POLITECNICO
MILANO 1863

DREAM project by Parcevaux - Pouliquen

Requirement Analysis and Specification Document

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1 Introduction

1.1 Purpose

As reported by the Food and Agriculture Organization of the United Nations [4], the Indian cultivated area went through a great expansion between 1970 and 2000, going from 140 million to 190 million hectares (ha). In the meantime, the number of farmholding skyrocketed, from 70.5 to 115.6 million. This is the reason why, the average size of farmholdings dropped from 2.30 to 1.41 ha.
Hence, the Indian government has to tackle many new farms with lower sizes, which may require some helps or incentives.
In this tense context, the United Nations Development Programme (UNDP) partnered with the state of Telangana to enhance good deviances in the state's agriculture through a data-driven approach.

- G1: Allow farmers to get advices for optimizing their production

  G1.1: Allow farmers to retrieve personalized suggestions if they perform poorly

  G1.1.1: Provide farmers with a regular performance monitoring

  G1.1.2: Allow farmers to get a personal help when required

  G.1.2: Allow farmers to discuss with other farmers about their issues

  G1.2.1: Allow farmers to create a discussion forum

  G1.2.2: Allow farmers to look for a specific topic among discussion forums

  G1.2.3: Allow farmers to send messages on a forum already created

  G1.2.4: Allow farmers to contact another farmer privately

- G2: Allow farmers to get data about natural circumstances that impact their production.

  G2.1: Allow farmers to access data about weather conditions and predictions

  G2.2: Allow farmers to access data about soil moisture

  G2.3: Allow farmers to access data about soil organic carbon

  G2.4: Allow farmers to access data about vegetation index

- G3: Allow policy makers to globally enhance the productivity of the farmers of their area

  G3.1: Allow policy makers to identify well and poorly performing farmers of their area, according to a chosen metric

  G3.2: Allow policy makers to incent well performing farmers

  G3.3: Allow policy makers to fetch best practices among farmers and provide them to others

  G3.4: Allow policy makers to support poorly performing farmers with personalized suggestions

1.2 Scope

1.2.1 World Phenomena

- Farmers seed their crops with a given seed rate
- Farmers fertilize their crops
- Farmers measure the amount of fertilizer used for a specific cropping
- Farmers harvest their crops

- Farmers measure their production
- Water consumption figures are updated
- Soil moisture figures are updated
- Vegetation index figures are updated
- Rainfall conditions are updated
- Rainfall previsions are updated
- Global Positioning System (GPS) gets the farmer location

1.2.2 Shared Phenomena

- Farmer releases production data
- Farmer enters the fertilizers used
- Farmer enters the seed variety used
- Farmer enters the seed rate of the crop
- Farmer releases the amount of fertilizer used for cropping
- Farmer enters the start and end dates
- Farmer receives special incentive
- Farmer receives a request of best practices
- Farmer provides best practices
- Farmer visualizes the weather forecasts
- Farmer requests for help
- Farmer creates discussion forum
- Farmer searches for a discussion forum on a specific topic
- Farmer sends a message in a discussion forum
- Farmer sends a message to another farmer
- Farmer registers and provides personal data (mail, name)
- Farmer logs in
- Farmer provides exploitation data (location, type of production)
- Policy Maker registers and provides personal data (mail, name)
- Policy Maker logs in
- Policy Maker provides area he is responsible of
- Policy Maker asks for a ranking of the farmers he is in charge of, based on some metric
- Policy Maker searchs for a discussion forum on a specific topic

- Policy Maker sends a message to a farmer
- DREAM displays a notification to farmer for production release
- DREAM displays a notification to farmer for lack of soil or weather data
- DREAM displays a notification to farmer for new message from another farmer
- DREAM displays a notification to farmer for new message from a policy maker
- DREAM displays a notification to farmer for a suggestion from a policy maker
- DREAM displays a notification to farmer for help request proposal
- DREAM displays a notification to farmer for best practice
- DREAM displays a notification to farmer for e-voucher
- DREAM displays a notification to policy maker for help request from a farmer
- DREAM displays a notification to policy maker for new registration in his/her area
- DREAM displays a notification to policy maker for completion of production data

1.2.3 Machine Phenomena

- Identifies best performing farmers from a list with respect to a specific metric given their production releases
- Identifies worst performing farmers from a list with respect to a specific metric given their production releases
- Transmit messages between users
- Fetchs farmers within a policy maker area
- Fetchs the policy maker responsible of a given farmer’s area
- Fetchs weather forecasts for a given time and a delimited zone
- Fetchs weather conditions for a given time and a delimited zone
- Fetchs organic carbon figures for a given time and a delimited zone
- Fetchs soil moisture figures for a given time and a delimited zone
- Fetchs vegetation index figures for a given time and a delimited zone
- Fetchs data from water irrigation system
- Fetchs user’s location

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

- User: is a person who received a registration link and successfully registered. It can be a farmer or a policy maker
- Policy maker: is a user employed by the state of Telangana to (at least) supervise the agricultural activities in a given area
- Farmer: is a user who holds an agricultural business and is recognized as such in the state of Telangana
- Maintener: is the person in charge of the maintenance of DREAM
- Release: is a set of information that relates what a farmer croped on a specific field during a season, how much water and fertilizer was necessary and what the farmer obtained from it. It has two statutes. Incomplete, when the bare minimum of information that is available at the beginning of the season is input. Complete when the release is completed by data that can't be known before the end of the season.
- Batch: is a set of releases of a farmer which are on the same season. Releasing, analyzing a batch thus means releasing and analyzing the production of a farmer on a given season. A batch can be "confirmed" by the farmer, as to say that all the production data are there and are true.
- Release and analysis periods: are the two months after the cropping season. The first month is dedicated to the completing of releases and confirming of batches. During the second month, policy makers are supposed to analyze the results, identify well and poorly performing farmers and ask them for best pratices or help them. The time allocated to these periods is based on a similar work, see [2].

