unit area. Furthermore, the low humidity of the soil made it necessary to increase the quantity of water for irrigation during the dry season, while the heavy rains during the rainy season made the soil less favorable for sowing, resulting in an increase in the quantity of seeds per kilogram of harvested product. Vipan, already used to the DREAM service, decides to ask other farmers and the reference agronomist for help. He accesses the DREAM web application, logs in and decides to post a request for help. Vipan fills in the appropriate form with the characteristics of the problem. The system shows the request to all farmers in his area and to the responsible agronomist. The request is read by the agronomist and the farmers and they propose solutions to increase the yield of the land. Vipan reads the answers and once satisfied he closes the request for help. Once closed, the system allows access but new messages cannot be added.

4. **(Farmers): Constructive discussions**

Sweta Patel is a curious girl and loves to experiment new methods to increase his harvest. Sweta has read in an agricultural magazine about a new sowing technique used in European countries with a temperate climate and is planning to implement it in her area. The technique has low application costs if used on a minimum surface that is greater than that of the fields in her possession. The farmer decides to promote the technique to find other farmers with

whom to share the costs. The woman accesses the DREAM web app, enters the forum, creates a discussion and inserts information on the new method. Other farmers read the message, asking for clarification to which she replied. After a few days, some other farmers agreed to try the introduction of the new technique in their fields.

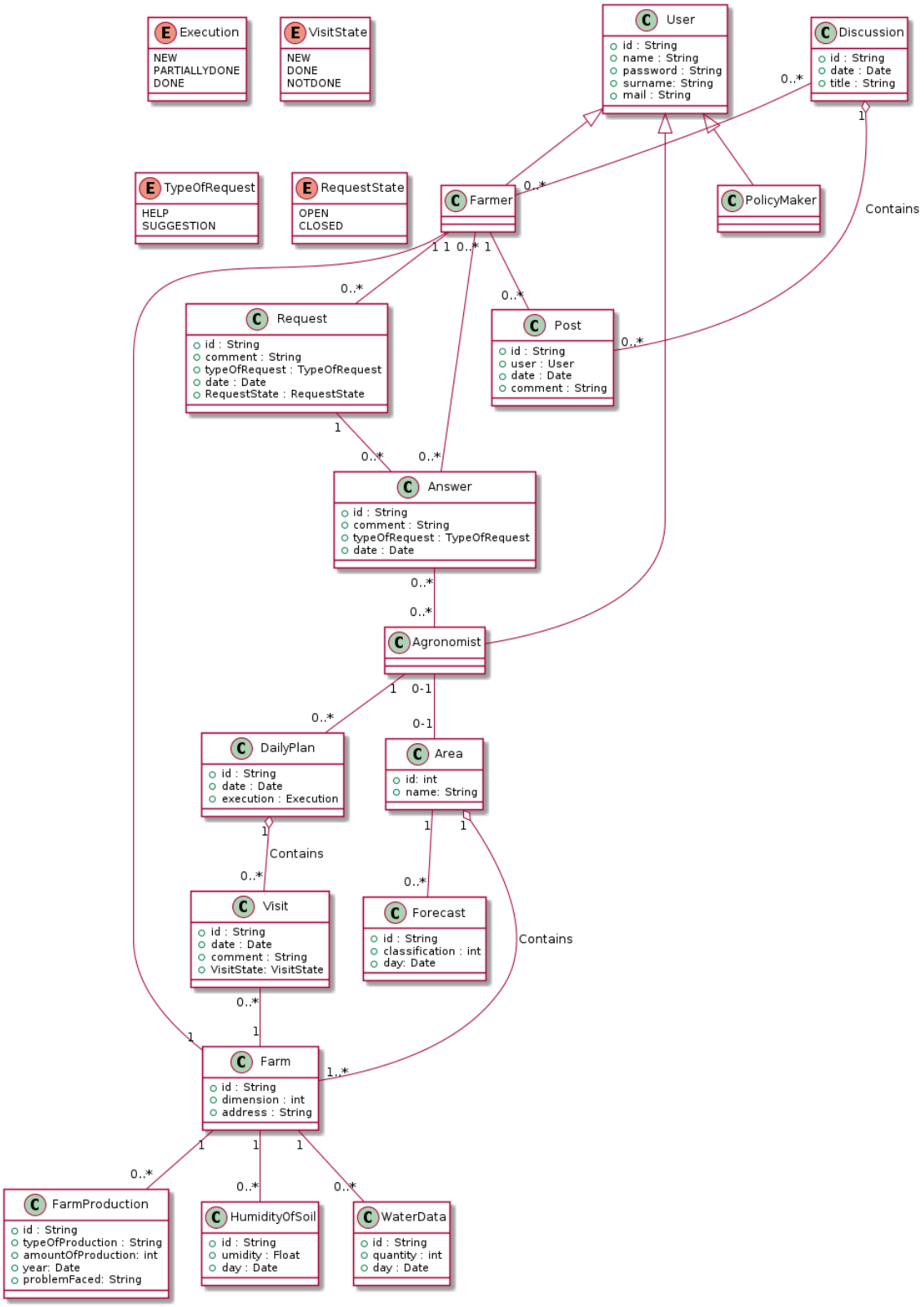
5. **(Agronomists): From stack to tech**

Pavan Singh, a renowned agronomist, is not used to interacting with technology and web applications so he was skeptical about DREAM. He decided to give the web app a try because everyone was talking well about it. After logging in the application for the first time he was pleased because it was really easy to navigate and to use. Being his first access, he had to choose his area of influence so he selected the area corresponding to where he usually offers his services, which was free, as he is the only agronomist within some kilometers. He was really happy to see how easy it was and he was even more convinced by the DREAM functionalities due to the daily plan he received the very next day which was easy to read and well designed.
The following year Pavan moved with his family to a new place. He noticed that visiting farms of his area required three more hours a day with respect to the previous zone. Hence he decided to change his area of influence and selected a new zone nearby that allowed him to visit farms with a shorter trip and thus to keep a good quality of life that helps to maintain his high performances and a good job experience.

6. **(Agronomists): The agronomist's breakfast**

The first thing that Manushri Narar, a young agronomist, does every day before having breakfast is accessing the DREAM application early in the morning. She is very proud of her job and wants to offer the best possible service. After logging in she sees her daily plan and all the statistics related to her area. In this way, she knows exactly what she will be required to face during the day and she can prepare by thinking about what to do during the visits to the farms or she can even consider changing his plan according to the last statistics the application provided her, especially by visiting farmers that sent an help request.

2.1.2 UML Class Diagram



The UML class diagram provides a model of the application structure, focusing on the main classes and attributes of the system to be developed. Thus, it does not include every class that will be necessary to define the complete architecture of the system. The roles of each class will be further explored in the Design Document. Down here there is a brief explanation of each class with its function and attributes:

- **User:** The user class manages data which are related to the authentication process of the actors. Moreover it is the father class of three possible kinds of users which are Farmer, Agronomist and PolicyMaker.

- **Forum:** This is a class that's an aggregate of posts instances, primarily used for communication between farmers. The post itself represents a message reporting its author and the time of publication. The posts are used in order to let the users communicate asynchronously.

- **Area:** This is a class that represents a geographic region of competence of an agronomist, defined by a group of farms owned by farmers. This class represents the workspace of an agronomist.

- **Request:** This class is used for direct communication between farmers and agronomists with the aim of requesting help or providing suggestions for the practical management of agricultural activities.

- **Farm:** This is a class that describes the set of resources of a farmer and the set of information related to the management of the farm itself. In particular, data related to local weather forecasts, type and amount of production, technical data about humidity of the soil, or water consumption of the property are all listed in here.

- **FarmProduction:** This is a class that describes the amount and the type of products grown and harvested in a particular field in relation to a specific period.

- **HumidityOfSoil:** This is a class that collects data about the humidity of the soil of a particular cultivated farm in relation to a specific period.

- **WaterData:** This is a class that collects data about the water consumption of a particular cultivated farm in relation to a specific period.

- **Forecast:** This is a class that collects data about short and long term weather forecasts for a particular field in relation to a specific period.

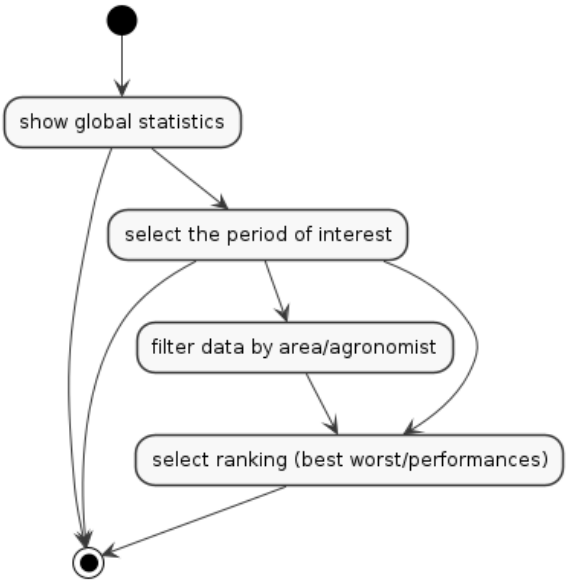
- **DailyPlan:** This class represents a daily schedule of visits of agronomists to farms belonging to his working area in order to promote initiatives to improve the yield of the fields and disseminate best practices in the management of agricultural fields. Such a class is given by a composition of Visits instances .Such a schedule can be updated from an agronomist in order to meet the needs of the farmers.

- **Visit:** this class describes a scheduled/performed visit by an agronomist to a farmer belonging to his working area.

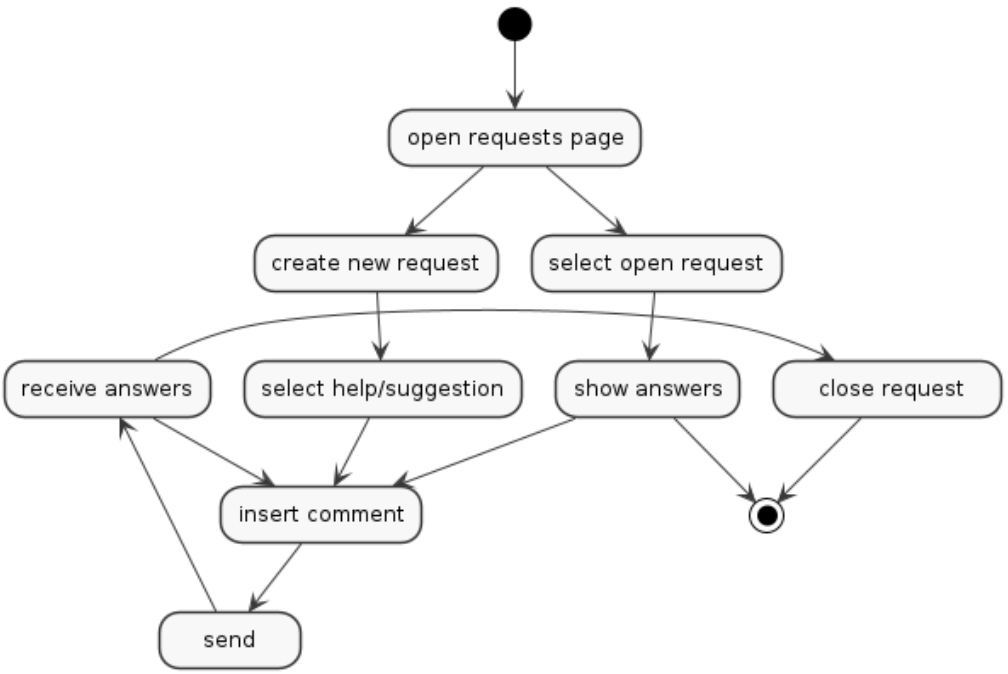
2.1.3 Statechart diagrams

In this section we are going to analyze the most critical features of the application for each category of main actors: data visualization for policy makers, daily plan management for agronomists and creation of help or suggestion requests for farmers. Modeling the behaviors of the system and showing its evolution, from state to state, over time is achieved through state diagrams, which are reported below.

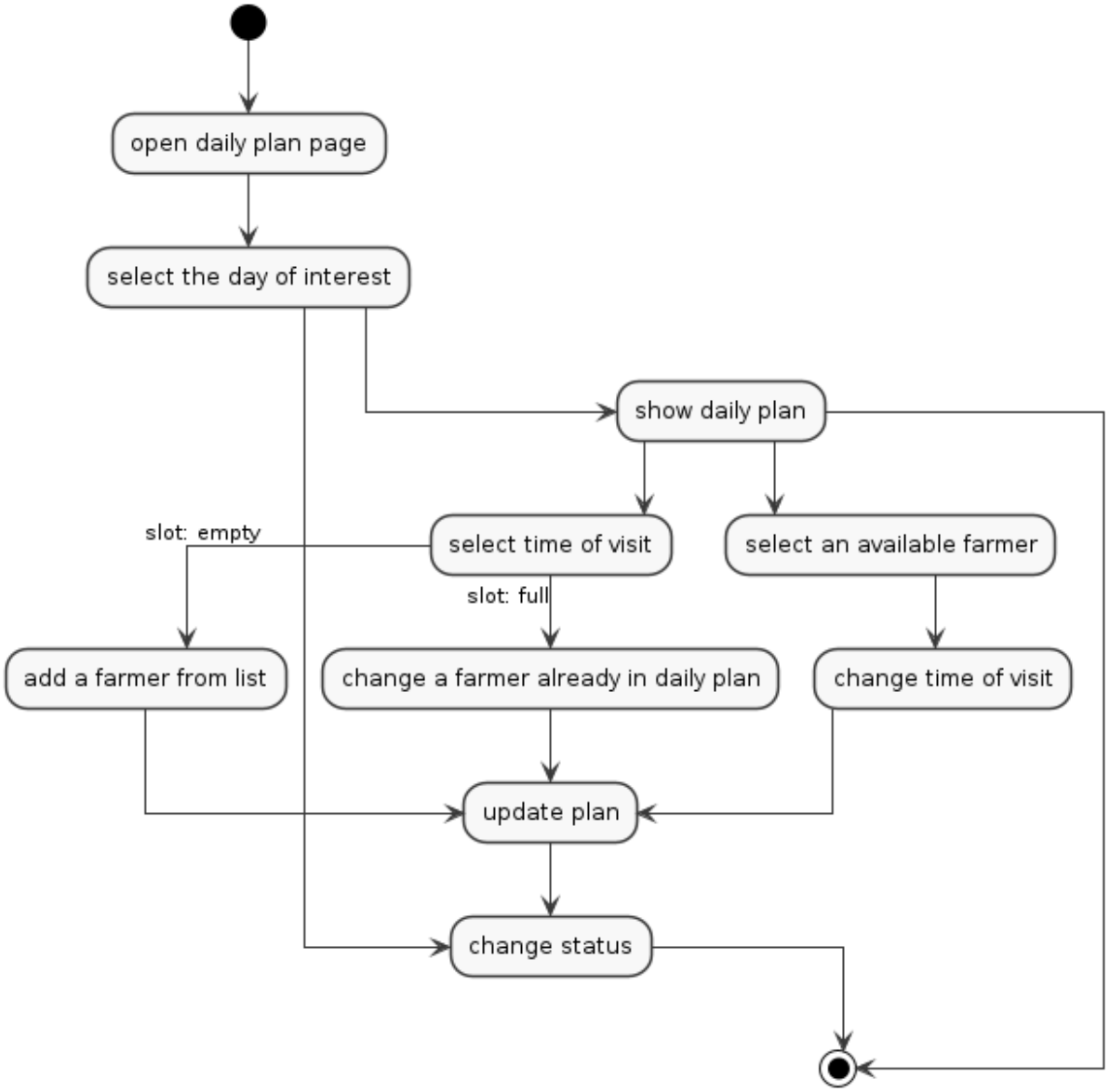
- **Data visualization for policy makers**



- **Request management for farmers**



- **Daily plan management for agronomists**



2.2 Product functions

In this section the main functionalities of DREAMS are listed and explored in detail. They are linked to the main type of actors that will use the application.

2.2.1 [Policy makers] Monitoring general statistics.

The main job of policy makers is not directly addressed by the DREAM application. Nevertheless, the system is the perfect solution to support the activities of policy makers by showing data in the best possible way, offering them an overview of the agricultural situation in Telangana. After logging in, Policy makers are presented with data grouped into tables so that they can comfortably inspect general statistics or filter data tightening the scope of their

research to fit their needs. They can filter data either for area or for time periods. Thereafter, they can easily identify best or worst farmers in terms of performances or understand the changes in the production.

2.2.2 [Farmers] Monitoring their own statistics.

The DREAM application offers farmers a view on their own data appropriately elaborated and grouped in tables together with data about weather forecasts, humidity sensors and water consumption for irrigation. They can obtain some of these statistics just by logging in into the system in their home page where they find general data. Then, in another page, they can find their past production data in a table. The tabular view offered by the system is really convenient because it gives an overview of the situation with just a glance. Farmers can apply filters on the table to better explore their statistics by ordering data according to a particular column.

2.2.3 [Farmers] Inserting data about production and about problems encountered.

Farmers have to communicate to Telangana their production data and the problem they face. DREAM allows every farmer to do it in an easy way, they can find the appropriate button in their home page. After pressing it, they are moved to a new page with a form to fill with all the mandatory fields. Data is uploaded in the system when submitted. Farmers can insert data whenever they harvest part or all the crop.

2.2.4 [Farmers] Sending help and suggestion requests.

DREAM offers farmers a way to broadcast their requests immediately to all farmers in the same area and to the responsible agronomist. In the request page every farmer can see a table with a list of old requests that can be either help or suggestion ones. Near the table they can find the button to navigate from the main page to the form that allows farmers to insert a new request. The request is immediately sent to other farmers in the area and the responsible agronomist and it will collect the responses. Once that the farmer is satisfied he can select his request and change its state to “close” so that new insertions are prevented.

2.2.5 [Farmers] Responding to help and suggestion requests.

As we have seen, the system allows all farmers to send help or suggestion requests to their peers in the area and to the responsible agronomist. In their request page, they are offered the list of all requests so that they can either read old requests to collect the pieces of advice that they consider useful or they can respond to “open” requests by giving their expertise on the presented topic/problem. When they decide to reply to a request, DREAM shows them the appropriate form. Once filled they just have to submit their response.

2.2.6 [Farmers] Creating and interacting with forum discussions.

The DREAM application provides to all farmers the discussion forum which is a safe place where to start a discussion on any topic agriculture related. In this way, everyone can interact with a plethora of peers by creating a new discussion or joining a new one. The forum is easily reachable from the home page. The farmers are shown the page with the list of all discussions already created and the button to create a new one. He can participate in an existing discussion just by appending a new comment or, if he prefers, he can start a new one by clicking the previously mentioned button and then inserting in the appropriate form the title and the first message.

2.2.7 [Agronomists] Selecting area of influence.

DREAM optimizes the Telangana management of agronomists. This process is obtained by grouping all farms into areas that can be followed by a single agronomist. When an area is assigned to an agronomist it cannot be given to another one until it's freed from the previous supervisor. During the very first interaction with the app, a form is shown to the agronomists, asking them to select the area where they prefer to perform their job. The area can be changed at any moment and the new choice is assigned to them provided that it's available.

2.2.8 [Agronomists] Monitoring statistics of their area of influence.

DREAM shows to agronomists data related to their area of influence after careful elaboration and aggregation into appropriate tables. They can obtain the overview of their area immediately in the home page after the log in. Agronomists can inspect general statistics like weather conditions and forecasts or the production of each farmer in their area. As for other actors they can filter data to change the scope of their view.

2.2.9 [Agronomists] Responding to help and suggestion requests.

DREAM offers an automatic system through which farmers can send either help or suggestion requests. Agronomists can see all requests belonging to their own area in their request page and they are allowed to respond to the entries marked as "open". Old entries, which are in a "close" state and thus cannot be modified anymore, are still available for reading.

2.2.10 [Agronomists] Managing the daily plan.

DREAM offers agronomists the perfect tool to easily plan the visits to the nearby farms. In their home page, agronomists can visualize their current daily plan, which is automatically computed, together with all other statistics and data. The application wants not only to support agronomists by helping them to organize their daily activities, but also to leave them flexibility and autonomy. In fact, the system offers them the possibility to update their plans in advance just by moving to the appropriate page and by clicking on the time slot. After completing the form and submitting it the changes become effective. The only constraint is that every farm has to be visited at least twice every year. Last but not least, the system asks

agronomists to confirm the execution of their plan or to specify the deviations from the original one so that consistency is maintained in case that some unforeseen circumstances had emerged.