  Cropping season: is the timelapse during which seed are planted, cultivated and finally harvested. There are two major ones in India (officially recognized): Rabi for the spring season and Kharif for the autumnal one.
- Help request: is a message from a farmer to his/her policy maker with a label that highlights its importance. The policy maker is supposed to reply with the best pratices or the expertise of agronomists (out of scope).
- Incentive: is a financial support from policy maker to a well performing farmer. Assumed to be generated as an e-voucher to improve the working conditions.
- Vegetation index: is a number that measures from distance the presence of green vegetation and by such the "health" of the vegetation on a given land. It characterizes the climate resilience (see [6])

1.3.2 Acronyms

- RASD: Requirement Analysis and Specification Document
- DREAM: Data-dRiven PrEdictive FArMing in Telengana
- GPS: Global Positioning System
- FAO: Food and Agriculture Organization
- UNDP: United Nations Development Programme

- UML: United Modeling Language
- PM: Policy Maker
- SQL: Simple Query Language
- NICES: National Inforamtion System for Climate and Environment Studies
- API: Application Programming Interface
- ha: hectare

1.3.3 Abbreviation

- Gn: n^{th} Goal
- Rn: n^{th} Requirement
- PM: Policy Maker

1.4 Reference Documents

References

[1] Rajkumar Buyya Caesar Wu. Planned downtime. 2015.

[2] SEED CELL. Seed rolling plan 2022-2023 of telengana state. https://seednet.gov.in/PDFFILES/Breeder_Seed_Indent_Recommendation.pdf.

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[5] Parvathy Krishnank. Data4policy. https://github.com/UNDP-India/Data4Policy, 2021.

[6] Nguyen Xuan Thinh Mathias Schaefer and Stefan Greiving. How can climate resilience be measured and visualized? assessing a vague concept using gis-based fuzzy logic.

[7] Minister of Law Shri Ravi Shankar Prasad, Communications Justice, Electronics, and Information Technology. The personal data protection bill, 2019. Bill No. 373 of 2019.

2 Overall Description

2.1 Product perspective

The product will be used by farmers, policy makers and agronomists.

2.1.1 Scenarios

Scenario 1: Farmer registration

Ishaan receives an e-mail from administration that redirects him to the DREAM website registration page. He registers by providing his email address, name, surname, farm name and finally location which he provides by means of the geo-tracking functionality of his smartphone. The system checks that the email address isn't already registered, then sends a validation email to Ishaan.

After validation, the system fetchs Ishaan's district and mandal, based on his location. It then displays rainfall conditions and predictions, respectively based on Ishaan's mandal and location, on the homepage of Ishaan. It then fetchs the policy makers corresponding to this area. The system sends a notification to the policy maker in charge of the area to acknowledge the registration of Ishaan.

Scenario 2: Production data and type release

Shyla has just finished his crop. She measures her production. She logs in on the DREAM platform where she had already registered. She goes to the page "Release production". She fills the following sections: seed variety, seed rate, production amount, surface area of the cultivated fields, amount of water consumed, start and end date.

Scenario 3: Discussion forum creation

Dhruv's old tractor is broken. He wonders if he should try to repair it, if possible, and if not, what modern model he should choose. He looks for feedbacks on the forum discussion of the DREAM platform. As he can't find any on the kind of engine he owns, he creates a new topic, explains his issue and waits for answers.

Scenario 4: Prediction check

Ashwin wants to know what are the soil and weather conditions of his mandal to correctly dose his fertilizer. He logs in on the DREAM platform. He goes to the homepage. He checks the soil moisture data, weather conditions and predictions.

Scenario 5: Request for production data and type release

Between April and October, Amar crops and harvests rice during the so-called "Kharif"season. In November, he receives a notification from DREAM that urges him to release his production data - seed variety, seed rate, production amount, surface area of the cultivated fields, amount of water consumed, start and end date - by the end of the month. He instantly performs. On the first of December, a notification telling the completeness of the database gathering the production data of the farmers in Amar's area based on the location of his farm is sent by the system to the dedicated policy maker.

Scenario 6: Research among discussion forums

Diya is not sure about the law regarding some specific fertilizer. She looks for discussion forums on DREAM. She uses as keywords "law", the name of the fertilizer and she filters the results to get late discussions - she knows that the law has changed in the previous years. She finds some farmer whose response handles her issue. Since she wants some more precision, she contacts the farmer, via DREAM, in a private discussion.

Scenario 7: Help request notification

Sahil receives a notification from his policy maker suggesting him some practices fertilizer,crops and overall practices to improve his productivity and a proposal for a specific help request.

Scenario 8: Well performing farmers identification

Nikhil is a policy maker. On December, 1st, he receives a notification from DREAM telling that all farmers of his area have delivered their production data. He selects some performance metrics among those proposed. The systems ranks the farmers accordingly and displays the ranking. Nikhil selects the farmer that he wants to congratulate. He sends to each one a message via DREAM, and ticks a box to send an e-voucher that the system generates and enclose. In the messages, Nikhil asks for best practices to the farmers.