2.3 User characteristics

DREAM is an application suitable for every actor involved in Telangana's agricultural sector that owns or has access to a digital device. It is an application developed to support people that are likely to have really low technical skills in using digital devices and applications. Thus, the application will be really easy to use.

2.3.1 Actors

- **Policy Maker**: is a person responsible for or involved in formulating policies in Telangana and has access to the DREAM application.
- **Farmer**: is a person who owns or manages a farm in Telangana and has access to the DREAM application.
- **Agronomist**: is a person expert in the science of soil management and crop production and has access to the DREAM application.
- **System**: it represents DREAM and the software in a generic way.

NB: In the document we will address an actor as generic **User** whenever we want to refer to an actor without specifying it's category (Policy maker, agronomist, farmer). In that case, the term user will refer to all three categories or to an explicitly mentioned subset.

2.4 Assumptions, dependencies and constraints

2.4.1 Domain assumptions

Domain Assumptions	Description
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.

D8	Every area contains the same fixed number of farms.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D12	Quantitative data in the system are managed following the international system of units.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
D15	The production performance rankings are computed by using a lexicographic ordering of the following parameters: production data, amount of water used for irrigation, humidity of soil and weather forecasts
D16	The weather forecasts of every farm are the same as the ones of the area they are part of.

2.4.2 Dependencies and constraints

Since the S2B is mainly a web application, the main dependency is to own any digital device, which must provide the following features:

1. Good internet connection.
2. A web browser to reach the DREAM website.

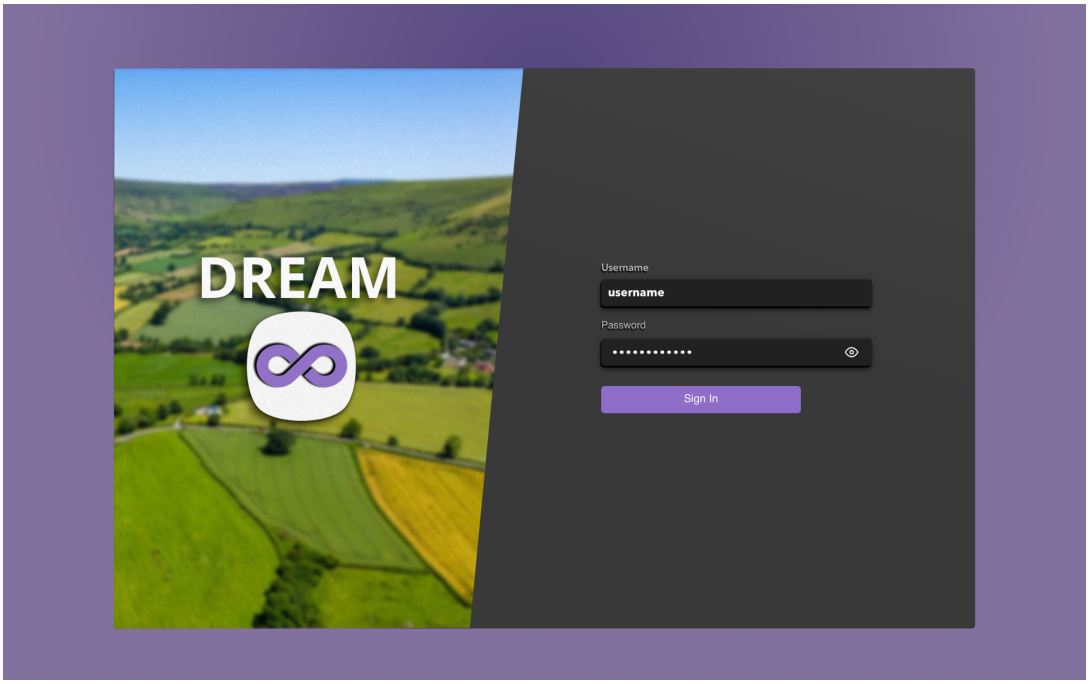
3. SPECIFIC REQUIREMENTS

3.1 External Interface Requirements

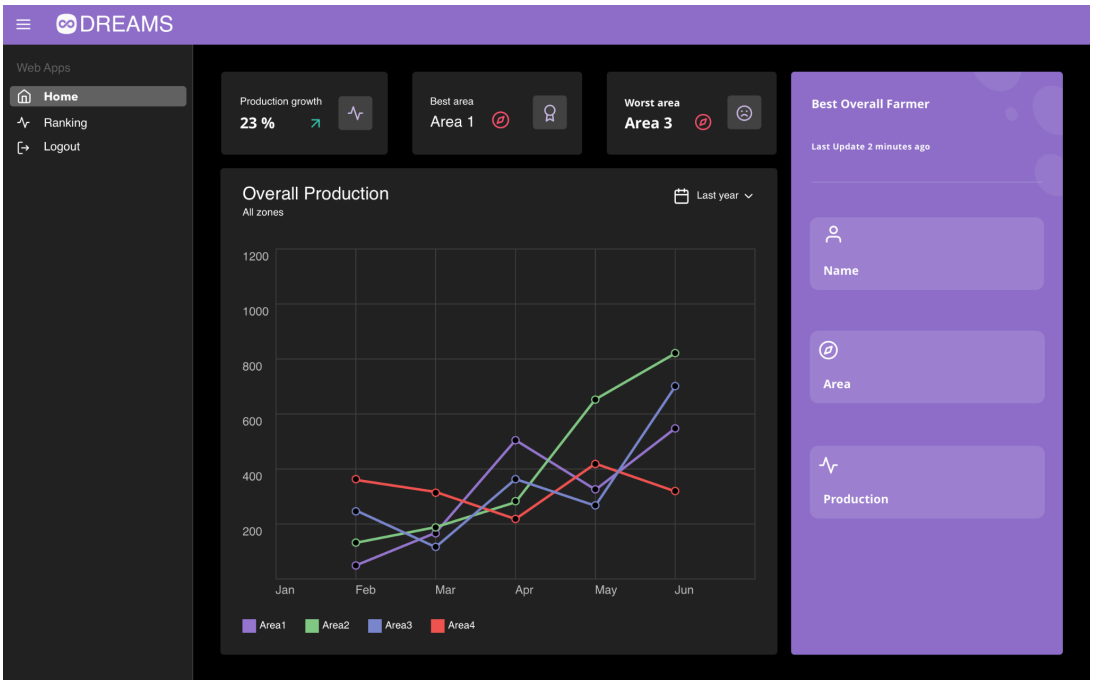
3.1.1 User Interfaces

In this section we include a series of mockups that show the main pages of the web application.