Scenario 9: Poorly performing farmers identification

Ananya is a policy maker. On December, 1st, she receives a notification from DREAM telling that all farmers of her area have delivered their production data. She selects some performance metrics among those proposed. The systems ranks the farmers accordingly and displays the ranking. Ananya selects the farmers that may require help. She sends them a message via DREAM to tell them these suggestions and propose them to be helped.

Scenario 10: Major issues identification

Nila is a policy maker. Crop is coming to end. She wants to correctly understand the issues that face the farmers of her area, in order to ask relevant questions to well performing farmers. She spends some time on forum discussions and note the most repeating concerns of farmers.

Scenario 11: Help request

Tamia requires the insight of some expert on crops for the coming seeding. She goes to the "help request" section. She sends message. Based on her location, the system forwards the message to the adequate policy maker. The latter will send the request to an agronomist, who will afterwards contact Tamia.

2.1.2 Product functions

- R1: The system should integrate a calendar that rythms the alternance of cropping season/release period/analysis period.

- R2: Two weeks before the end of the release period, DREAM should recall the farmer to confirm the batch of production (if the farmer didn't confirm it yet).

- R3: Two weeks before the end of the analysis period, DREAM should recall the policy maker to identify well and poorly performing farmers (if not done).

- R4: Two weeks before the end of the analysis period, DREAM should recall the policy maker to send messages/incentives/help proposal to farmers, if some of the well or poorly performing ones weren't contacted yet.

- R5: DREAM should enable messaging between farmers and a farmer and a policy maker from the same area.

- R6: When an area is given, DREAM should fetch the policy maker in charge of it.

- R7: DREAM should enable any farmer to create a discussion forum, with a title, tags and filters.

- R8: When requested, DREAM should provide discussion forums ordered by semantic proximity of a given topic.

- R9: DREAM should enable unlimited answers in the thread of a forum.

- R10: When a location is asked and the user has agreed so, DREAM should fetch the position thanks to the GPS functionality of a device.

- R11: Given a date and a location, DREAM should fetch from the external databases the closest and latest weather conditions.

- R12: Given a date, a location and a number of days, DREAM should fetch from the external databases the closest and most adequate (with respect to the number of days of prediction) weather predictions.

- R13: Given a date and a location, DREAM should fetch from the external databases the closest and latest soil moisture data (that is, figures and locations).

- R14: Given a date and a location, DREAM should fetch from the external databases the closest and latest soil organic carbon data (that is, figures and locations).

- R15: Given a date and a location, DREAM should fetch from the external databases the closest and latest vegetation index data (that is, figures and locations).

- R16: Given a list of figures and locations, DREAM should display them on an interactive map, with a nice legend.

- R17: On a move, the map displayed should be reactive. That is to say: it should query new values to fit in the new spatial frame.

- R18: DREAM should have a clock synchronous with the Indian time zone and Gregorian calendar.

- R19: Given a metric and a batch from a location, DREAM should fetch the required data at the date that correspond to the batch. The system should then correctly compute the performance.

- R20: The system should be able to rank a list of farmers during a given season with respect to a metric.

- R21: Given a two dates and a farmer identity, DREAM should fetch from the water irrigation system the total amount of water consumed during the time-lapse by the farmer.

- R22: If any necessary piece of information is missing at some point of a process, DREAMS should display an error message.

- R23: Given a user identity, DREAMS should be able to access all the personal data of this user.

- R24: When a policy maker decides to make an incentive, DREAMS should create via an external API an e-voucher of the amount wanted.

- R25: Given a farmer identity, DREAM should be capable of fetching the corresponding batch.

2.1.3 Assumptions, dependencies and constraints

- A1: Cropping seasons are the same on the whole Telengana State and follow the Kharif/Rabi calendar, see Figure 1, as related in [3].

- A2: Farmers put rightful information on their location and data on their production. Fraud is possible but it is the responsibility of policy makers to prevent it, with the help of agronomists.

- A3: If a policy maker is missing at some farmer's registration, he/she will be found before the end of the cropping season.

- A4: All users that register have access to internet in some way and have access to the application.

- A5: All humidity data are collected through the database of the NICES project. The system thus doesn't require its own sensors.

- A6: To avoid money transfers and check the use of the money, incentives are sent as e-vouchers. This decisions was supported by the stakeholder, see [5].

- A7: The irrigation system is supposed to provide the water consumption data thanks to an external API.

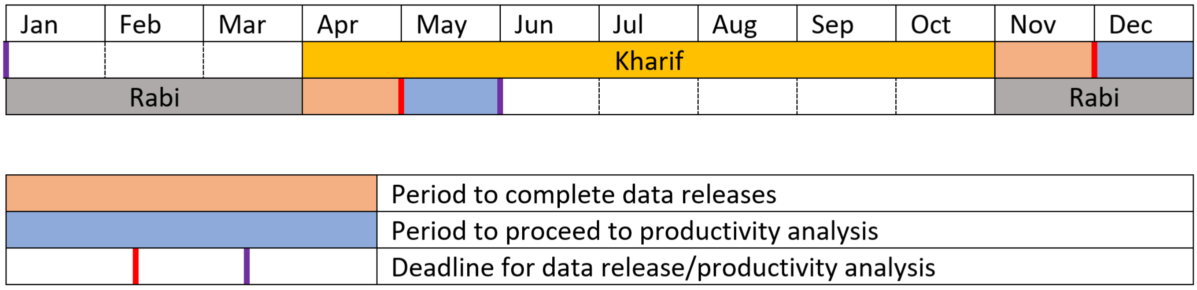

Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Kharif
Rabi
Rabi
Period to complete data releases
Period to proceed to productivity analysis
Deadline for data release/productivity analysis