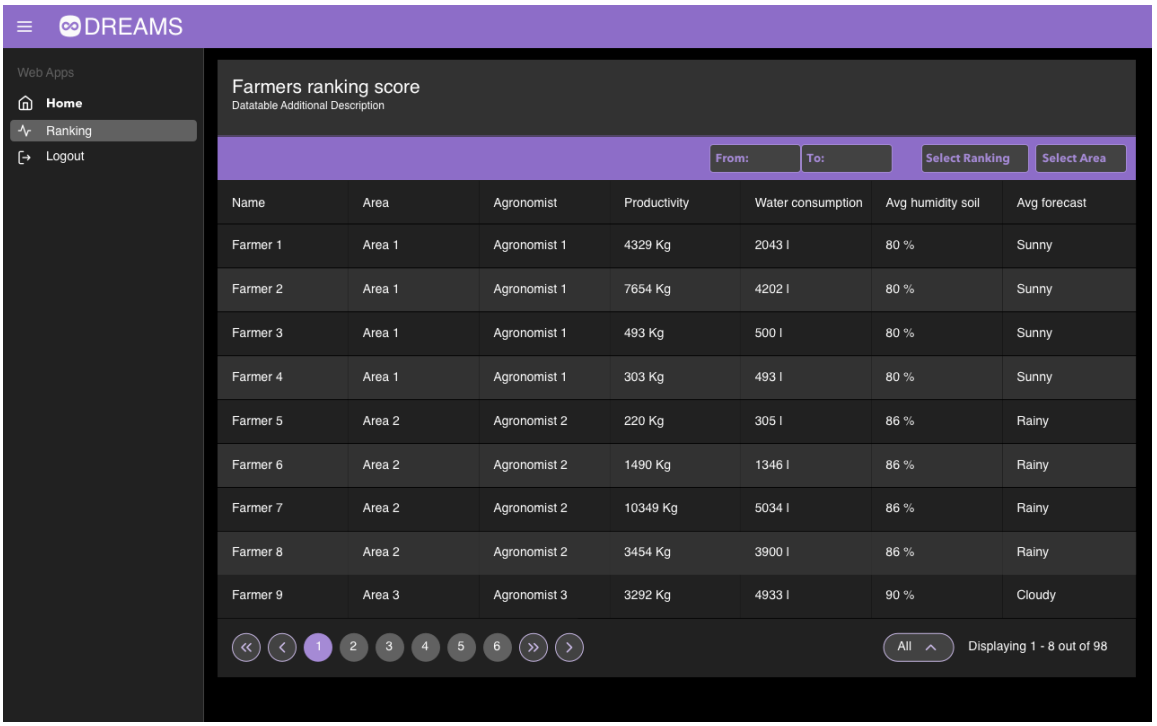
1. ***Login***



2. ***Home Policy Maker***

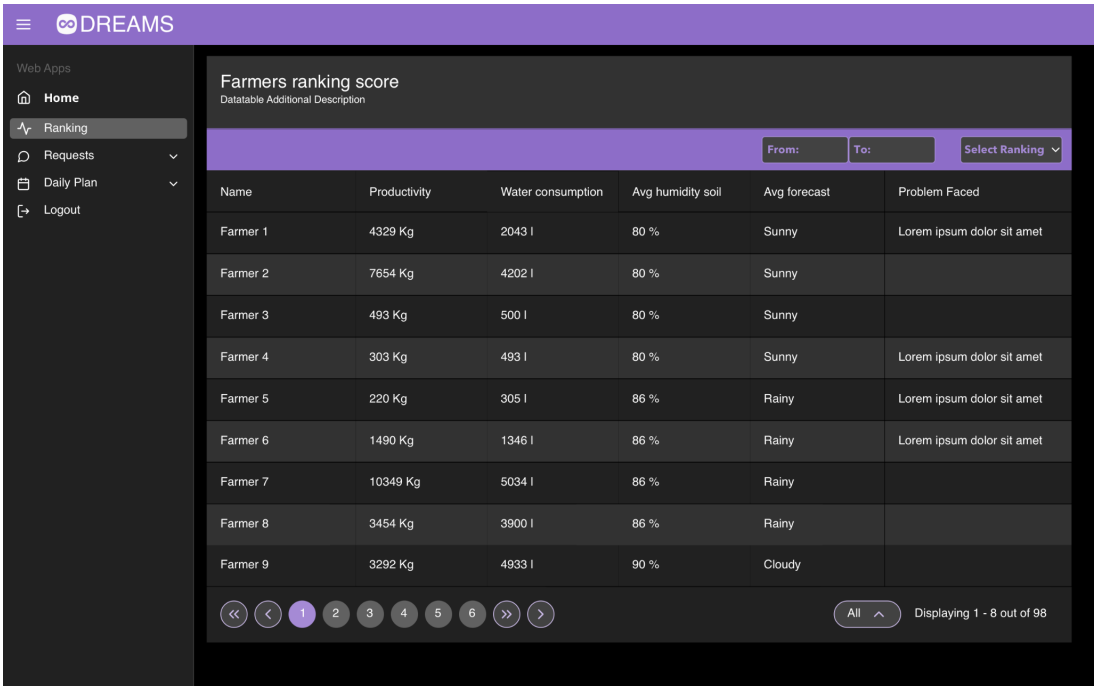


3. ***Advanced ranking Policy Maker***

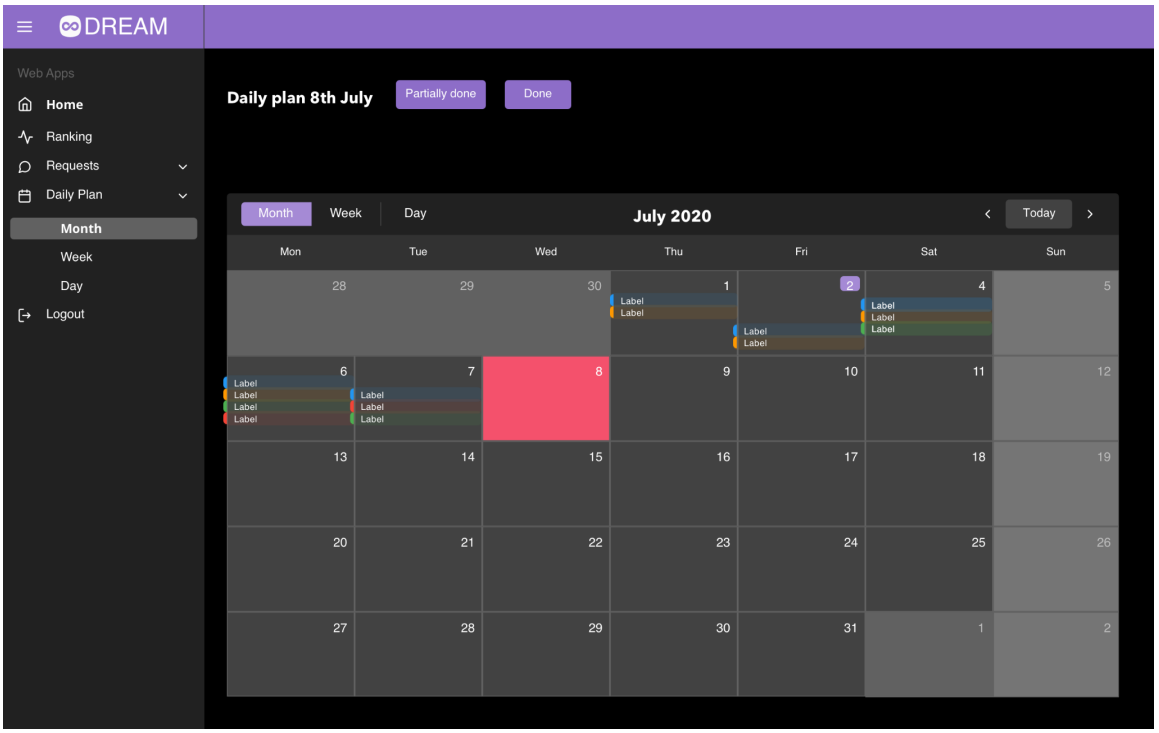


4. ***Home Agronomist***

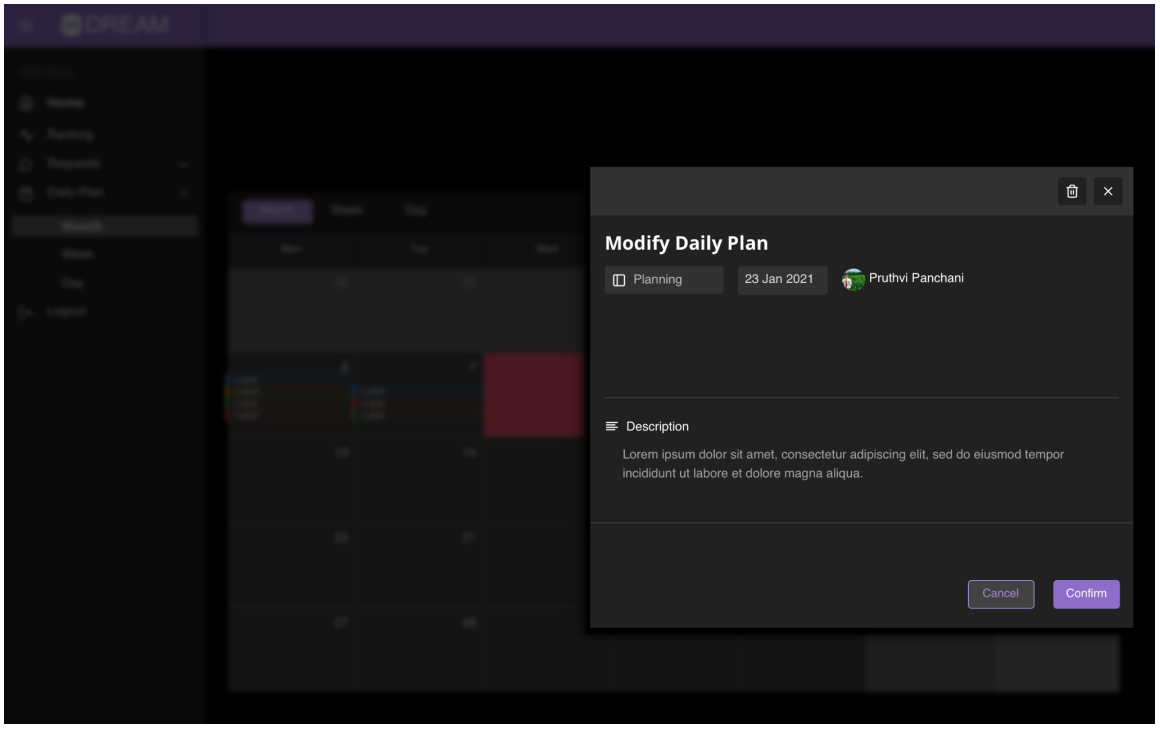
5. ***Advanced ranking Agronomist***



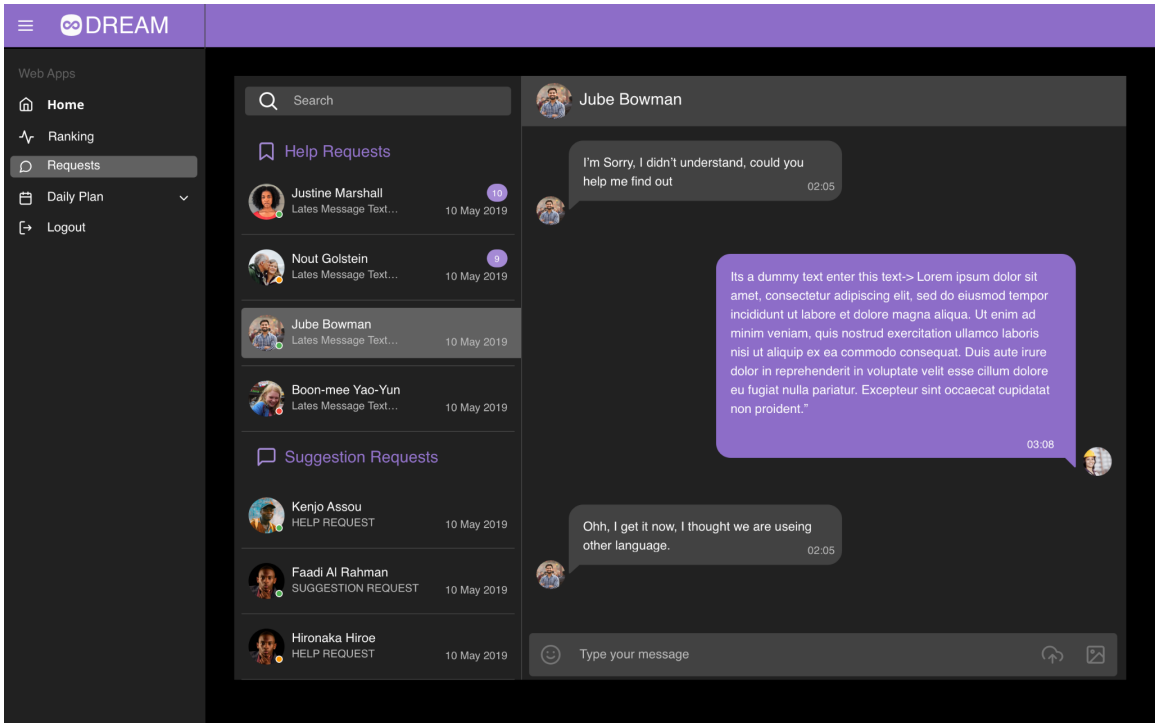
6. ***Advanced daily plan Agronomist***

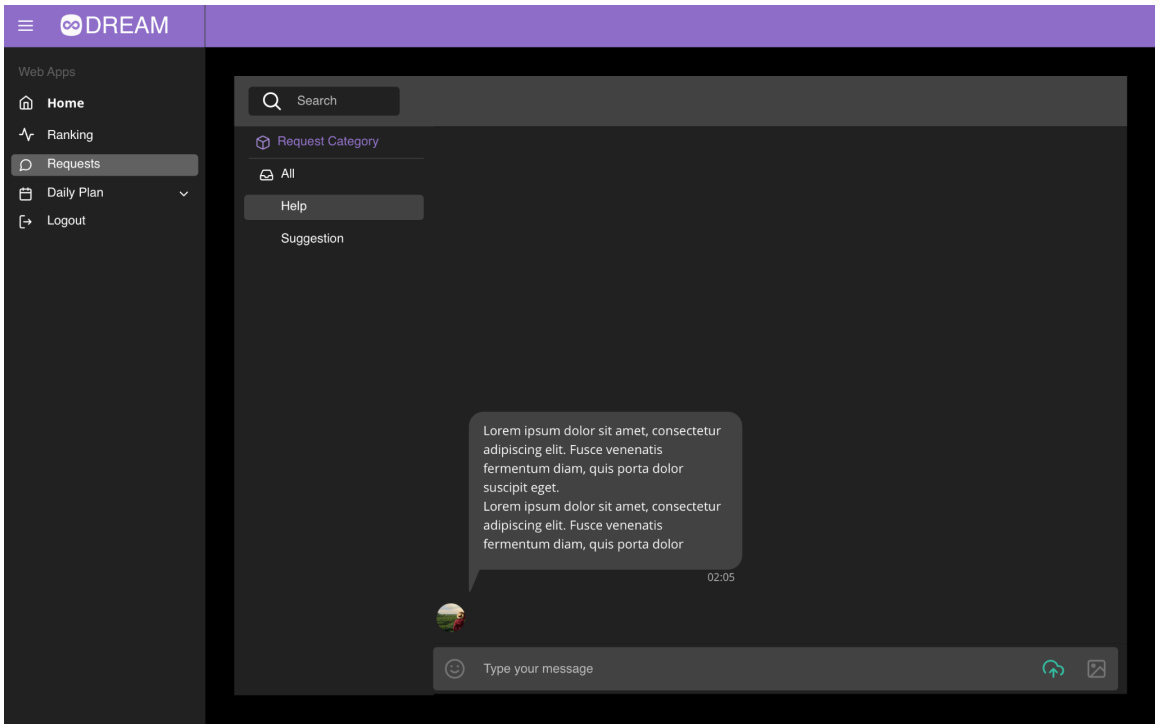


7. ***Modify daily plan Agronomist***

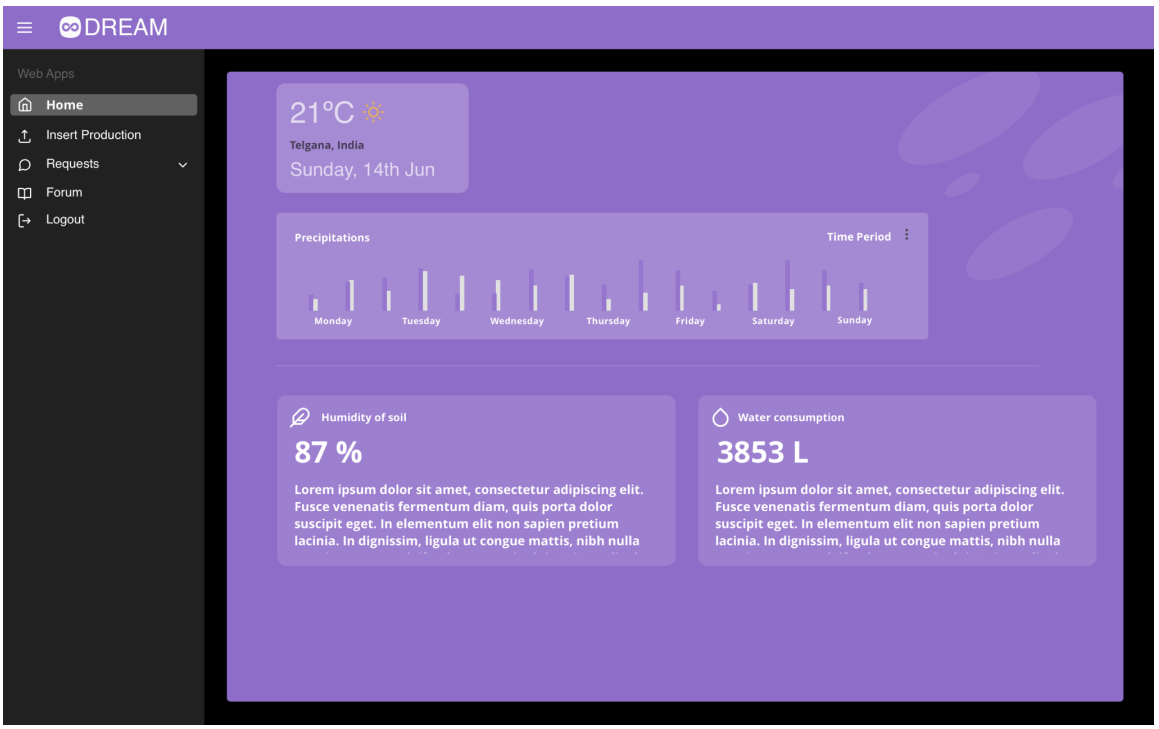


8. ***Request management Agronomist***

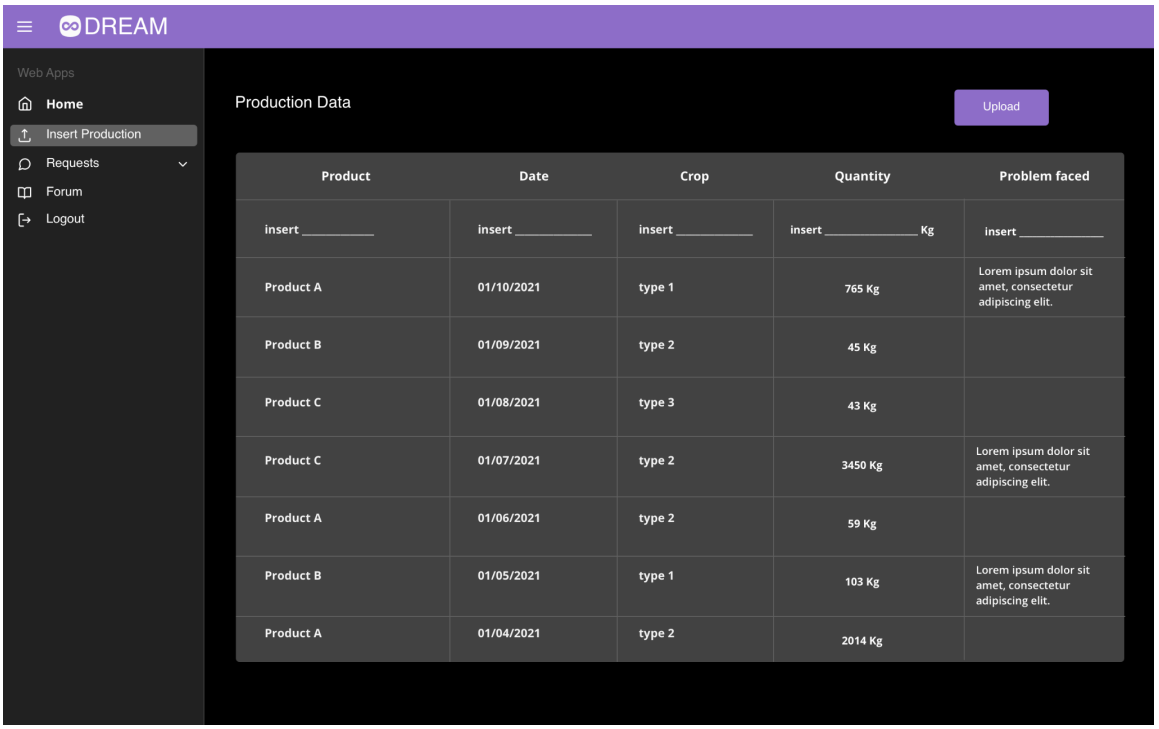




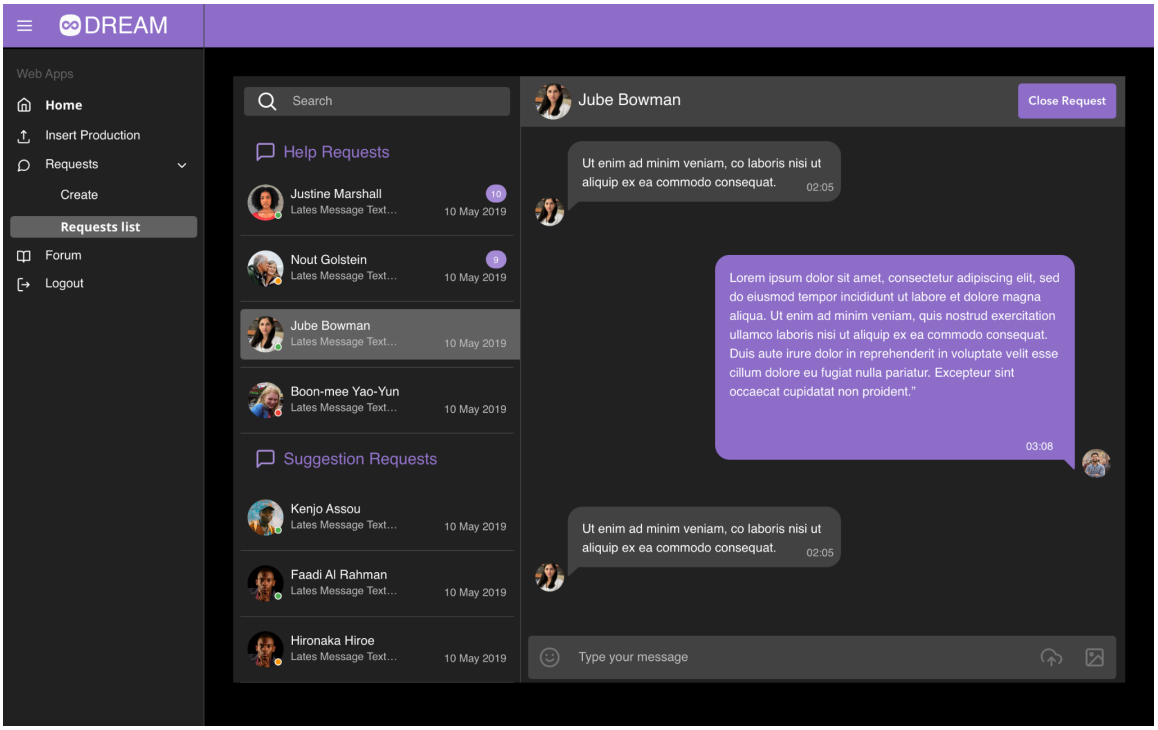
9. ***Home Farmer***

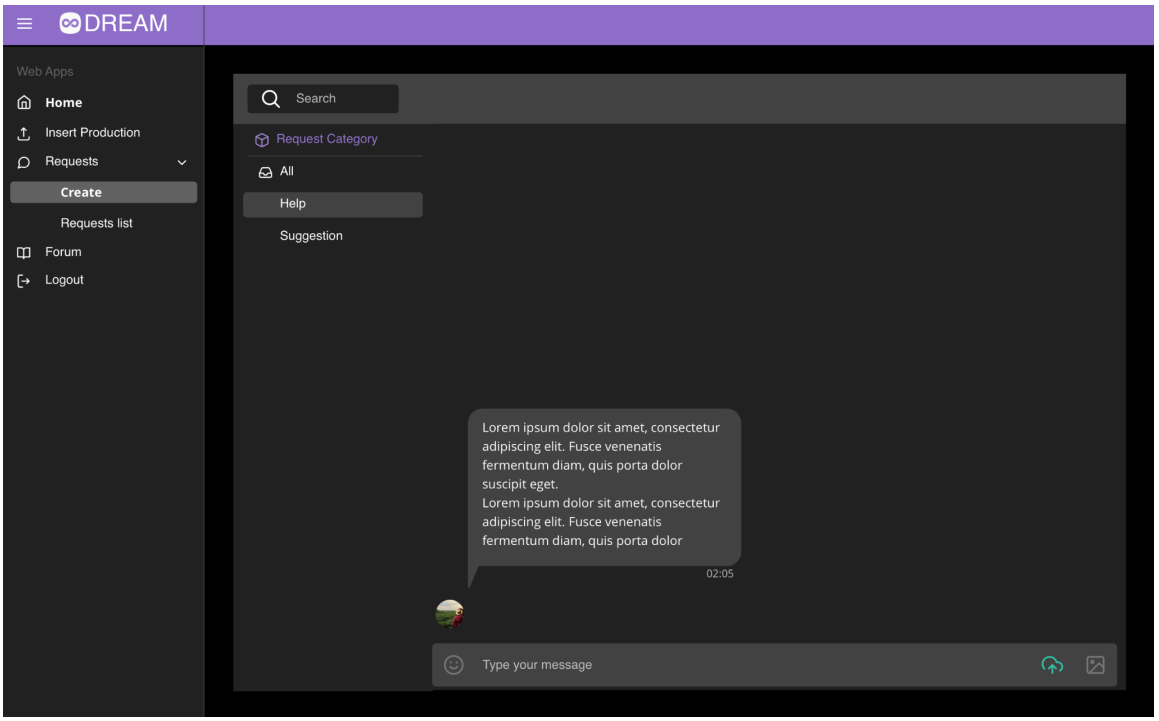


10. ***Production page Farmer***

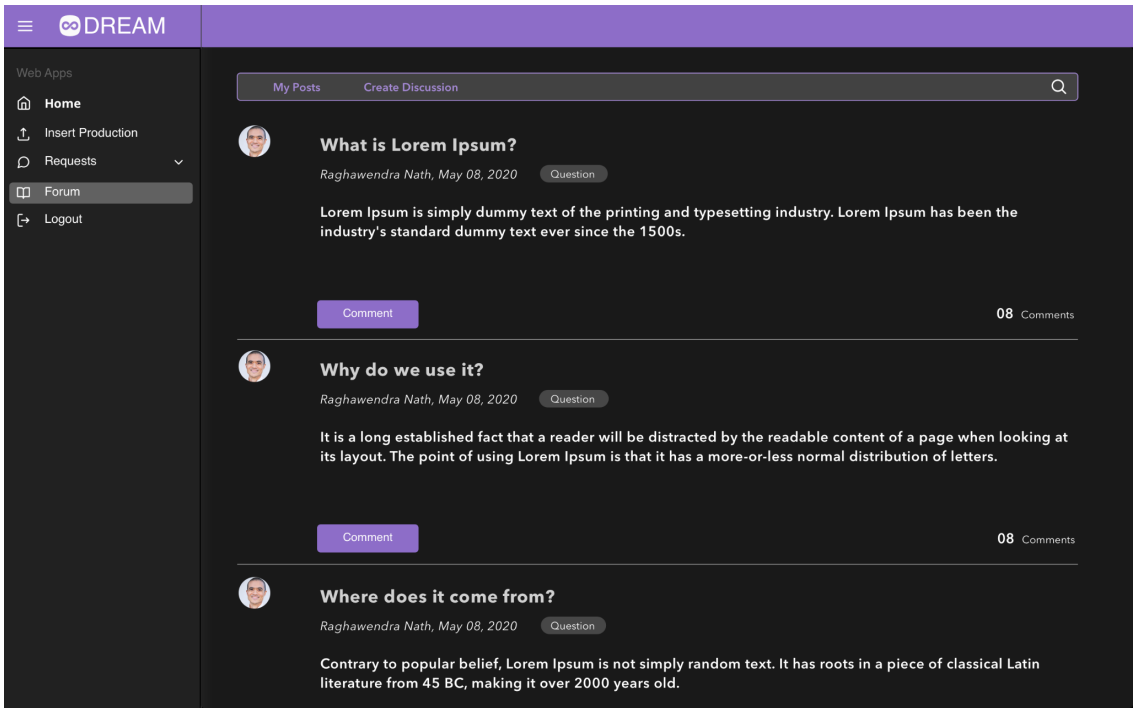


11. ***Request management Farmer***





12. ***Forum page Farmer***



3.1.2 Hardware Interfaces

All users of the system are required to have a digital device able to navigate the internet and to access the DREAM webapp. The system does not require the use of dedicated hardware. The access to a browser is sufficient to use the web application which is able to adapt to both desktop computers, laptops and smartphones.

3.1.3 Software Interfaces

DREAM application shall offer appropriate APIs to allow the systems collecting data to send them to the system. The system should provide interfaces to obtain short-term and long-term forecasts, information from the water irrigation system and humidity of soil recorded through sensors.

3.1.4 Communication Interfaces

The S2B will make use of the classic http protocol to create an API that guarantees the connection between the users and the backend. The way information is exchanged over this protocol can be chosen among the different de-facto standard formats, and it will be discussed in the Design Document.

3.2 Functional Requirements

3.2.1 List of Requirements

R1	The system must be able to retrieve the data of the weather forecasts.
R2	The system must be able to receive data from water irrigation systems.
R3	The system must be able to receive humidity data from soil sensors.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R7	The system must provide to policy makers quantitative data about farmers' production performances.
R8	The system must normalize production data for field dimension.
R9	The system must be able to receive production and problem data from farmers.

R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R11	The system must be able to compute a ranking of the farmers based on production and environmental data.
R12	The farmer must be able to insert her production data.
R13	The farmer must be able to insert the problems she faced during the production.
R14	The policy maker must be able to filter the farmers' production data for areas.
R15	The policy maker is authorized to see the production data of all farmers.
R16	The policy maker is authorized to see the production data of all areas and their agronomists.
R17	The agronomist is authorized to see the production data of all farmers in his area.
R18	The user must be able to filter the farmers' production data for time periods.
R19	The farmer is authorized to see the production data of his farm.
R20	The farmer must be able to obtain local short and long term weather forecasts.
R21	The farmer must be able to obtain humidity of the soil values collected by the sensors associated with his own field.
R22	The farmer must be able to obtain his water consumption from the irrigation systems.
R23	The farmer must be able to create new discussions in the forum.
R24	The farmer must be able to visualize all discussions in the forum.
R25	The farmer must be able to visualize the comments of forum discussions.
R26	The farmer must be able to add a new comment to a forum discussion.
R27	The system must be able to send the help requests to all farmers and to the agronomist of the area.
R28	The farmer must be able to send help requests to farmers and to the agronomist of the area.
R29	The system must be able to show all the help requests previously sent or received and all their included comments to the user of the area.

R30	The system must be able to send the suggestion requests to all farmers and to the agronomist of the area.
R31	The farmer must be able to send suggestion requests to farmers and to the agronomist of the area.
R32	The system must be able to show all the suggestion requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R34	The system must prevent any user from further responding to a close request.
R35	The farmer cannot close a request before receiving at least one response comment.
R36	Farmers must be able to insert their production data and the problems they faced for that harvest.
R37	The agronomist must select an area which he wants to be responsible for.
R38	The agronomist must be able to change his area of influence.
R39	The user must be able to reply to help requests.
R40	The user must be able to reply to suggestion requests.
R41	The agronomist must be able to obtain local short and long term weather forecasts for his area of influence.
R42	The system must be able to retrieve all the daily plans of an agronomist.
R43	The agronomist is not allowed to see other agronomists' daily plans.
R44	The system must be able to compute the daily plans of an agronomist.
R45	The system must be able to keep the visits count for every farm.
R46	The agronomist must be able to confirm the execution of his daily plan.
R47	The system must be able to show the areas that have not been assigned to an agronomist yet.
R48	The agronomist must be able to modify his own daily plan.
R49	The agronomist must be able to specify the deviations from the original daily plan.
R50	The system must be able to update the daily plans to maintain the two visits per farm every year constraint.