Figure 1: Seasons

2.1.4 Mapping on goals

Goals	*Assumptions*	*Requirements*
G1.1.1	A1,A3,A4	R1,R2,R3,R4,R5,R6,R25
G1.1.2	A3,A4	R5, R23
G1.2.1	A4	R7
G1.2.2	A4	R8,R18
G1.2.3	A4	R9,R18
G1.2.4	A4	R5,R23
G2.1	A4	R9,R10,R11,R12,R16,R17,R18
G2.2	A4,A5	R9,R10,R11,R13,R16,R17,R18
G2.3	A4	R9,R10,R11,R14,R16,R17,R18
G2.4	A4	R9,R10,R11,R15,R16,R17,R18
G3.1	A2,A4,A7	R9,R10,R11,R12,R13,R14,R15,R16,R17,R18,R19,R20,R21
G3.2	A4,A6	R5,R24
G3.3	A4	R5
G3.4	A4	R5

3 Specific Requirements

3.1 External Interface Requirements

3.1.1 User interfaces

The user interface will be responsive and should be multiple platform. Even if it should be mainly done for phones.

Where as the application for policy makers should be also responsive but mainly optimized for computer.

First we will present the interfaces for farmers. They are not exhaustive but the goal here is to give a good overview of what the app will look like. The figure 2 represents the general login page. Depending on the mail the user will then be a farmer or a policy maker.

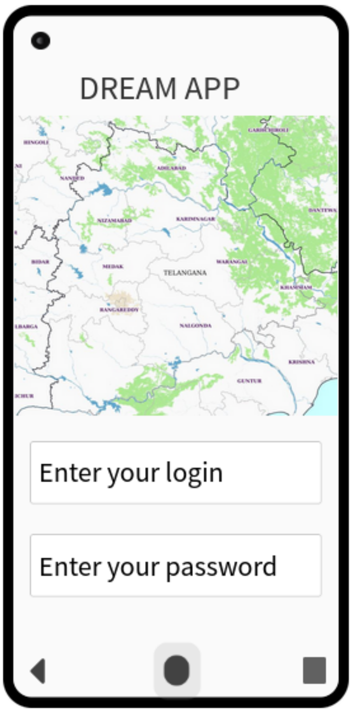
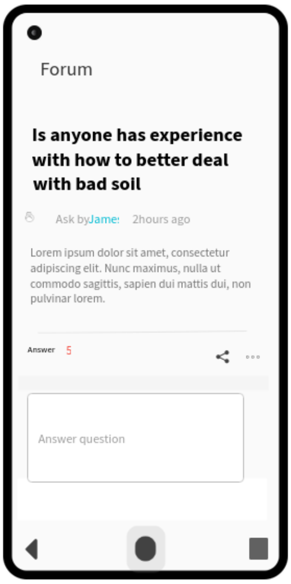


Figure 2: login from a phone

The figure 3 shows the view of the forum on a phone, this view as the others will also be visible from a computer as all the app will be responsive. Next to it the figure 4 gives access to the main data simply and in a rapid way.



Is anyone has experience with how to better deal with bad soil

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc maximus, nulla ut commodo sagittis, sapien dui mattis dui, non pulvinar lorem.