3.2.2 Mapping

Goals	Domain Assumptions	Requirements
G1.1	D1, D3, D4, D5, D6, D9, D10, D11, D12, D15, D16	R6, R7, R8, R9, R10, R11, R12, R14, R15, R16, R18, R36
G1.2	D1, D3, D4, D6, D10, D11, D12, D15, D16	R1, R2, R3, R6, R7, R8, R9, R10, R11, R12, R14, R15, R18, R36
G1.3	D1, D3, D4, D6, D10, D11, D12, D15, D16	R1, R2, R3, R6, R7, R8, R9, R10, R11, R12, R14, R15, R18, R36
G1.4	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D16	R6, R7, R8, R9, R10, R11, R12, R14, R15, R16, R18, R36
G2.1	D1, D3, D4, D5, D6, D9. D10, D11, D12, D16	R1, R2, R3, R6, R8, R9, R10, R12, R18, R19, R20, R21, R22, R36
G2.2	D1, D10, D11	R4, R5, R6, R10, R23, R24
G2.3	D1, D10, D11	R4, R5, R6, R10, R23, R24, R25, R26
G2.4	D1, D2, D3, D4, D5, D6, D7, D8, D10, D11, D13, D14	R4, R5, R6, R10, R27, R28 R29, R33, R34, R35, R39
G2.5	D1, D2, D3, D4, D5, D6, D7, D8, D10, D11, D13, D14	R4, R5, R6, R10, R30, R31, R32, R33, R34, R35, R40
G2.6	D1, D3, D4, D5, D6, D8, D10, D11	R6, R10, R27, R28, R29, R33, R35, R39
G2.7	D1, D3, D4, D5, D6, D8, D10, D11	R6, R10, R30, R31, R32, R33, R35, R40
G2.8	D1, D3, D4, D5, D6, D8, D10, D11, D13, D14	R4, R5, R6, R10, R29, R33, R35, R39
G2.9	D1, D3, D4, D5, D6, D8, D10, D11, D13, D14	R4, R5, R6, R10, R32, R33, R35, R40
G2.10	D1, D3, D4, D5, D6, D9, D10, D11, D12	R4, R5, R6, R8, R9, R10, R12, R13, R36
G2.11	D1, D3, D4, D5, D6, D9, D10, D11, D12	R4, R5, R6, R9, R10, R36
G3.1	D1, D2, D7, D8, D11, D13, D14	R4, R5, R6, R37, R38, R47
G3.2	D1, D2, D3, D4, D5, D6, D7, D8, D10,	R6, R10, R27, R28, R29,

	D11, D13, D14	R33, R35, R37, R39
G3.3	D1, D2, D3, D4, D5, D6, D7, D8, D10, D11, D13, D14	R6, R10, R30, R31, R32, R33, R35, R37, R40
G3.4	D1, D2, D3, D4, D5, D6, D7, D8, D10, D11, D13, D14	R4, R5, R6, R10, R17, R27, R28, R29, R33, R34, R35, R37, R39
G3.5	D1, D2, D3, D4, D5, D6, D7, D8, D10, D11, D13, D14	R4, R5, R6, R10, R17, R30, R31, R32, R33, R34, R35, R37, R40
G3.6	D1, D2, D7, D9, D10, D11, D13, D14, D16	R6, R37, R41
G3.7	D1, D2, D3, D4, D5, D6, D7, D8, D10, D11, D12, D13, D14, D15, D16	R1, R2, R3, R6, R8, R10, R11, R12, R13, R17, R18, R37
G3.8	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D13, D14	R6, R10, R37, R38, R42, R43, R44, R45, R49, R50
G3.9	D1, D2, D3, D4,D5, D6, D7, D8, D10, D11, D14, D16	R4, R5, R6, R10, R11, R17, R18, R37, R38, R41, R42, R43, R44, R45, R48, R49, R50
G3.10	D1, D2, D3, D4, D5, D6, D8, D10, D11, D14	R4, R5, R6, R10, R37, R38, R42, R43, R45, R46, R49
G3.11	D1, D2, D3, D4, D5, D6, D8, D10, D11, D14	R4, R5, R6, R10, R37, R38, R42, R44, R45, R46, R49
G4.1	D4, D5, D9, D12, D16	R1, R4, R5
G4.2	D4, D5, D9, D12	R2, R4, R5
G4.3	D4, D5, D9, D12	R3, R4, R5

The next tables represent the mapping of each goal with the corresponding domain assumptions and requirements included in order to make the mapping easier to read and understand.

G1.1	**Provide policy makers with data about farmers' production performances.**
D1	All users have access to a digital device to use the DREAM application.
D3	Every farm is associated with only one farmer.

D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D12	Quantitative data in the system are managed following the international system of units.
D15	The production performance rankings are computed by using a lexicographic ordering of the following parameters: production data, amount of water used for irrigation, humidity of soil and weather forecasts.
D16	The weather forecasts of every farm are the same as the ones of the area they are part of.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R7	The system must provide to policy makers quantitative data about farmers' production performances.
R8	The system must normalize production data for field dimension.
R9	The system must be able to receive production and problem data from farmers.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R11	The system must be able to compute a ranking of the farmers based on production and environmental data.
R12	The farmers must be able to insert his production data.
R14	The policy maker must be able to filter the farmers' production data for areas.
R15	The policy maker is authorized to see the production data of all farmers.
R16	The policy maker is authorized to see the production data of all areas and their agronomists.
R18	The user must be able to filter the farmers' production data for

	time periods.
R36	Farmers must be able to insert their production data and the problems they faced for that harvest.

G1.2	**Allow policy makers to identify farmers with best performances, especially the ones that faced adverse weather conditions.**
D1	All users have access to a digital device to use the DREAM application.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D6	Users do not falsify data they insert in the system.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D12	Quantitative data in the system are managed following the international system of units.
D15	The production performance rankings are computed by using a lexicographic ordering of the following parameters: production data, amount of water used for irrigation, humidity of soil and weather forecasts.
D16	The weather forecasts of every farm are the same as the ones of the area they are part of.
R1	The system must be able to retrieve the data of the weather forecasts.
R2	The system must be able to receive data from water irrigation systems.
R3	The system must be able to receive humidity data from soil sensors.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R7	The system must provide to policy makers quantitative data about farmers' production performances.

R8	The system must normalize production data for field dimension.
R9	The system must be able to receive production and problem data from farmers.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R11	The system must be able to compute a ranking of the farmers based on production and environmental data.
R12	The farmers must be able to insert his production data.
R14	The policy maker must be able to filter the farmers' production data for areas.
R15	The policy maker is authorized to see the production data of all farmers.
R18	The user must be able to filter the farmers' production data for time periods.
R36	Farmers must be able to insert their production data and the problems they faced for that harvest.

G1.3	**Allow policy makers to identify farmers with worst performances.**
D1	All users have access to a digital device to use the DREAM application.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D6	Users do not falsify data they insert in the system.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D12	Quantitative data in the system are managed following the international system of units.
D15	The production performance rankings are computed by using a lexicographic ordering of the following parameters: production data, amount of water used for irrigation, humidity of soil and weather forecasts.
D16	The weather forecasts of every farm are the same as the ones of

	the area they are part of.
R1	The system must be able to retrieve the data of the weather forecasts.
R2	The system must be able to receive data from water irrigation systems.
R3	The system must be able to receive humidity data from soil sensors.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R7	The system must provide to policy makers quantitative data about farmers' production performances.
R8	The system must normalize production data for field dimension.
R9	The system must be able to receive production and problem data from farmers.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R11	The system must be able to compute a ranking of the farmers based on production and environmental data.
R12	The farmers must be able to insert his production data.
R14	The policy maker must be able to filter the farmers' production data for areas.
R15	The policy maker is authorized to see the production data of all farmers.
R18	The user must be able to filter the farmers' production data for time periods.
R36	Farmers must be able to insert their production data and the problems they faced for that harvest.

G1.4	**Allow policy makers to identify whether agronomist initiatives increase farmers' production performances.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.

D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D12	Quantitative data in the system are managed following the international system of units.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
D15	The production performance rankings are computed by using a lexicographic ordering of the following parameters: production data, amount of water used for irrigation, humidity of soil and weather forecasts.
D16	The weather forecasts of every farm are the same as the ones of the area they are part of.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R7	The system must provide to policy makers quantitative data about farmers' production performances.
R8	The system must normalize production data for field dimension.
R9	The system must be able to receive production and problem data from farmers.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it’s not explicitly allowed by the S2B.
R11	The system must be able to compute a ranking of the farmers based on production and environmental data.

R12	The farmers must be able to insert his production data.
R14	The policy maker must be able to filter the farmers' production data for areas.
R15	The policy maker is authorized to see the production data of all farmers.
R16	The policy maker is authorized to see the production data of all areas and their agronomists.
R18	The user must be able to filter the farmers' production data for time periods.
R36	Farmers must be able to insert their production data and the problems they faced for that harvest.

G2.1	**Provide quantitative data to each farmer based on location and type of production.**
D1	All users have access to a digital device to use the DREAM application.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D12	Quantitative data in the system are managed following the international system of units.
D16	The weather forecasts of every farm are the same as the ones of the area they are part of.
R1	The system must be able to retrieve the data of the weather forecasts.
R2	The system must be able to receive data from water irrigation systems.
R3	The system must be able to receive humidity data from soil

	sensors.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R8	The system must normalize production data for field dimension.
R9	The system must be able to receive production and problem data from farmers.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R12	The farmers must be able to insert his production data.
R18	The user must be able to filter the farmers' production data for time periods.
R19	The farmer is authorized to see the production data of his farm.
R20	The farmer must be able to obtain local short and long term weather forecasts.
R21	The farmer must be able to obtain humidity of the soil values collected by the sensors associated with his own field.
R22	The farmer must be able to obtain his water consumption from the irrigation systems.
R36	Farmers must be able to insert their production data and the problems they faced for that harvest.

G2.2	**Allow farmers to open discussions between them in the forum.**
D1	All users have access to a digital device to use the DREAM application.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not

	explicitly allowed by the S2B.
R23	The farmer must be able to create new discussions in the forum.
R24	The farmer must be able to visualize all discussions in the forum.

G2.3	**Allow farmers to participate in forum discussions already opened**.
D1	All users have access to a digital device to use the DREAM application.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R23	The farmer must be able to create new discussions in the forum.
R24	The farmer must be able to visualize all discussions in the forum.
R25	The farmer must be able to visualize the comments of forum discussions.
R26	The farmer must be able to add a new comment to a forum discussion.

G2.4	**Allow farmers to send help requests to other farmers in the same area and the responsible agronomist.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same

	farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R27	The system must be able to send the help requests to all farmers and to the agronomist of the area.
R28	The farmer must be able to send help requests to farmers and to the agronomist of the area.
R29	The system must be able to show all the help requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R34	The system must prevent any user from further responding to a close request.
R35	The farmer cannot close a request before receiving at least one response comment.
R39	The user must be able to reply to help requests.

G2.5	Allow farmers to send requests for suggestions to other farmers in the same area and the responsible agronomist.
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R30	The system must be able to send the suggestion requests to all farmers and to the agronomist of the area.
R31	The farmer must be able to send suggestion requests to farmers and to the agronomist of the area.
R32	The system must be able to show all the suggestion requests previously sent or received and all their included comments to the user of the area.

R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R34	The system must prevent any user from further responding to a close request.
R35	The farmer cannot close a request before receiving at least one response comment.
R40	The user must be able to reply to suggestion requests.

G2.6	**Allow farmers to receive help requests from their peers in the same area.**
D1	All users have access to a digital device to use the DREAM application.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R27	The system must be able to send the help requests to all farmers and to the agronomist of the area.
R28	The farmer must be able to send help requests to farmers and to the agronomist of the area.
R29	The system must be able to show all the help requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.

R35	The farmer cannot close a request before receiving at least one response comment.
R39	The user must be able to reply to help requests.

G2.7	**Allow farmers to receive suggestion requests from their peers in the same area.**
D1	All users have access to a digital device to use the DREAM application.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R30	The system must be able to send the suggestion requests to all farmers and to the agronomist of the area.
R31	The farmer must be able to send suggestion requests to farmers and to the agronomist of the area.
R32	The system must be able to show all the suggestion requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R35	The farmer cannot close a request before receiving at least one response comment.
R40	The user must be able to reply to suggestion requests.

G2.8	Allow farmers to reply to help requests they received.
D1	All users have access to a digital device to use the DREAM application.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R29	The system must be able to show all the help requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R35	The farmer cannot close a request before receiving at least one response comment.
R39	The user must be able to reply to help requests.

G2.9	Allow farmers to reply to suggestion requests they received.

D1	All users have access to a digital device to use the DREAM application.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R32	The system must be able to show all the suggestion requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R35	The farmer cannot close a request before receiving at least one response comment.
R40	The user must be able to reply to suggestion requests.

G2.10	**Allow farmers to insert their production data in the system.**
D1	All users have access to a digital device to use the DREAM application.

D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D12	Quantitative data in the system are managed following the international system of units.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R8	The system must normalize production data for field dimension.
R9	The system must be able to receive production and problem data from farmers.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R12	The farmers must be able to insert his production data.
R13	The farmers must be able to insert the problems he faced during the production.
R36	Farmers must be able to insert their production data and the problems they faced for that harvest.

G2.11	**Allow farmers to insert into the system data about any problem they face.**
D1	All users have access to a digital device to use the DREAM application.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same

	farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D12	Quantitative data in the system are managed following the international system of units.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R9	The system must be able to receive production and problem data from farmers.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R36	Farmers must be able to insert their production data and the problems they faced for that harvest.

G3.1	**Allow agronomists to select their area of influence.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions

	to be managed by a single agronomist.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R37	The agronomist must select an area which he wants to be responsible for.
R38	The agronomist must be able to change his area of influence.
R47	The agronomist must be able to confirm the execution of his daily plan.

G3.2	**Allow agronomists to receive help requests from farmers in their area.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R6	The system must grant access to the S2B only if the user

	successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R27	The system must be able to send the help requests to all farmers and to the agronomist of the area.
D28	The farmer must be able to send help requests to farmers and to the agronomist of the area.
R29	The system must be able to show all the help requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R35	The farmer cannot close a request before receiving at least one response comment.
R37	The agronomist must select an area which he wants to be responsible for.
R39	The user must be able to reply to help requests.

G3.3	**Allow agronomists to receive suggestion requests from farmers in their area**.
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.

D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R30	The system must be able to send the suggestion requests to all farmers and to the agronomist of the area.
R31	The farmer must be able to send suggestion requests to farmers and to the agronomist of the area.
R32	The system must be able to show all the suggestion requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R35	The farmer cannot close a request before receiving at least one response comment.
R37	The agronomist must select an area which he wants to be responsible for.
R40	The user must be able to reply to suggestion requests.

G3.4	**Allow agronomists to reply to help requests from farmers in their area.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.

D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R17	The agronomist is authorized to see the production data of all farmers in his area.
R27	The system must be able to send the help requests to all farmers and to the agronomist of the area.
R28	The farmer must be able to send help requests to farmers and to the agronomist of the area.
R29	The system must be able to show all the help requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R34	The system must prevent any user from further responding to a close request.
R35	The farmer cannot close a request before receiving at least one response comment.
R37	The agronomist must select an area which he wants to be responsible for.
R39	The user must be able to reply to help requests.

G3.5	Allow agronomists to reply to suggestion requests from farmers in their area.
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R17	The agronomist is authorized to see the production data of all farmers in his area.
R30	The system must be able to send the suggestion requests to all farmers and to the agronomist of the area.
R31	The farmer must be able to send suggestion requests to farmers and to the agronomist of the area.

R32	The system must be able to show all the suggestion requests previously sent or received and all their included comments to the user of the area.
R33	The farmer must be able to mark as closed any of his request messages that are not already closed.
R34	The system must prevent any user from further responding to a close request.
R35	The farmer cannot close a request before receiving at least one response comment.
R37	The agronomist must select an area which he wants to be responsible for.
R40	The user must be able to reply to suggestion requests.

G3.6	**Allow agronomists to get weather forecasts of their area of influence.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
D16	The weather forecasts of every farm are the same as the ones of the area they are part of.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R37	The agronomist must select an area which he wants to be responsible for.

R41	The agronomist must be able to obtain local short and long term weather forecasts for his area of influence.

G3.7	**Allow agronomists to get the list of farmers ordered according to best or worst performances in the area.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D12	Quantitative data in the system are managed following the international system of units.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
D15	The production performance rankings are computed by using a lexicographic ordering of the following parameters: production data, amount of water used for irrigation, humidity of soil and weather forecasts.
D16	The weather forecasts of every farm are the same as the ones of the area they are part of.
R1	The system must be able to retrieve the data of the weather forecasts.
R2	The system must be able to receive data from water irrigation systems.

R3	The system must be able to receive humidity data from soil sensors.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R8	The system must normalize production data for field dimension.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R11	The system must be able to compute a ranking of the farmers based on production and environmental data.
R12	The farmers must be able to insert his production data.
R13	The farmers must be able to insert the problems he faced during the production.
R17	The agronomist is authorized to see the production data of all farmers in his area.
R18	The user must be able to filter the farmers' production data for time periods.
R37	The agronomist must select an area which he wants to be responsible for.

G3.8	**Provide agronomists with a daily plan of the farms to be visited.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D9	Data from external sources is transmitted to the system by

	means of appropriate interfaces.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D13	The number of agronomists is sufficient to handle the total amount of areas and farmers.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R37	The agronomist must select an area which he wants to be responsible for.
R38	The agronomist must be able to change his area of influence.
R42	The system must be able to retrieve all the daily plans of an agronomist.
R43	The agronomist is not allowed to see other agronomists' daily plans.
R44	The system must be able to compute the daily plans of an agronomist.
R45	The system must be able to keep the visits count for every farm.
R49	The agronomist must be able to specify the deviations from the original daily plan.
R50	The system must be able to update the daily plans to maintain the two visits per farm every year constraint.

G3.9	**Allow agronomists to update their daily plan.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same

	farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D7	The agronomists can change their area of influence whenever they want provided that the area is free.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
D16	The weather forecasts of every farm are the same as the ones of the area they are part of.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R11	The system must be able to compute a ranking of the farmers based on production and environmental data.
R17	The agronomist is authorized to see the production data of all farmers in his area.
R18	The user must be able to filter the farmers' production data for time periods.
R37	The agronomist must select an area which he wants to be responsible for.
R38	The agronomist must be able to change his area of influence.
R41	The agronomist must be able to obtain local short and long term weather forecasts for his area of influence.
R42	The system must be able to retrieve all the daily plans of an agronomist.
R43	The agronomist is not allowed to see other agronomists' daily plans.

R44	The system must be able to compute the daily plans of an agronomist.
R45	The system must be able to keep the visits count for every farm.
R48	The agronomist must be able to modify his own daily plan.
R49	The agronomist must be able to specify the deviations from the original daily plan.
R50	The system must be able to update the daily plans to maintain the two visits per farm every year constraint.

G3.10	**Allow agronomists to confirm the execution of the daily plan.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.
R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R37	The agronomist must select an area which he wants to be

	responsible for.
R38	The agronomist must be able to change his area of influence.
R42	The system must be able to retrieve all the daily plans of an agronomist.
R43	The agronomist is not allowed to see other agronomists' daily plans.
R45	The system must be able to keep the visits count for every farm.
R46	The agronomist must be able to confirm the execution of his daily plan.
R49	The agronomist must be able to specify the deviations from the original daily plan.

G3.11	**Allow agronomists to specify the deviations from the original plan at the end of each day.**
D1	All users have access to a digital device to use the DREAM application.
D2	Every agronomist chooses only one area of influence that is not already under someone else's.
D3	Every farm is associated with only one farmer.
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D6	Users do not falsify data they insert in the system.
D8	Every area contains the same fixed number of farms.
D10	User credentials are provided by the government so there is no need to sign up.
D11	All users have access to an internet connection.
D14	The number of farms in a single area is of adequate dimensions to be managed by a single agronomist.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.
R6	The system must grant access to the S2B only if the user successfully types his username and the matching password.

R10	The system must not allow the user to alter or delete data and inputs previously inserted either by himself or by others if it's not explicitly allowed by the S2B.
R37	The agronomist must select an area which he wants to be responsible for.
R38	The agronomist must be able to change his area of influence.
R42	The system must be able to retrieve all the daily plans of an agronomist.
R44	The system must be able to compute the daily plans of an agronomist.
R45	The system must be able to keep the visits count for every farm.
R46	The agronomist must be able to confirm the execution of his daily plan.
R49	The agronomist must be able to specify the deviations from the original daily plan.