Figure 3: forum from a phone

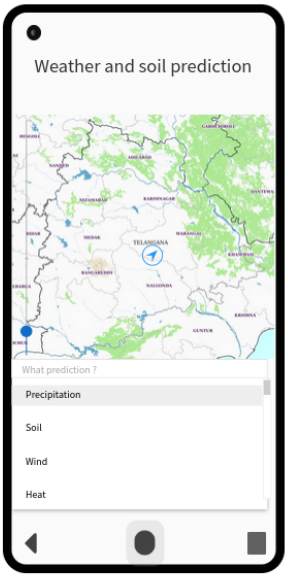


Figure 4: have access to data

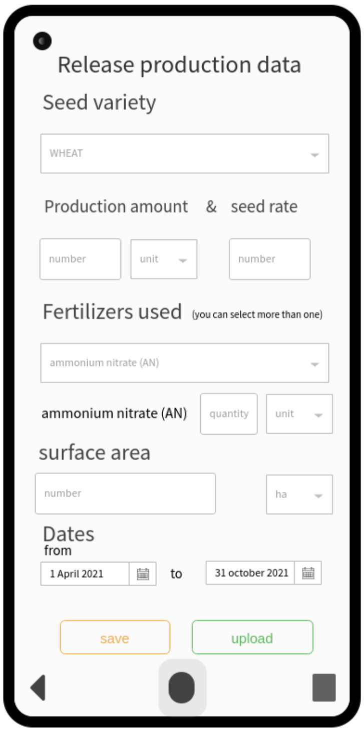
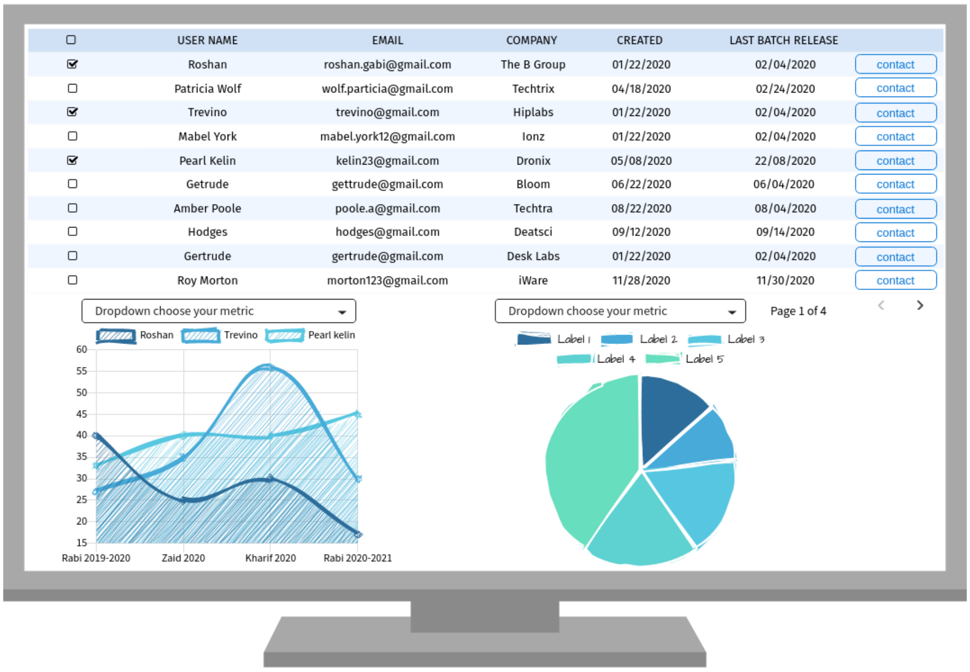
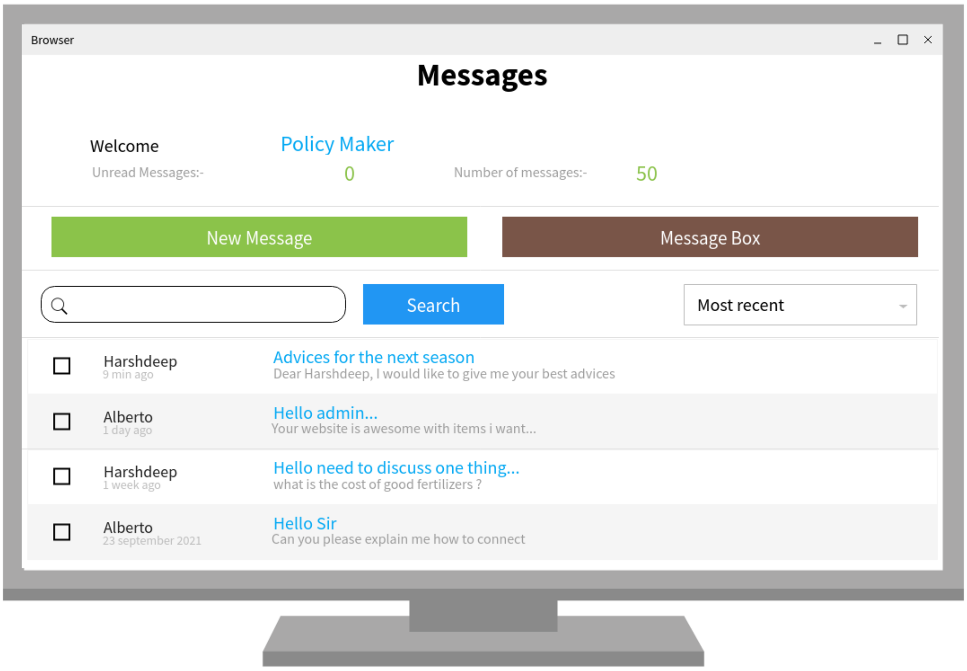


Figure 5: release data



☐	USER NAME	EMAIL	COMPANY	CREATED	LAST BATCH RELEASE	
☑	Roshan	roshan.gabi@gmail.com	The B Group	01/22/2020	02/04/2020	contact
☐	Patricia Wolf	wolf.particia@gmail.com	Techtrix	04/18/2020	02/24/2020	contact
☑	Trevino	trevino@gmail.com	Hiplabs	01/22/2020	02/04/2020	contact
☐	Mabel York	mabel.york12@gmail.com	Ionz	01/22/2020	02/04/2020	contact
☑	Pearl Kelin	kelin23@gmail.com	Dronix	05/08/2020	22/08/2020	contact
☐	Getrude	gettrude@gmail.com	Bloom	06/22/2020	06/04/2020	contact
☐	Amber Poole	poole.a@gmail.com	Techtra	08/22/2020	08/04/2020	contact
☐	Hodges	hodges@gmail.com	Deatsci	09/12/2020	09/14/2020	contact
☐	Gertrude	gertrude@gmail.com	Desk Labs	01/22/2020	02/04/2020	contact
☐	Roy Morton	morton123@gmail.com	iWare	11/28/2020	11/30/2020	contact

Figure 6: Policy Maker comparing farmer on different factors



Messages

Welcome Policy Maker

Unread Messages:- 0

Number of messages:- 50

☐ Harshdeep 9 min ago — Advices for the next season
Dear Harshdeep, I would like to give me your best advices

☐ Alberto 1 day ago — Hello admin...
Your website is awesome with items i want...

☐ Harshdeep 1 week ago — Hello need to discuss one thing...
what is the cost of good fertilizers ?

☐ Alberto 23 september 2021 — Hello Sir
Can you please explain me how to connect

Figure 7: Policy Maker messages

3.1.2 Communication Interfaces

The communication interfaces of the different sensors is external.