G4.1	**Allow the DREAM system to acquire data concerning meteorological short-term and long-term forecasts.**
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D12	Quantitative data in the system are managed following the international system of units.
D16	The weather forecasts of every farm are the same as the ones of the area they are part of.
R1	The system must be able to retrieve the data of the weather forecasts.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.

G3.2	**Allow the DREAM system to acquire data measured by the water irrigation systems.**

D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D12	Quantitative data in the system are managed following the international system of units.
R2	The system must be able to receive data from water irrigation systems.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.

G4.3	**Allow the DREAM system to acquire soil humidity data obtained by sensors.**
D4	All fields owned by a farmer are considered as part of the same farm.
D5	Every farm cannot be inside two different areas of influence.
D9	Data from external sources is transmitted to the system by means of appropriate interfaces.
D12	Quantitative data in the system are managed following the international system of units.
R3	The system must be able to receive humidity data from soil sensors.
R4	The system must not allow the upload of data with invalid format.
R5	The system must not allow the upload of null data.

3.2.3 Use Cases

1. *Login*

Name	Login
Actors	User
Entry Condition	1. The user has already opened the browser.

Event Flow	1. The user opens the web application. 2. The user clicks on the “Login” button and inserts username and password. 3. The system checks the input and sends back a session token.
Exit Conditions	The user is redirected to the appropriate homepage (w.r.t. the type of user) of the web application.
Exceptions	1. The username inserted does not exist or is empty. 2. The password inserted does not match the username. These exceptions are handled by notifying the user and keeping him in the login page. 3. The system cannot not complete the task correctly. This exception is handled by showing a notification to the user.

2. *Check statistics*

Name	Checking statistics
Actors	Policy maker
Entry Condition	1. Policy Maker has already logged in the web application.
Event Flow	1. Policy Maker opens the homepage. 2. (Optional)Policy Maker selects the period of interest. 3. (Optional)Policy Maker selects an area/agronomist from a filter. 4. (Optional)Policy Maker selects the type of data ranking. 5. The System manipulates and shows the statistics.
Exit Conditions	Policy makers visualize filtered data.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user.

3. *Check data of an area*

Name	Checking data of an Area

Actors	Agronomist
Entry Condition	1. Agronomist has already logged in in the web application.
Event Flow	1. Agronomist opens the homepage. 2. (Optional)Agronomist selects the period of interest. 3. (Optional)Agronomist selects a group of farmers from a filter. 4. (Optional)Agronomist selects the type of data ranking. 5. The System selects, ranks and shows the statistics.
Exit Conditions	Agronomists visualize filtered data.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user.

4. *Check data of a farm*

Name	Checking farm data
Actors	Farmer
Entry Condition	1. Agronomist has already logged in in the web application.
Event Flow	1. Farmer opens the homepage. 2. (Optional)Farmer selects the period of interest. 3. The System selects, and shows the statistics.
Exit Conditions	Farmers visualize filtered data.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user.

5. *Creation of a request*

Name	Creation of a request
Actors	Farmer, Agronomist
Entry Condition	1. The user has already logged in in the web application.

Event Flow	1. Farmer clicks on the “Request” button. 2. Farmer selects the “Create” option. 3. Farmer selects the type of request. 4. Farmer writes down the message in the textbox. 5. Farmer clicks the “Submit” button. 6. The system sends the message to the target.
Exit Conditions	An alert confirms the sent message.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user. 2. The farmers try to send an empty message This exception is handled by showing a failed attempt message.

6. *Creation of a forum post*

Name	Creation of a forum post
Actors	Farmer
Entry Condition	1. The user has already logged in in the web application.
Event Flow	1. Farmer opens the “Forum page”. 2. Farmer selects a discussion. 3. The farmer clicks on the “Create post” button. 4. The system shows an appropriate form. 5. Farmer writes the message. 6. The system shows a preview of the message. 7. Farmer selects the send button. 8. System uploads the new post.
Exit Conditions	An alert confirms the created posts and the farmer is redirected to the main “Forum page”.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user. 2. The farmer tries to create a post without fulfilling the title text area. This exception is handled by showing a “missing title” error message. 3. The farmer tries to create a post without fulfilling the content text area. This exception is handled by showing a “missing content”

	error message.

7. *Creation of a forum discussion*

Name	Creation of a forum discussion
Actors	Farmer
Entry Condition	1. The user has already logged in in the web application.
Event Flow	1. Farmer opens the “Forum page”. 2. Farmer clicks on the button “Create discussion”. 3. The system shows an appropriate form. 4. Farmer writes the title and a description of the discussion. 5. The system shows a “Post” form. 6. Farmer writes the first message. 7. The system shows a preview of the message. 8. Farmer selects the “Submit” button. 9. System uploads the new post. 10. The system shows a preview of the message. 11. Farmer selects the “Send” button. 12. System uploads the new discussion and the first post.
Exit Conditions	An alert confirms the created posts and the farmer is redirected to the main forum page.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user. 2. The farmer tries to create a post without fulfilling the title text area. This exception is handled by showing a “missing title” error message. 3. The farmer tries to create a post without fulfilling the content text area. This exception is handled by showing a “missing content” error message.

8. *Production data upload*

Name	Production data upload
Actors	Farmers
Entry Condition	1. The user has already logged in in the web application.
Event Flow	1. Farmers click on the “Insert production” button. 2. System shows the form with all the parameters and empty text areas. 3. Farmer fills in every area with the data. 4. The farmer selects the upload button. 5. The system uploads the data.
Exit Conditions	An alert confirms the uploaded data and the farmer is redirected to his home page (showing historical and new data).
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user. 2. The farmer inserts with the wrong format This exception is handled by showing a “data format” error message and showing the right format. 3. The farmer leaves as empty at most one text area This exception is handled by showing a “missing data” error message and highlighting in red the corresponding text field.

9. Check the daily plan

Name	Check the daily plan
Actors	Agronomist
Entry Condition	1. The user has already logged in the web application. 2. The user has already selected his area of influence.
Event Flow	1. The Agronomist opens the homepage. 2. The agronomist selects the “Daily Plan”. 3. The system loads the “Daily Plan page”. 4. The agronomist selects the Daily Plan from a list. 5. The system loads the computed daily plan and shows it to the user.
Exit Conditions	The user visualized his daily plan.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the

	user.

10. Edit the daily plan

Name	Edit the daily plan
Actors	Agronomist
Entry Condition	1. The user has already logged in the web application. 1. The user has already selected his area of influence.
Event Flow	1. The agronomist reaches the home page. 2. The agronomist selects the “Daily Plan”. 3. The system loads the “Daily Plan page”. 4. The agronomist selects the “Daily Plan” to be modified from a list. 5. The system loads the computed daily plan and shows it to the user. 6. The agronomist clicks on a time slot for a visit (either empty or taken). 7. The system presents him a form with the data of the current visit. 8. The agronomist changes the farmer currently in the slot or insert a new one if the slot was empty and then submit his decision. 9. The system updates the daily plan.
Exit Conditions	The user edited his daily plan.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user. 2. The user tries to make changes to the plan that are likely to invalidate the two visits per year rule (e.g. removing a visit to a farm that requires it to be visited the last work day of the year). This exception is handled by notifying the user with an error message and not allowing him to perform the change.

11. Validate the daily plan

Name	Validate the daily plan
Actors	Agronomist
Entry Condition	1. The user has already logged in the web application.

	2. The user has already selected his area of influence.
Event Flow	3. The agronomist opens the HomePage. 4. The agronomist selects the Daily Plan List page. 5. The system loads the Daily Plan List page. 6. The agronomist selects the Daily Plan from a list 7. The system loads the selected daily plan 8. The agronomist click the validate bottom 9. The system close the daily plan
Exit Conditions	The user validates the daily plan.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user. 2. The user tries to validate the daily plan before the day of the execution of the plan. This exception is handled by notifying the user with an error message and not allowing him to perform the validation.

12. <u>Responding to help and suggestion requests</u>

Name	Responding to help and suggestion requests
Actors	Farmer, Agronomist
Entry Condition	1. The user has already logged in to other farmers in the same area and the responsible agronomist.he web application. 2. The user has some requests that are not closed yet.
Event Flow	1. The user opens the homepage. 2. The system shows the user all the requests of his area separated into requests and suggestions. 3. The user selects a request that is not closed yet. 4. The system shows an answer form. 5. The user inserts his reply to the request. 6. The user clicks the “Submit" button. 7. The system sends the answer to the target audience. 8. The system updates the homepage.
Exit Conditions	The user submitted his reply.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user. 2. The author of the requests closes it just before the user has submitted his reply. This exception is handled by preventing the submission of

	the reply and by notifying the user.

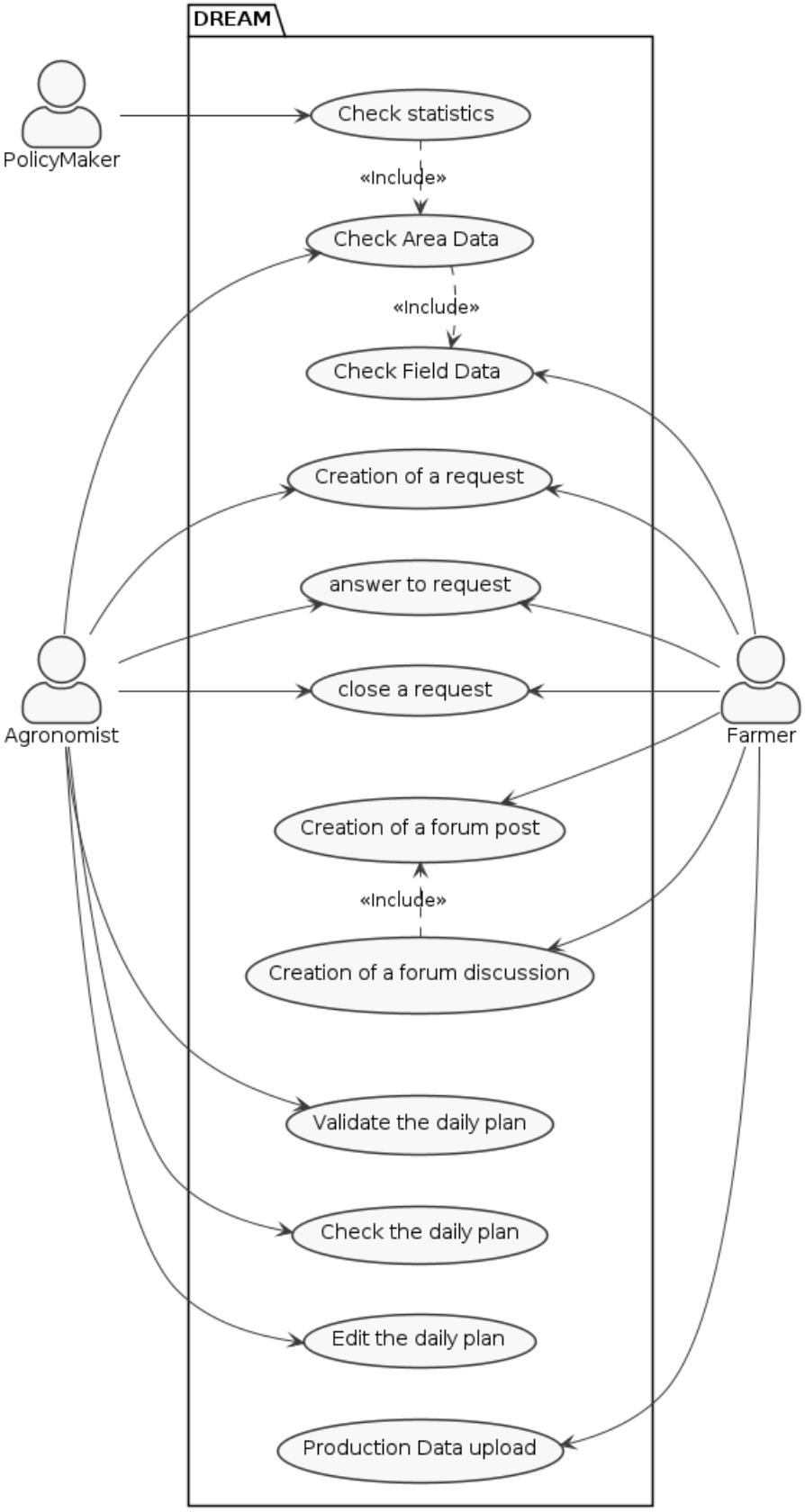
13. Closure of a request

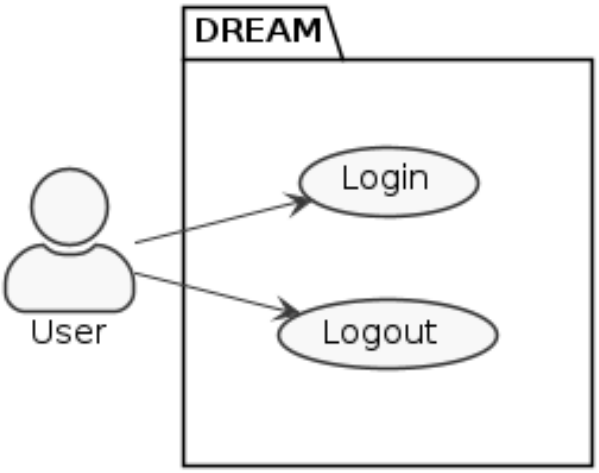
Name	Closure of a request
Actors	Farmer, Agronomist
Entry Condition	1. The user has already logged in the web application. 2. The user has some requests that are not closed yet.
Event Flow	1. The user opens the homepage. 2. The system shows the user all the requests of his area separated into requests and suggestions. 3. The user selects a request that is not closed yet and that has been created by him. 4. The system shows an answer form. 5. The user clicks the “Close” button. 6. The system closes the request.
Exit Conditions	The user closed a request.
Exceptions	1. The system cannot complete the task correctly. This exception is handled by showing a notification to the user. 2. The user tries to close a request not created by him. This exception is handled by disabling the ability to click the close button for users other than the author.

14. Logout

Name	Logout
Actors	User
Entry Condition	1. The user has already logged in the web application.
Event Flow	1. The user reaches his homepage. 2. The user clicks on the logout button. 3. The system redirects the user to the Login page.
Exit Conditions	User is logged out successfully.
Exceptions	3. The system cannot complete the task correctly. This exception is handled by showing a notification to the user.

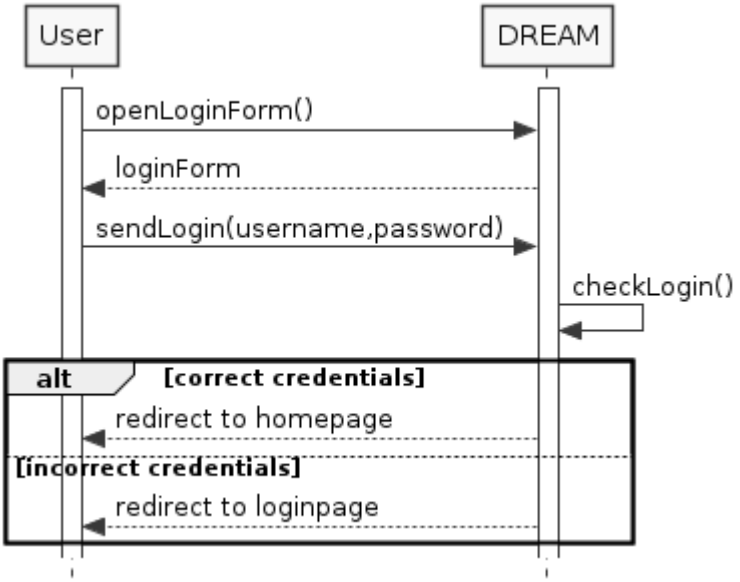
3.2.4 Use Case diagrams



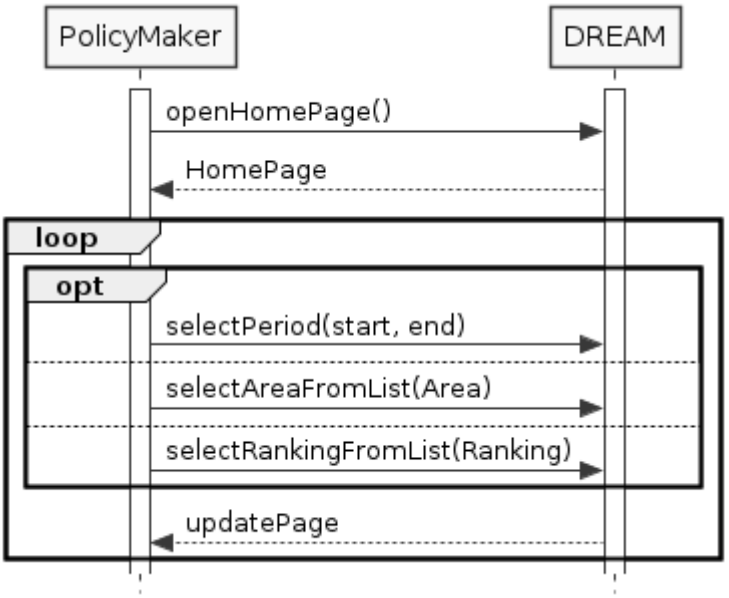


3.2.5 Sequence Diagrams

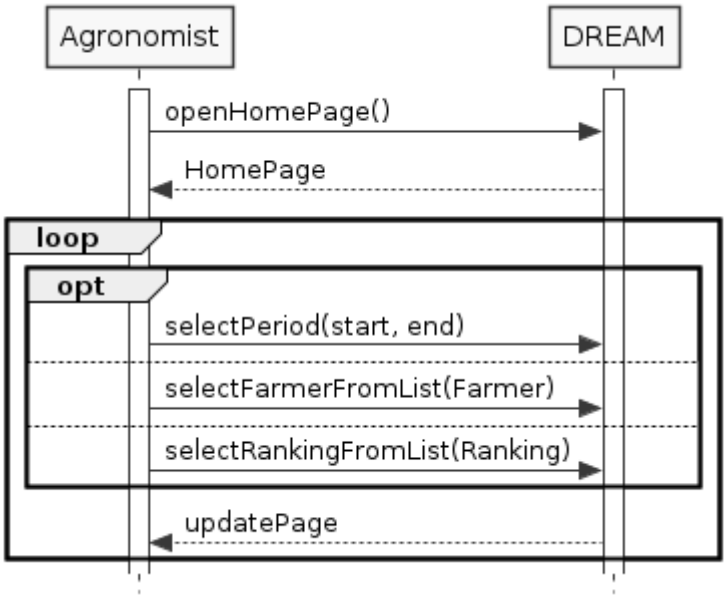
1. Login of a user (Use case 1)



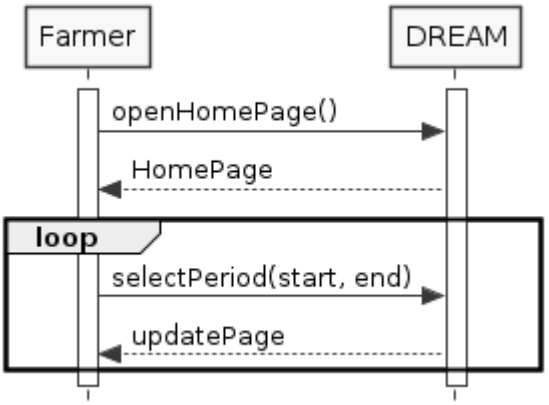
2. PolicyMaker check statistics (Use case 2)



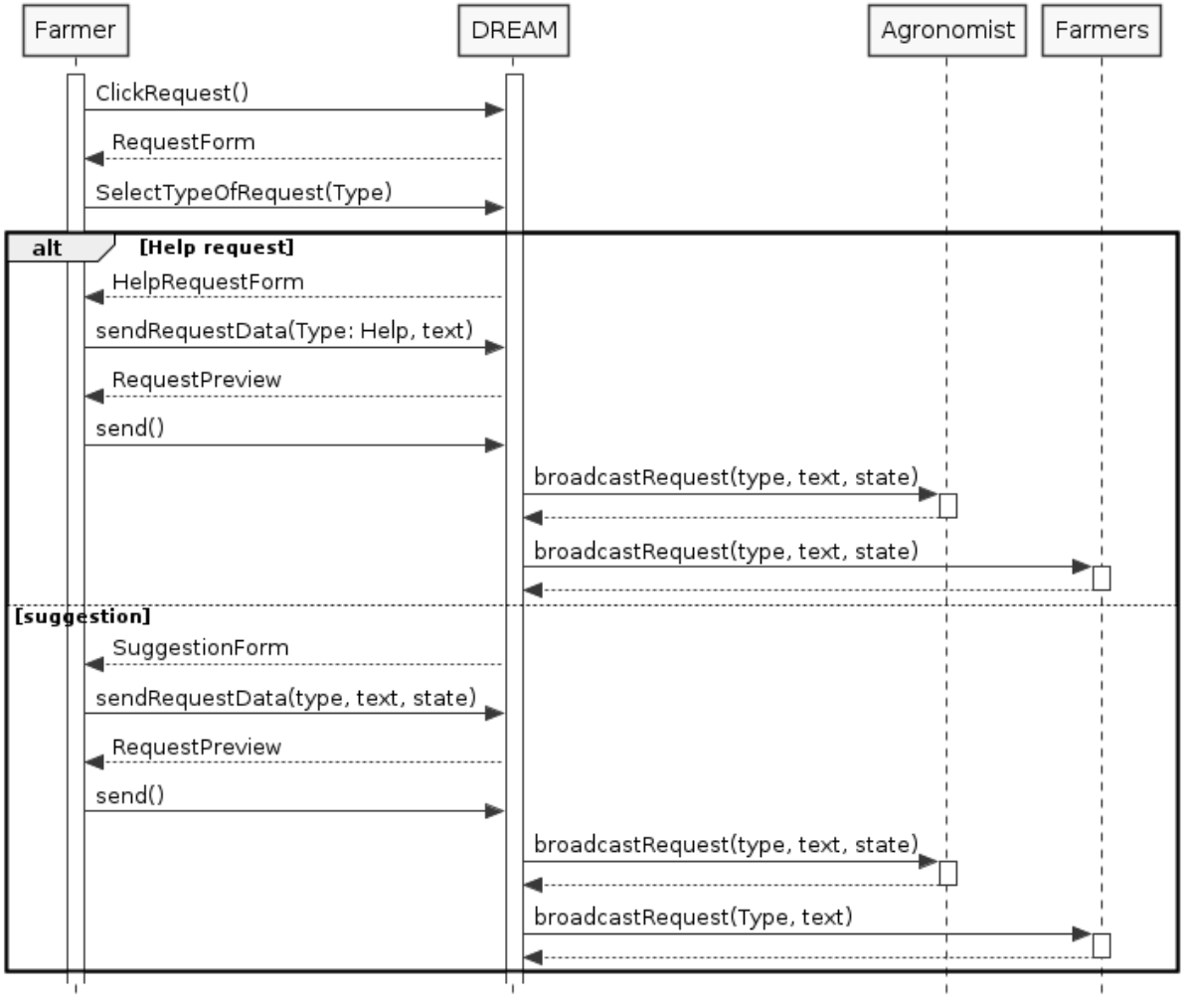
3. Agronomist check statistics (Use case 3)



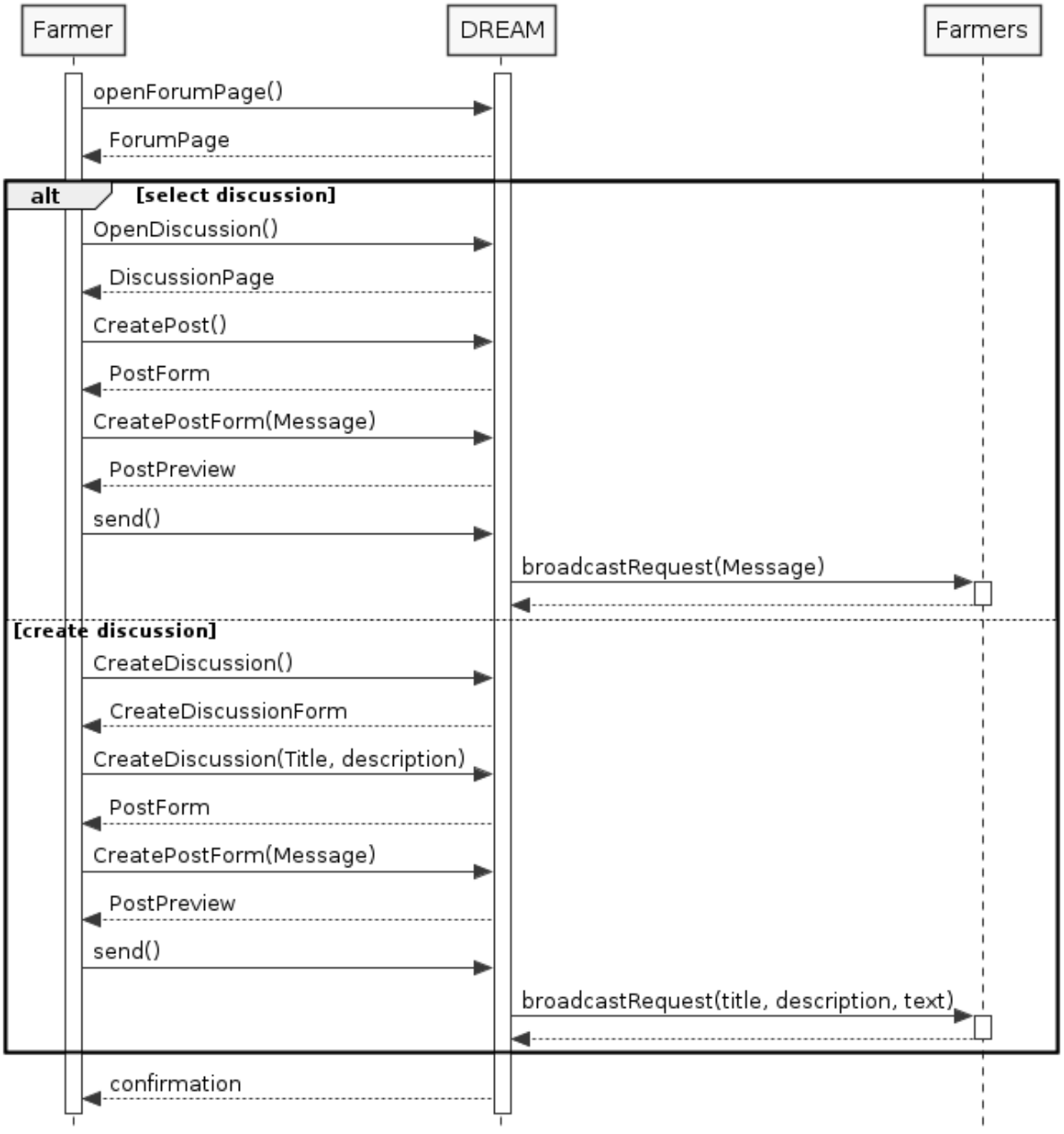
4. Farmer Checks statistics (Use case 4)



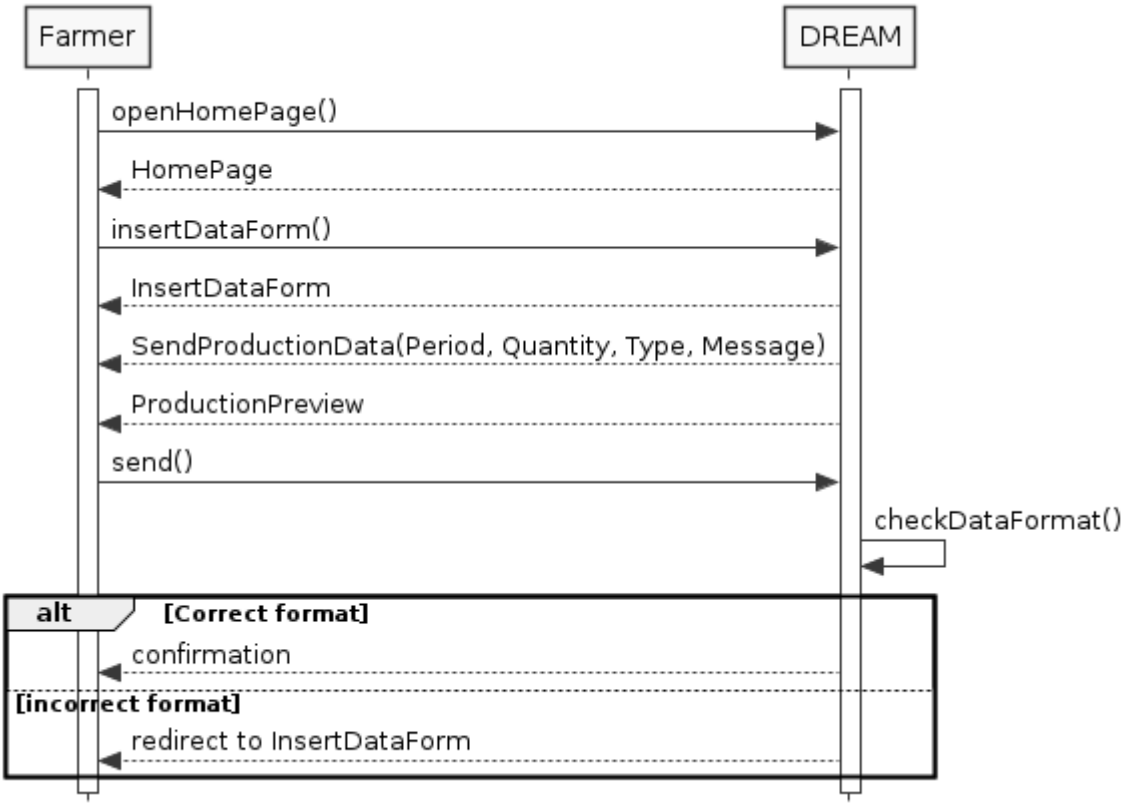
5. Creation of a request (Use case 5)



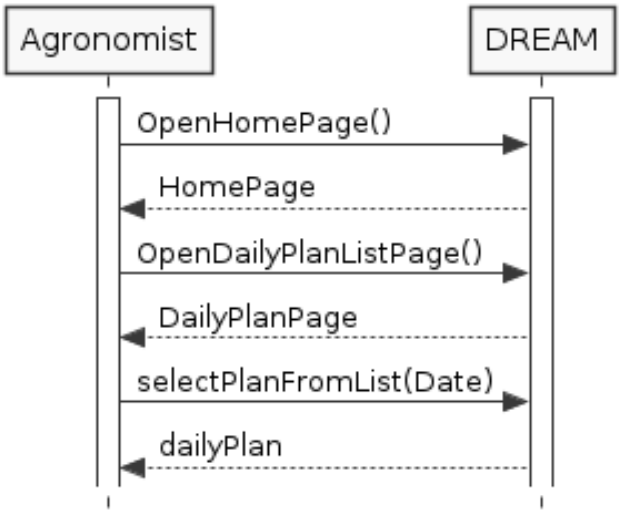
6. Creation of a forum post/forum discussion (Use case 6 and 7)



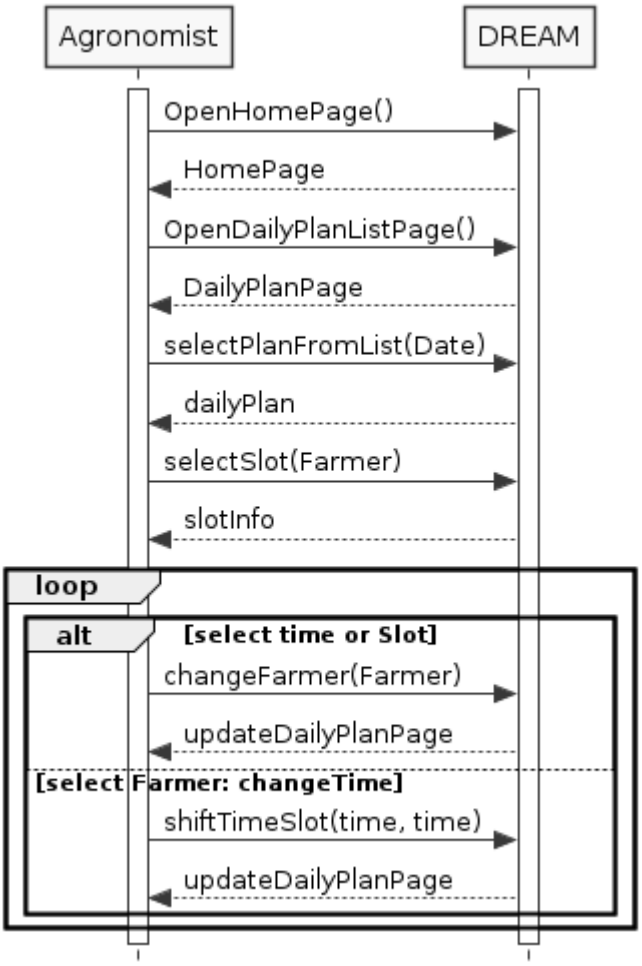
7. Farmer Inserts data about production and about problems encountered (Use case 8)



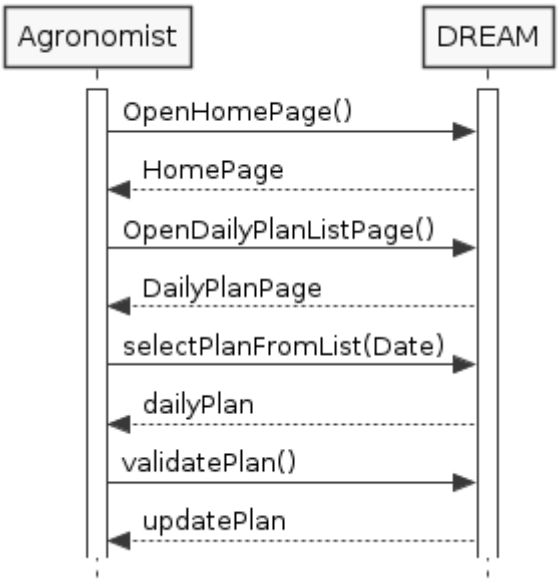
8. Agronomist checks daily plan (Use case 9)



9. Agronomist edits daily plan (Use case 10)

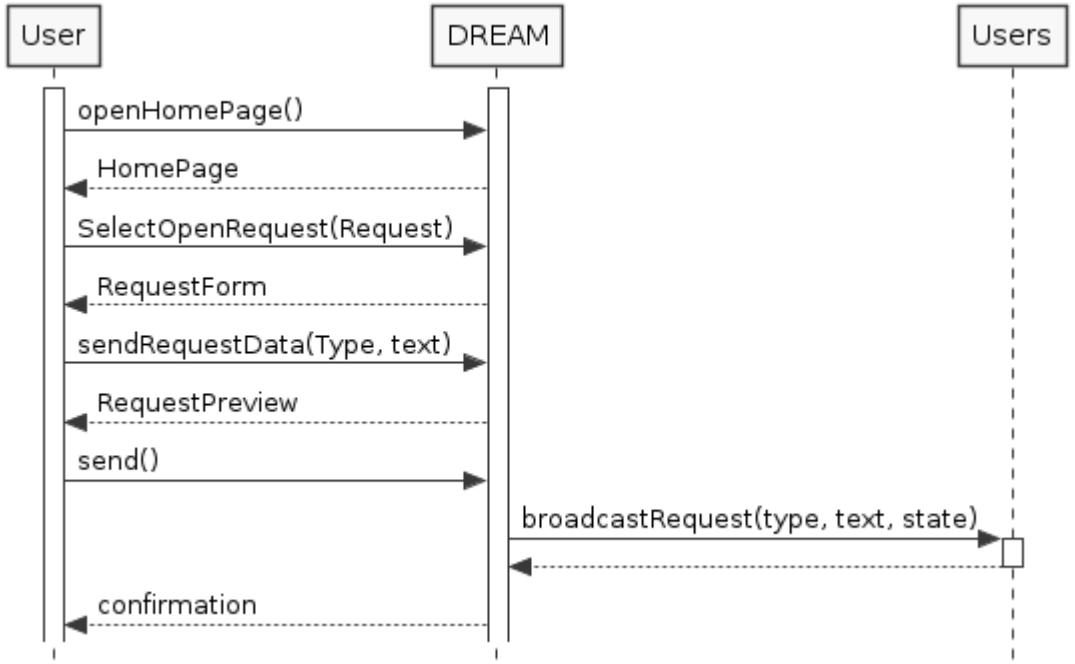


10. Agronomist validates the daily plan (Use case 11)



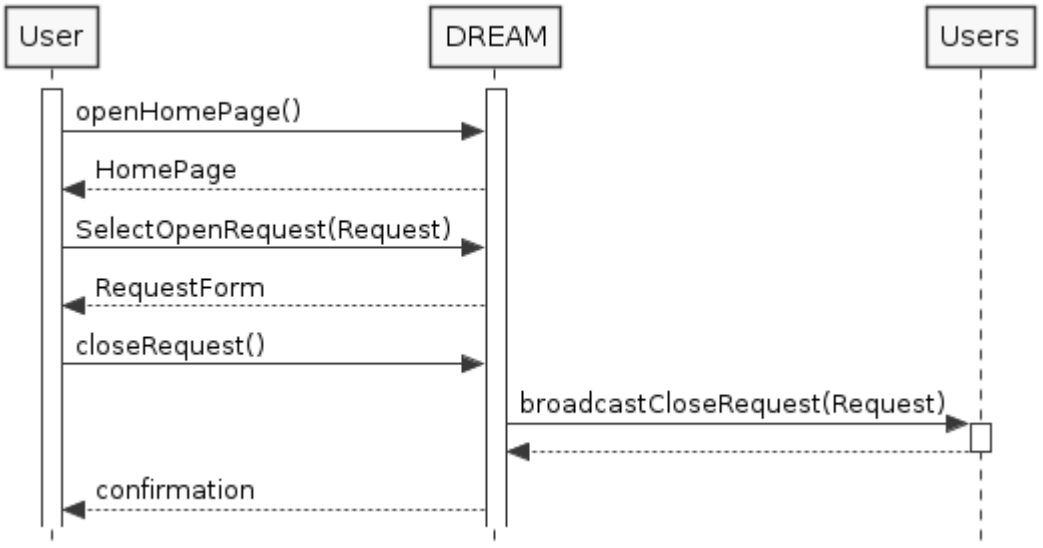
11. Answer to help and suggestion requests (Use case 12)

NB: *In this case, the term user identifies agronomists and farmers.*

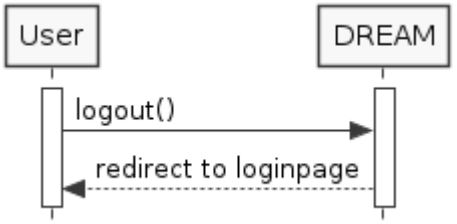


12. Closure of a request (help/suggestion) (Use case 13)

NB: *In this case, the term user identifies agronomists and farmers.*



13. Logout (Use case 14)



3.3 Performance Requirements

The system must be able to work with simultaneous requests from multiple users and must be able to bear peaks of usage in certain hours because farmers are expected to access all at the same time. Performances are not a key aspect of the DREAM system because there aren't any critical actions that require them to be executed within milliseconds. The application can experience some transient delays as long as it ensures that each operation is executed within a few seconds.

3.4 Design Constraints

3.4.1 Standards compliance

The app is available on all platforms because it's a web application and thus is compatible with all operating systems. DREAM is developed to work properly on the most widespread browsers such as Google Chrome, Chrome compatible browsers, Microsoft Edge and Mozilla Firefox.

3.4.2 Hardware limitations

Most farmers may have outdated devices with poor performances. The web application will be developed keeping in mind that, making it as light as possible. The only thing that farmers will have to assure is a stable internet connection.

3.5 Software System Attributes

3.5.1 Reliability

In order to guarantee continuity, services are required to be fault tolerant. Error handling and fault containment mechanisms to prevent error propagation and data loss are to be arranged.