3.2 Functional requirements

Name	***FarmerRegistration***
Actors	Farmers
Entry conditions	The farmer is on the DREAM registration form page
Event flow	1. The system asks for farmer's data: name, surname, e-mail address, location. 2. The farmers fill out the form. The farmer can optionally enable geo-tracking to complete the location field. 3. The farmer confirms the responses. 4. The system sends an e-mail containing a validation link to the given e-mail address. 5. The system asks the farmer to check his/her e-mail box. 6. The farmer clicks on the validation link. 7. The system adds the data provided by the farmer to the database. 8. Based on the location given by the farmer, the system retrieves the e-mail address of the policy maker dedicated to the farmer newly registered. 9. The system sends an e-mail to the policy maker to acknowledge that a new farmer has registered.
Exit conditions	The data are correctly added to the database
Exceptions	- The given e-mail address is already in the database. The system displays a message prompting the farmer to modify the dedicated field of the form. - The data provided by the farmer have an invalid type or the e-mail address is incorrect. The system displays a message prompting the farmer to modify the dedicated field(s) of the form. - There is no registered policy maker dedicated to the area. In that case, no acknowledgement e-mail is sent, but instead a warning message is sent to the maintener to urge him/her to contact the adequate policy maker.

Name	***ProductionRelease***
Actors	Farmers
Entry conditions	The farmer has begun the cropping season (and eventually finished). The farmer is already registered on the DREAM platform
Event flow	1. The farmer logs in on the platform and clicks on the “Release production data” tab. 2. The farmer clicks on the “New release” button 3. The system displays a form with the following fields: seed variety (to be chosen among a certain list), seed rate, production amount, surface area of the cultivated fields, fertilizer (can be several, to be chosen among a certain list), amount of fertilizer used (one field per fertilizer used), start and end date. 4. The farmer completes the fields, with respect to the measure units given by the system. 5. The farmer confirms. 6. The system adds the data to the database with the status "Complete".
Exit conditions	The data are correctly added to the database
Exceptions	- The data provided by the farmer have an invalid type. The system displays a message prompting the farmer to modify the dedicated field(s) of the form - All the data are not provided (e.g. the end date, the production amount) because cropping has not ended yet. The data are added to the database with an “Incomplete” status. If seed variety, seed rate, surface area or start date are not provided, the system displays an error message

Name	***ForumCreation***
Actors	Farmers
Entry conditions Event flow	The farmer is already registered on the DREAM platform 1. The farmer logs in on the platform and clicks on the “Forum” tab. 2. The farmer clicks on the “New topic” button. 3. The farmer completes the title and message fields 4. The farmer can optionally add some tags to characterize the topic 5. The system adds the topic to the database
Exit conditions	The data are correctly added to the database
Exceptions	- The data provided by the farmer have an invalid type. The system displays a message prompting the farmer to modify the dedicated field(s) of the form. - The title or the message is empty. The system displays a message prompting the farmer to fill them both.

Name	***PredictionCheck***
Actors	Farmers
Entry conditions	The farmer is already registered on the DREAM platform
Event flow	1. The farmer logs in on the platform 2. From the homepage, the farmer clicks on the desired button, between “soil”, “weather” and “vegetation index”. 3. Based on the location of the farmer, the system displays a map for the conditions (and eventually another one for the predictions), with the time period. 4. The farmer can optionally zoom in/out and move on the map provided by the system.
Exit conditions	The farmer leaves the homepage
Exceptions	- There is no data corresponding to the current time or the location of the farmer. In the first case, the system proposes to display results for a close time (if it exists). In the second case, it zooms out until finding a place where data are available (if they exist)

Name	***RequestForProductionData***
Actors	Farmers
Entry conditions	The farmer is already registered on the DREAM platform and has not confirmed the data for the last cropping season. The current date is in a 15 days-range before the end of a cropping season (15/11-01/12, 15/04-01/5 or 15/07-01/08).
Event flow	1. The system sends an e-mail to recall the farmer to release the production data 2. The farmer logs in on the platform. 3. The system displays a notification with a link to the “Release production data” tab. 4. The farmer clicks on the link. 5. The system displays the “Release production data” tab, with an additional “Confirm the data for this season” button. 6. The farmer eventually creates a new release or completes the releases with an "Incomplete" (see ProductionRelease use case). 7. Within 15 days, the farmer clicks on the button “Confirm the data for this season” 8. The system adds the farmer to the list of farmers who confirmed their release for the season 9. The system hides the button “Confirm the data for this season”
Exit conditions	The system adds the farmer to the list of farmers who completed their release
Exceptions	- The farmer does not click on the button “Confirm the data for this season”. At every log in, the system will display the notification to release the data production - The farmer adds or modifies a production data release after having clicked on the button “Confirm the data for this season”. The system removes the farmer from the list of farmers who completed their release for the season. The system displays the button “Confirm the data for this season” again

Name	***TopicResearch***
Actors	Farmer, Policy Maker
Entry conditions	The actor is already registered on the DREAM platform
Event flow	1. The actor logs in on the platform and clicks on the “Forum” tab. 2. The actor clicks on the “Search” button. 3. The system displays a search bar and two optional filters: date and tags. 4. The actor completes the field and eventually add some filters. 5. The actor confirms the request. 6. The system fetches and displays the list of results. 7. The actor clicks on one of them. 8. The system displays the discussion thread on the topic. 9. The actor can optionally add a message, reply to another one, or put a thumb up/down to someone’s contribution. 10. The systems commits the eventual updates in the database
Exit conditions	The actor leaves the "Forum" tab
Exceptions	- The system doesn’t find any result that matches to the actor request. It displays an error message and proposes to make another request. - The data provided by the actor have an invalid type. The system displays a message prompting to modify the fields concerned.

Name	***ContactingPoorlyPerformingFarmers***
Actors	Policy Maker
Entry conditions	The policy maker is already registered on the DREAM platform. The farmers have already released their production data.
Event flow	1. The policy maker logs in on the platform and clicks on the “Visualize productivity” tab. 2. The policy maker chooses a metric, a period, ticks the “bottom” box and enters the number of results wanted. 3. The system fetches and displays the results ordered by the performance metric. 4. The policy maker clicks on some farmers line. 5. The system displays more precise information about the results (seed variety and rate, field surface, production amount, fertilizers, amount of fertilizer used, start and end date). 6. The policy maker clicks on the “Contact” button. 7. The policy maker enters a message in the dedicated field and ticks the “help suggestion” box. 8. The system sends the message to the farmer. The message includes an help request form.
Exit conditions	The message arrives in the farmer’s personal contact tab
Exceptions	- There is not any result on the policy maker request (because no production data release or lacking some fields for the chosen metric). The system displays an error message and eventually proposes to choose another metric.

Name	***HelpRequest***
Actors	Farmer
Entry conditions	The farmer is already registered on the DREAM platform.
Event flow	1. The policy maker logs in on the platform and clicks on the “Contact” tab. 2. The farmer clicks on the “New help request” button. 3. The farmer writes down a message and ticks for the correct level of priority. 4. The farmer confirms. 5. The system sends the message to the dedicated policy maker’s messages tab. 6. An e-mail is sent to the policy maker’s address
Exit conditions	The message arrives in the policy maker’s personal box
Exceptions	- There is no registered policy maker dedicated to the area. In that case, an error message is displayed to the farmer, and a warning message is sent to the developer to urge him/her to contact the adequate policy maker.

Name	***ContactingWellPerformingFarmers***
Actors	Policy Maker
Entry conditions	The policy maker is already registered on the DREAM platform. The farmers have already released their production data.
Event flow	1. The policy maker logs in on the platform and clicks on the “Visualize productivity” tab. 2. The policy maker chooses a metric, a period, ticks the “bottom” box and enters the number of results wanted. 3. The system fetches and displays the results ordered by the performance metric. 4. The policy maker clicks on some farmers line. 5. The system displays more precise information about the results (seed variety and rate, field surface, production amount, fertilizers, amount of fertilizer used, start and end date). 6. The policy maker clicks on the “Contact” button. 7. The policy maker enters a message in the dedicated field and ticks the “e-voucher” box and enters the amount of the incentive. Within the message, the policy maker asks for suggestions to the farmer. 8. The system sends the message and an e-voucher link to the farmer
Exit conditions	The message arrives in the farmer’s personal contact tab
Exceptions	- There is not any result on the policy maker request (because no production data release or lacking some fields for the chosen metric). The system displays an error message and eventually proposes to choose another metric.