3.5.2 Availability

The software should be available and functioning 24/7, so that users can access data whenever they need. This is reasonable due to the fact that farmers' working hours are highly variable and some information may be searched in late hours preparing for the following day or in very early hours before working. The application should have an availability of approximately 99.8% (corresponding to 2.88 minutes of downtime per day). In any case, if the server is not reachable, a 50* error message will be displayed from the browser. Anyway the system is not involved in critical activities so slight downtimes are acceptable.

3.5.3 Security

The data stored in the system has to be encrypted in order to ensure that users' privacy is protected. Passwords are managed through hashing so that the system never handles the password plaintext. DREAM uses HTTPS for secure communication.

3.5.4 Maintainability

The System will follow good software engineering practices thus the software is deemed to be easily maintainable. The system will be developed keeping it modular so that it'll be easy to add new functionalities and modifying existing ones should not require too much of an effort.

3.5.5 Portability

The system should be a client web application such that it will be easily portable anywhere regardless of the type of device, its performances or its OS. The only thing strictly required is an internet connection and a compatible browser.

4. FORMAL ANALYSIS USING ALLOY

This section contains the Alloy model which explains in more detail the features of the system with particular focus on some constraints. The code sequentially contains Signatures, Functions, Facts, Asserts, Checks, Predicates and Runs.

4.1 Alloy Code

```
/*** SIGNATURES ***/

abstract sig User {
    id: one Int,
```

```
    name: one Int,
    password: one Int,
    surname: one Int,
    mail : one Int
}
{
    id > 0 and
    name > 0 and
    password > 0 and
    surname > 0 and
    mail > 0
}

sig PolicyMaker extends User {}


sig Farmer extends User {
    farm : one Farm,
    request : set Request,
    discussion : set Discussion
}


sig Agronomist extends User {
    area: lone Area,
    dailyPlan: set DailyPlan
}

sig Area {
    id: one Int,
    name: one Int,
    forecast: set Forecast,
    farm: some Farm
}
{
    id > 0
}

sig Forecast {
    id: one Int,
    classification: one Int,
    day: one DateTime
}
```

```
{
    id > 0
}

sig Farm {
    id: one Int,
    address: one Int,
    dimension: one Int,
    farmProduction: set FarmProduction,
    humidityOfSoil: set HumidityOfSoil,
    waterData : set WaterData
}
{
    id > 0
}

sig FarmProduction {
    id: one Int,
    typeOfProduction: one Int,
    amountOfProduction: one Int,
    year: one DateTime,
    problemFaced: one Int,
}
{
    id > 0 and
    typeOfProduction >0 and
    amountOfProduction >= 0
}

sig HumidityOfSoil {
    id: one Int,
    humidity: one Int,
    day: one DateTime,
}
{
    id > 0 and
    humidity >= 0
}

sig WaterData {
    id: one Int,
    quantity: one Int,
    day: one DateTime,
```

```
}
{
    id > 0 and
    quantity >= 0
}

sig DailyPlan {
    id: one Int,
    date: one DateTime,
    excecution: one Int, // 0 => NEW, 1 => PARTIALLYDONE, 2 => DONE
    visit: set Visit
}{
    id > 0 and
    excecution >= 0 and
    excecution <=2
}

sig Visit {
    id: one Int,
    date: one DateTime,
    comment: one Int,
    visitState: one Int,
    farm: one Farm,
}{
    id > 0 and
    visitState >= 0 and // 0 => NEW, 1 => DONE, 2 => NOTDONE
    visitState <= 2
}

sig Request {
    id: one Int,
    comment: one Int,
    typeOfRequest: one Int, // 0 => HELP, 1 => SUGGESTION
    date: one DateTime,
    requestState: one Int, // 0 => OPEN, 1 => CLOSED
    answer: set Answer
}{
    id > 0 and
    requestState >= 0 and
    requestState <= 1 and
    typeOfRequest >=0 and
    typeOfRequest <=1
}
```

```
sig Answer {
    id: one Int,
    comment: one Int,
    typeOfRequest: one Int,  // 0 => HELP, 1 => SUGGESTION
    date: one DateTime,
    farmer: lone Farmer,
    agronomist: lone Agronomist
}{
    id > 0 and
    typeOfRequest >=0 and
    typeOfRequest <=1
}

sig Discussion {
    id: one Int,
    date: one DateTime,
    title: one Int,
    post: some Post
}
{
    id > 0
}



sig Post {
    id: one Int,
    farmer: one Farmer,
    date: one DateTime,
    comment: one Int,
}
{
    id > 0
}

sig Time{
    hour:one Int,
    minute: one Int
}
{  // correct constraints not inserted to avoid long computation
```

```
    hour >0  and
    minute >0
}


sig Date{
    day: one Int,
    month: one Int,
    year: one Int
}
{  // correct constraints not inserted to avoid long computation
    day >0 and
    month >0 and
    year > 0
}


sig DateTime{
    date: Date,
    time: Time
}

/*** END  SIGNATURES ***/




/*** FUNCTION ***/
//Functions return a value

fun compareTime(t1 : DateTime, t2 : DateTime) : one Int {
    t1.date.year < t2.date.year implies -1 else (
    t1.date.year > t2.date.year implies 1 else (
    t1.date.month < t2.date.month implies -1 else (
    t1.date.month > t2.date.month implies 1 else (
    t1.date.day < t2.date.day implies -1 else (
    t1.date.day > t2.date.day implies 1 else (
    t1.time.hour < t2.time.hour implies -1 else (
    t1.time.hour > t2.time.hour implies 1 else (
    t1.time.minute < t2.time.minute implies -1 else (
    t1.time.minute > t2.time.minute implies 1 else 0
    )))))))))
}
```

```
fun compareDay(t1 : DateTime, t2 : DateTime) : one Int {
    t1.date.year < t2.date.year implies -1 else (
    t1.date.year > t2.date.year implies 1 else (
    t1.date.month < t2.date.month implies -1 else (
    t1.date.month > t2.date.month implies 1 else (
    t1.date.day < t2.date.day implies -1 else (
    t1.date.day > t2.date.day implies 1 else 0
    )))))
}

fun compareYear(t1 : DateTime, t2 : DateTime) : one Int {
    t1.date.year < t2.date.year implies -1 else (
    t1.date.year > t2.date.year implies 1 else 0
    )
}

/*** END FUNCTION ***/



/*** FACTS ***/
//Facts are considered true from the Alloy analyzer

/***Check Unique Id ***/
fact userUniqueId {
    no disjoint u1,u2 : User |
    u1.id = u2.id
}

fact areaUniqueId {
    no disjoint a1, a2 : Area |
    a1.id = a2.id
}

fact farmUniqueId{
    no disj f1,f2: Farm |
    f1.id = f2.id
}

fact discussionUniqueId{
    no disj d1,d2: Discussion |
```

```
    d1.id = d2.id
}

fact postUniqueId{
    no disj p1,p2: Post |
    p1.id = p2.id
}

fact requestUniqueId{
    no disj r1,r2: Request |
    r1.id = r2.id
}

fact answerUniqueId{
    no disj a1,a2:Answer |
    a1.id = a2.id
}

fact dailiyPlanUniqueId{
    no disj d1,d2: DailyPlan |
    d1.id = d2.id
}

fact visitsUniqueId{
    no disj v1,v2: Visit |
    v1.id = v2.id
}

fact forecastUniqueId{
    no disj f1,f2: Forecast |
    f1.id = f2.id
}

fact waterDataUniqueId{
    no disj w1,w2: WaterData |
    w1.id = w2.id
}

fact humidityOfSoilUniqueId{
    no disj h1,h2: HumidityOfSoil |
    h1.id = h2.id
}
```

```
fact farmProductionUniqueId{
    no disj f1,f2: FarmProduction|
     f1.id = f2.id
}
/***End Check Unique Id ***/




/*** User Facts***/
fact userUniqueMail {
    no disjoint u1, u2 : User |
    u1.mail = u2.mail
}

/*** End User Facts***/




/*** Area and Farms Facts***/
//Two different farmers cannot have the same farm
fact eachFarmerOneFarm {
    no disjoint f1, f2 : Farmer |
    f1.farm.id = f2.farm.id
}

fact eachFarmMustBeAssociatedToFarmer {
    all f : Farm |
    one fr: Farmer |
    f in fr.farm
}

//Two different agronomists cannot have the same area
fact eachAgronomistOneArea{
    no disjoint a1, a2 : Agronomist |
    one a: Area |
    a1.area = a and a2.area = a
}

fact farmUniqueAddress {
```

```
    no disjoint f1, f2 : Farm |
     f1.address = f2.address
}

//Two different areas cannot contain the same farm
fact eachAreaContainsDifferentFarms {
    no disjoint a1, a2 : Area |
    a1.farm.id = a2.farm.id
}

fact eachFarmMustBeInAnArea {
    all f : Farm |
    one a : Area |
    f in a.farm
}


/*** End Area and Farms Facts***/


/*** Daily Plan Facts***/

fact eachDailyPlanBelongToASingleAgronomist {
    all d: DailyPlan |
    no disj a1,a2: Agronomist |
    d in a1.dailyPlan and d in a2.dailyPlan
}

fact allDailyPlansBelongToSomeAgronomists {
    all d: DailyPlan |
    one a: Agronomist |
    d in a.dailyPlan
}

fact agronomistWithoutAreaMeansNoDailyPlan{
    all a: Agronomist |
    #a.area = 0 implies #a.dailyPlan = 0
}

//Two different DailyPlans cannot have the same visits
fact differentDailyPlanDifferentVisit {
    all disj d1,d2: DailyPlan |
    no v: Visit |
```

```
    v in d1.visit and v in d2.visit
}

fact eachVisitBelongToADailyPlan{
    all v: Visit |
    one d: DailyPlan |
    v in d.visit
}

// All visits inside the same daily plan cannot target the same farm
fact allDailyPlansVisitsDifferentFarms {
    all d: DailyPlan, disj v1,v2: Visit |
    (v1 in d.visit and v2 in d.visit) implies v1.farm != v2.farm
}

//All agronomists visit only farms in their area
fact agronomistsVisitOnlyFamsInHisArea{
    all a: Agronomist | all d: DailyPlan |
    d in a.dailyPlan implies d.visit.farm in a.area.farm
}

//TwoAgronomist cannot have the same visits
fact differentAgronomistHasDifferentVisits{
    no disjoint a1, a2 : Agronomist |
    one v: Visit |
    v in a1.dailyPlan.visit and v in a2.dailyPlan.visit
}

//All completed dailyplans cannot have visits not completed
fact allDailyPlansDoneHaveOnlyDoneVisits{
    all d: DailyPlan |
    no v: Visit |
    d.excecution = 2 and (v.visitState = 0 or v.visitState = 2)
}

// All visits in  partially done dailyplans must be either completed or
done or failed (not done)
fact partiallyDoneDailyPlanNoNewVisits{
    all d: DailyPlan |
    all v: Visit |
    (v in d.visit and d.excecution = 1) implies
    (v.visitState = 1 or v.visitState = 2)
}
```

```
// A partially done dailyplan must contain at least one failed (not
done) visit
fact partiallyDoneDailyPlanAtLeastOneNotDoneVisit{
    all d: DailyPlan |
    some v: Visit |
    d.excecution = 1 implies
    v in d.visit and v.visitState = 2
}

//All visits in a completed dailyplan must be completed
fact doneDailyPlanDoneAllVisits{
    all d: DailyPlan |
    all v: Visit |
    (v in d.visit and d.excecution = 2) implies v.visitState = 1
}

//All new dailyplans must have only new visits
fact newDailyPlanNewVisits{
    all d: DailyPlan |
    all v: Visit |
    (v in d.visit and d.excecution = 0) implies
    v.visitState = 0
}

//All dailyplans contains only visits with the same day
fact visitsAreInTheSameDayOfDailyPlan{
    all d: DailyPlan |
    all v: Visit |
    v in d.visit implies compareDay[d.date, v.date] = 0
}

/* Commented because it's slow but it works like a charm
//Two visits in the same dailyplan cannot have the same time
fact allDailyPlansHaveNoOverlappingVisits{
    all a: Agronomist, disj v1,v2: Visit |
    v1 in a.dailyPlan.visit and v2 in a.dailyPlan.visit implies(
        compareTime[v1.date, v2.date] = 1
        or
        compareTime[v1.date, v2.date] = -1
    )
}
*/
```

```
//Two dailyplans of the same agronomist cannot be related to the same
day
fact twoDailyPlanSameAgronomistNoOverlap{
    all a: Agronomist, disj d1,d2: DailyPlan |
    d1 in a.dailyPlan and d2 in a.dailyPlan implies(
        compareDay[d1.date, d2.date] = 1
        or
        compareDay[d1.date, d2.date] = -1
    )
}

/*** End Daily Plan Facts***/




/*** Request Facts***/
fact eachRequestHasAFarmer {
    all r : Request |
    one f : Farmer |
    r in f.request
}

//Two different farmers cannot have the same request
fact allRequestDifferentFarmer{
    all r: Request |
    no disj f1,f2: Farmer |
    r in f1.request and r in f2.request
}

fact allAnswersBelongToOneRequest{
    all a : Answer |
    one  r : Request |
    a in r.answer
}

fact eachAnswerOneReplier{
    all a: Answer |
    #(a.farmer + a.agronomist) = 1
}

fact allAnswersCannotHaveDifferentRequest {
```

```
    all a: Answer |
    no disj r1,r2: Request |
    a in r1.answer and a in r2.answer

}

//All answers must be newer than their request
fact noAnswersOlderThanRequest{
    all r: Request |
    no a: Answer |
    a in r.answer and compareTime[a.date, r.date] = -1
}

//All answers must be of the same type as the request
fact allAnswerOfSameTypeAsRequests{
    all r: Request |
    all a: Answer |
    a in r.answer implies a.typeOfRequest = r.typeOfRequest
}

/*** End Request Facts***/


/*** Discussion Facts***/
//Two farmers cannot have the same discussion
fact differentFarmersCannotHaveSameDiscussion{
    no disjoint f1,f2: Farmer |
    one d: Discussion |
    d in f1.discussion  and d in f2.discussion
}

//All discussions are written by one farmer
fact allDiscussionsHaveOneFarmer {
    all d: Discussion |
    one f: Farmer |
    d in f.discussion
}

//Two discussions cannot contain the same post
fact differentDiscussionsCannotHaveSamePost {
    all disjoint d1, d2 : Discussion |
    no p: Post |
    p in d1.post and p in  d2.post
```

```
}

//All posts are written by a farmer
fact allPostsAreWrittenByAFarmer{
    all p: Post |
    one f: Farmer |
    f in p.farmer
}

//All posts of a discussion are created after the discussion
fact noPostIsBeforeDiscussion{
    all d: Discussion |
    all p: Post |
    p in d.post implies (
        compareTime[p.date, d.date] = 1
    )
}

//All posts must have a discussion
fact allPostsMustHaveOneDiscussion{
    all p: Post |
    one d:Discussion |
    p in d.post
}

/*** End Discussion Facts***/

/*** Humidity, Water, Forecasts Facts***/
//All possible constraints not inserted because not directly part of
the scope

// All farms production data must be associated to one farm
fact eachProductionMustBeAssociatedToFarm {
    all fp : FarmProduction |
    one f : Farm |
    fp in f.farmProduction
}

//Two different farms cannot have the same production
fact eachProductionBelongsToOnlyOneFarm {
    all disjoint f1, f2: Farm |
    no fp: FarmProduction |
    fp in f1.farmProduction and fp in f2.farmProduction
```

```
}

// All humidity data must be associated to a farm
fact eachHumidityOfSoilMustBeAssociatedToFarm {
    all h : HumidityOfSoil |
    one f : Farm |
    h in f.humidityOfSoil
}

//Two different farms cannot have the same humidity data
fact eachProductionBelongsToOnlyOneFarm {
    all disjoint f1, f2: Farm |
    no h : HumidityOfSoil |
    h in f1.humidityOfSoil and h in f2.humidityOfSoil
}

// All water data must be associated to a farm
fact eachWaterDataMustBeAssociatedToFarm {
    all w : WaterData |
    one f : Farm |
    w in f.waterData
}

//Two different farms cannot have the same water data
fact eachWaterDataBelongsToOnlyOneFarm {
    all disjoint f1, f2: Farm |
    no w : WaterData |
    w in f1.waterData and w in f2.waterData
}

// All forecast must be associated to an area
fact eachForecastMustBeAssociatedToArea {
    all f : Forecast |
    one a : Area |
    f in a.forecast
}

//Two different areas cannot have the same forecasts
fact eachForecastBelongsToOnlyOneArea {
    all disjoint a1, a2: Area |
    no f : Forecast |
    f in a1.forecast and f in a2.forecast
}
```

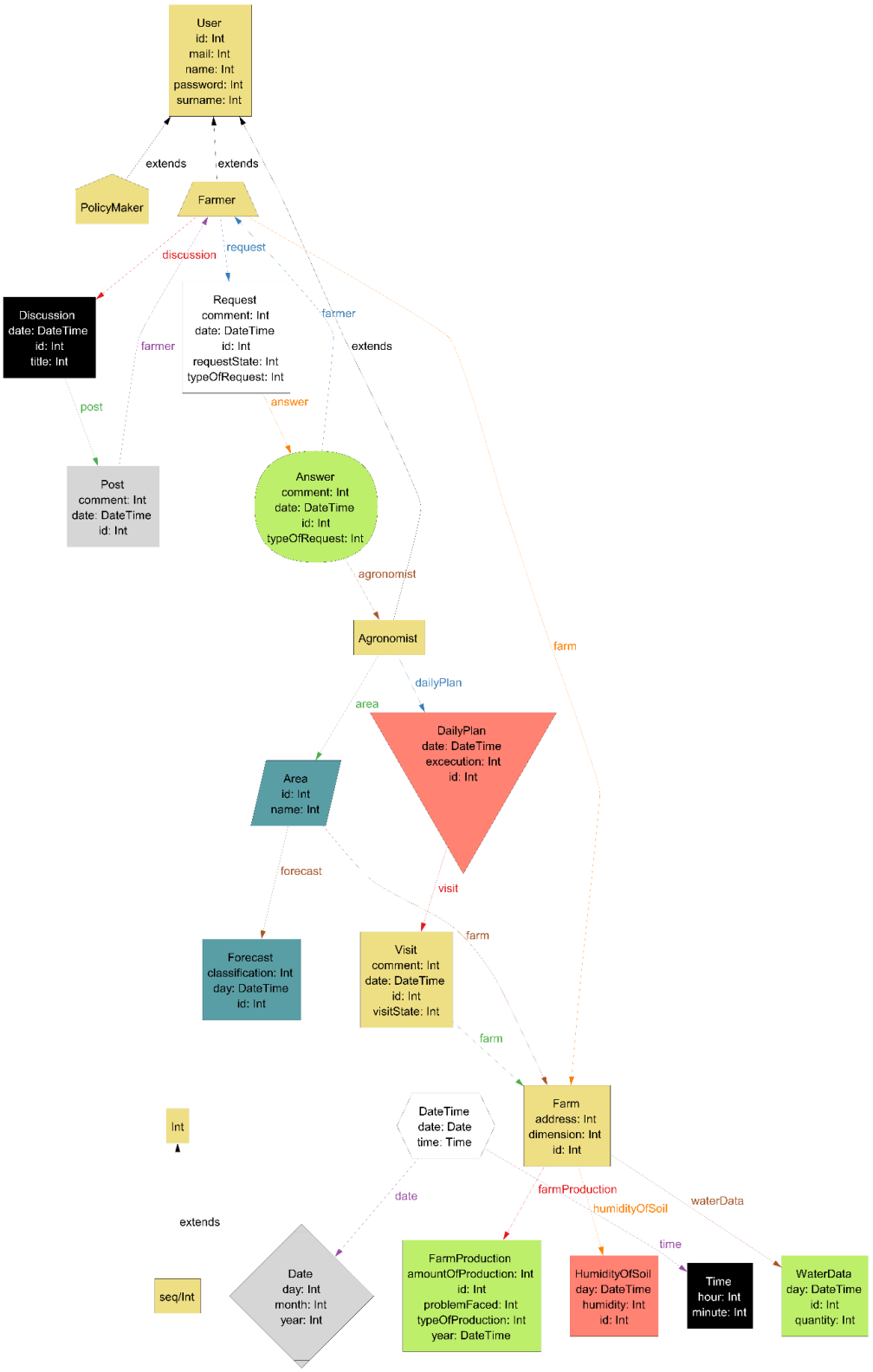
```
/*** EndHumidity, Water, Forecasts Facts***/

/*** END FACTS ***/



/*** ASSERTS ***/
//An assertion is a logical condition (true or false)

assert eachFarmBelongsToAFarmer{
    #Farmer = #Farm
}

assert  agronomistsVisitsInsideTheirArea{
    all a: Agronomist |
    all v: Visit |
    v in  a.dailyPlan.visit implies v.farm in a.area.farm
}

assert postsAreMoreOrEqualThanDiscussions {
    #Post >= #Discussion
}

/*** END ASSERTS ***/


/**** CHECKS  ****/
//A check tries to find a counterexample in which an assert is violated

check postsAreMoreOrEqualThanDiscussions for 4

check agronomistsVisitsInsideTheirArea for 4

check eachFarmBelongsToAFarmer for 4


/**** END CHECKS  ****/


/*** PREDICATES ***/
pred buildBasicWorldDailyPlans {}
```

```
pred buildBasicWorldRequests {}

pred buildBasicWorldDiscussions {}

pred buildComplexWorld {}

//This predicate is supposed to be inconsistent
pred error {
    one f: Farmer, disjoint a1,a2: Agronomist |
    f.farm in a1.area.farm and f.farm in a2.area.farm
}
/*** END PREDICATES ***/

/*** RUNS ***/

//This runs a predicate that is supposed to be inconsistent
run error for 8

//This shows daily plans
run buildBasicWorldDailyPlans for 10 but exactly 0 PolicyMaker, exactly
2 Agronomist, exactly 3 Farmer,
exactly 2 Area, exactly 0 Forecast, exactly 3 Farm, exactly 0
WaterData, exactly 0 FarmProduction,
exactly 0 HumidityOfSoil, exactly 4 DailyPlan, exactly 6 Visit, exactly
0 Request, exactly 0 Answer,
exactly 0 Discussion, exactly 0 Post, exactly 4 DateTime, exactly 2
Date, exactly 2 Time

//This shows requests
run buildBasicWorldRequests for 10 but exactly 0 PolicyMaker, exactly 2
Agronomist, exactly 3 Farmer,
exactly 2 Area, exactly 0 Forecast, exactly 3 Farm, exactly 0
WaterData, exactly 0 FarmProduction,
exactly 0 HumidityOfSoil, exactly 0 DailyPlan, exactly 0 Visit, exactly
6 Request, exactly 5 Answer,
exactly 0 Discussion, exactly 0 Post, exactly 3 DateTime, exactly 3
Date, exactly 3 Time

//This shows discussions
run buildBasicWorldDiscussions for 10 but exactly 0 PolicyMaker,
exactly 0 Agronomist, exactly 3 Farmer,
exactly 2 Area, exactly 0 Forecast, exactly 3 Farm, exactly 0
WaterData, exactly 0 FarmProduction,
```

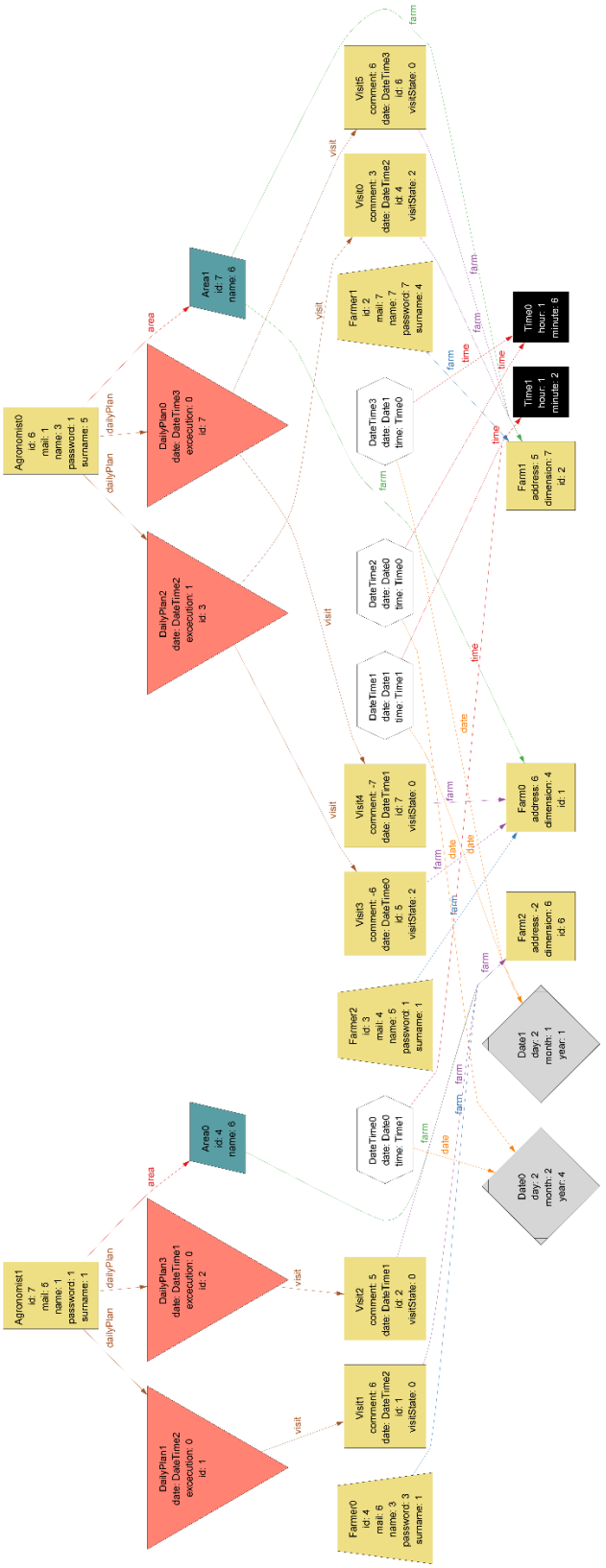
```
exactly 0 HumidityOfSoil, exactly 0 DailyPlan, exactly 0 Visit, exactly
0 Request, exactly 0 Answer,
exactly 1 Discussion, exactly 2 Post, exactly 2 DateTime, exactly 2
Date, exactly 2 Time

//This shows everything
run buildComplexWorld for 10 but exactly 2 PolicyMaker, exactly 2
Agronomist, exactly 3 Farmer,
exactly 2 Area, exactly 3 Forecast, exactly 3 Farm, exactly 3
WaterData, exactly 4 FarmProduction,
exactly 3 HumidityOfSoil, exactly 4 DailyPlan, exactly 6 Visit, exactly
5 Request, exactly 4 Answer,
exactly 5 Discussion, exactly 6 Post, exactly 4 DateTime, exactly 2
Date, exactly 2 Time

/***END RUNS ***/
```

```
8 commands were executed. The results are:
   #1: No counterexample found. postsAreMoreOrEqualThanDiscussions may be valid.
   #2: No counterexample found. agronomistsVisitsInsideTheirArea may be valid.
   #3: No counterexample found. eachFarmBelongsToAFarmer may be valid.
   #4: No instance found. error may be inconsistent.
   #5: Instance found. buildBasicWorldDailyPlans is consistent.
   #6: Instance found. buildBasicWorldRequests is consistent.
   #7: Instance found. buildBasicWorldDiscussions is consistent.
   #8: Instance found. buildComplexWorld is consistent.
```

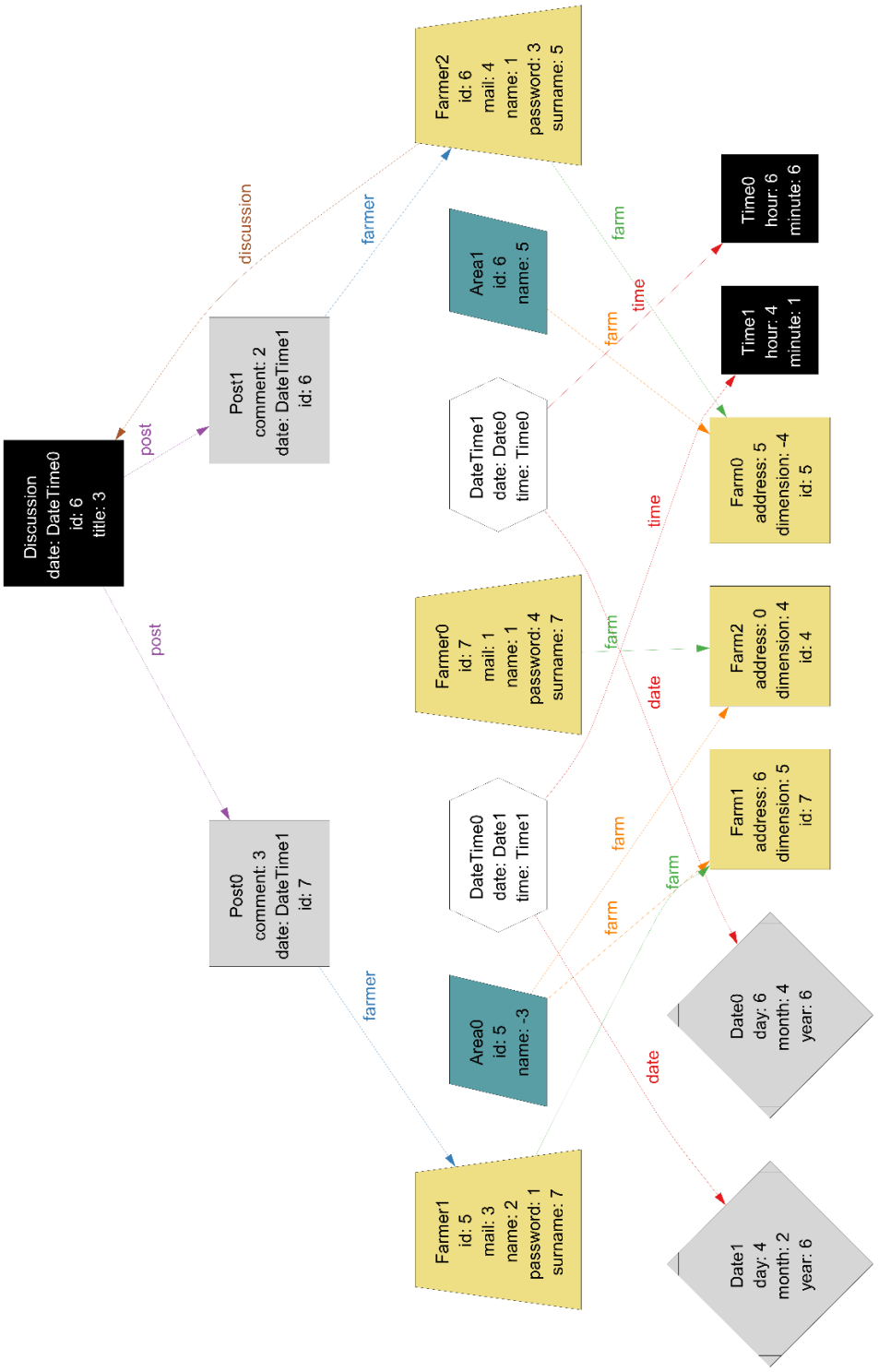
4.2 Meta Model



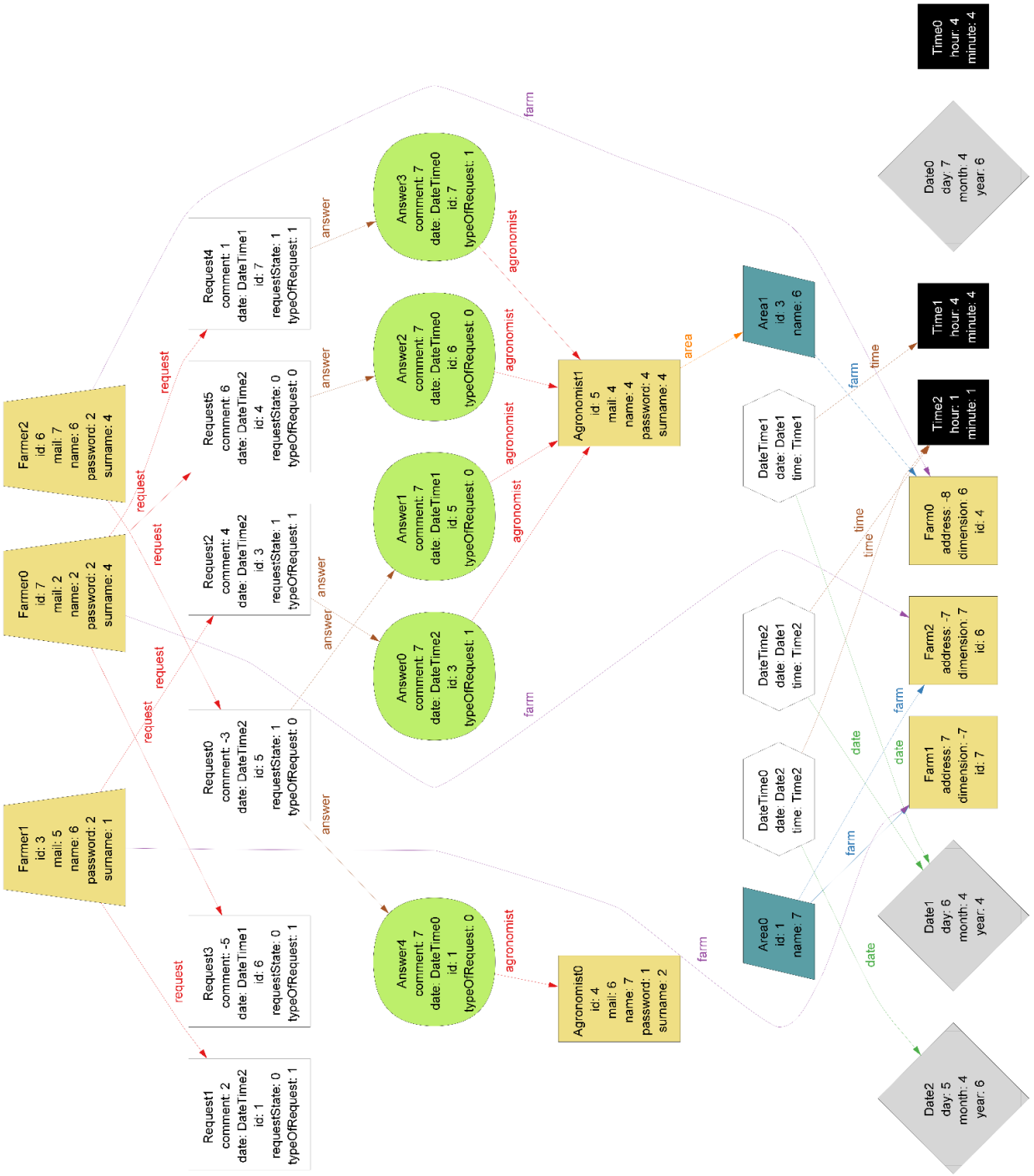
4.3 Daily Plan Simple World



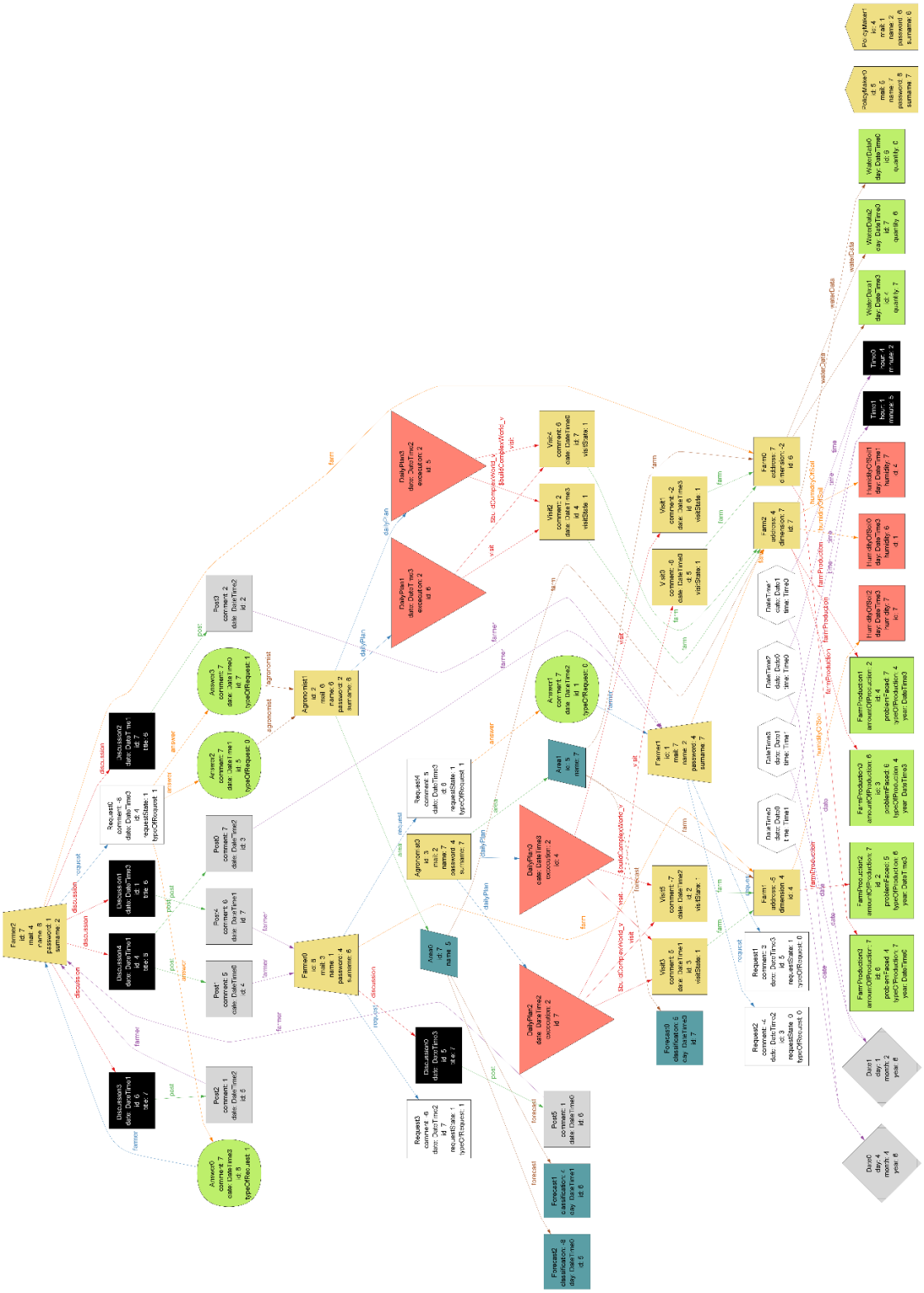
4.4 Discussions Simple World



4.5 Requests Simple World



4.6 Complex World



5. EFFORT SPENT

5.1 Teamwork

Task	Hours
Initial briefing	2
Brainstorming	3
Purpose & Scope (and goals)	6
Product perspective and functions	3
User characteristics and domain assumptions	2
Interfaces	2
Requirements and constraints	12
UML	7
Alloy	7
Document Revision	4

5.2 Luca Bertelli

Task	Hours
Purpose & Scope (and goals)	6
Product perspective and functions	3
User characteristics and domain assumptions	7
Interfaces	6
Requirements and constraints	4
Use cases and UML	15
Alloy	3
Document Revision	6

5.3 Matteo Savino

Task	Hours
Purpose & Scope (and goals)	6
Product perspective and functions	9
User characteristics and domain assumptions	6
Interfaces	3
Requirements and constraints	12
Use cases and UML	6
Alloy	10
Document Revision	6

5.4 Giacomo Vinati

Task	Hours
Purpose & Scope (and goals)	2
Product perspective and functions	4
User characteristics and domain assumptions	3
Interfaces	12
Requirements and constraints	6
Use cases and UML	3
Alloy	18
Document Revision	3

6. REFERENCES

- Slides of the lectures
- ISO/IEC/IEEE 29148-2018 - International Standard - Systems and software engineering - Life Cycle Process - Requirements Engineering

- Telangana website: Telangana State Development Planning Society
- Community paper: *Artificial Intelligence for Agriculture Innovation*
- About the Unified Modeling Language Specification Version 2.5.1
- PlantUML