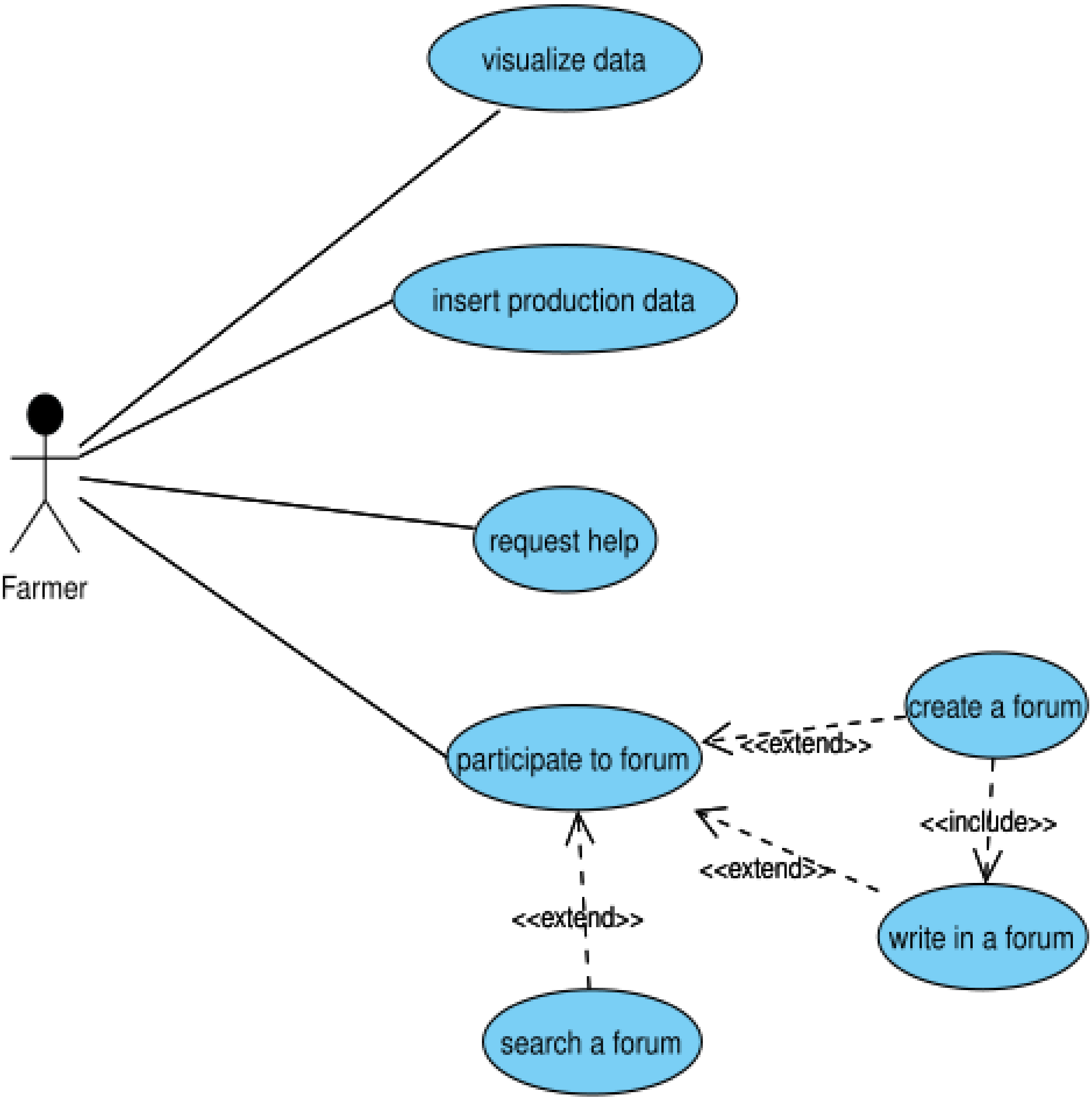


Figure 8: Use case diagram for logged in farmer

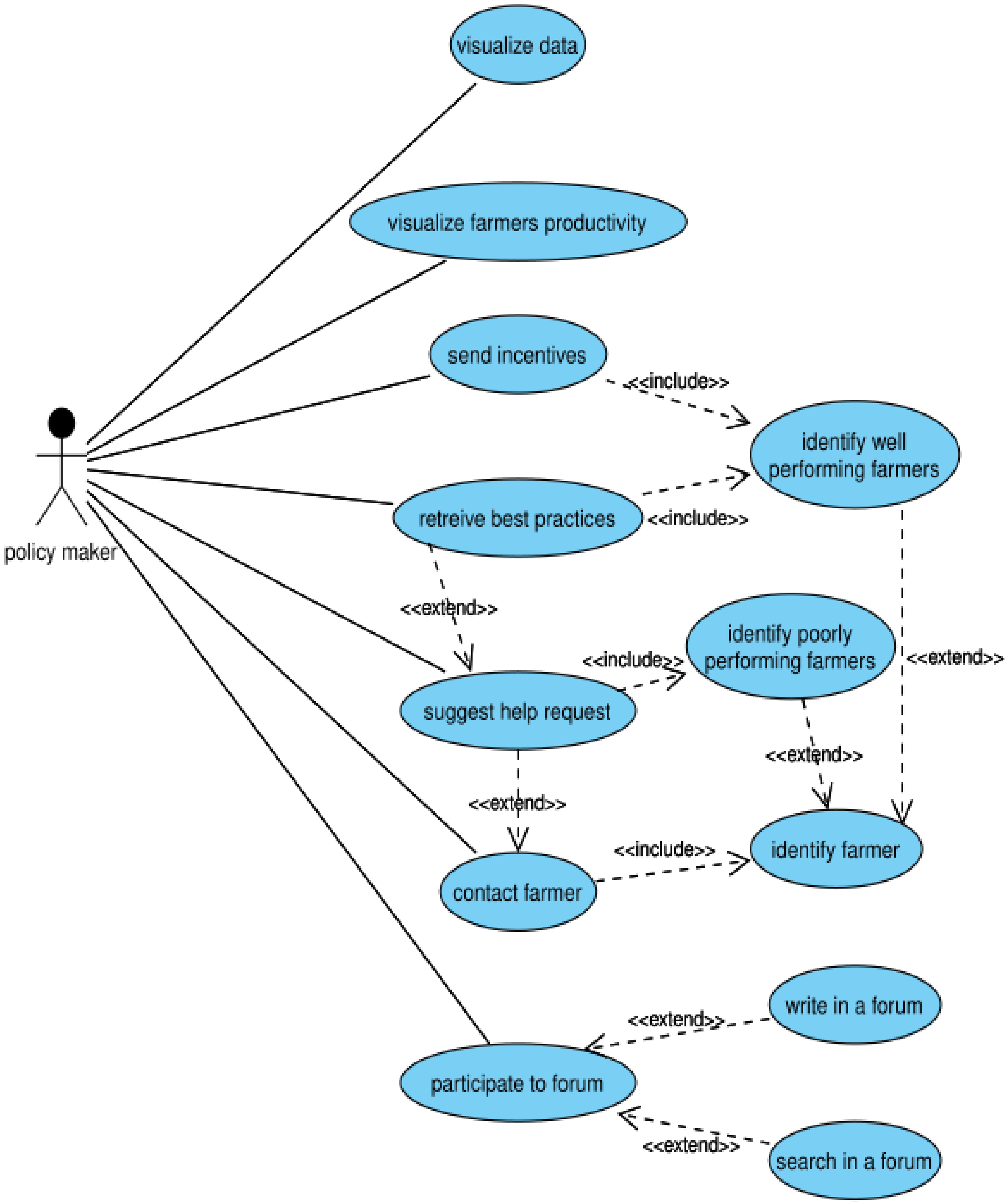


Figure 9: Use case diagram for logged in policy makers

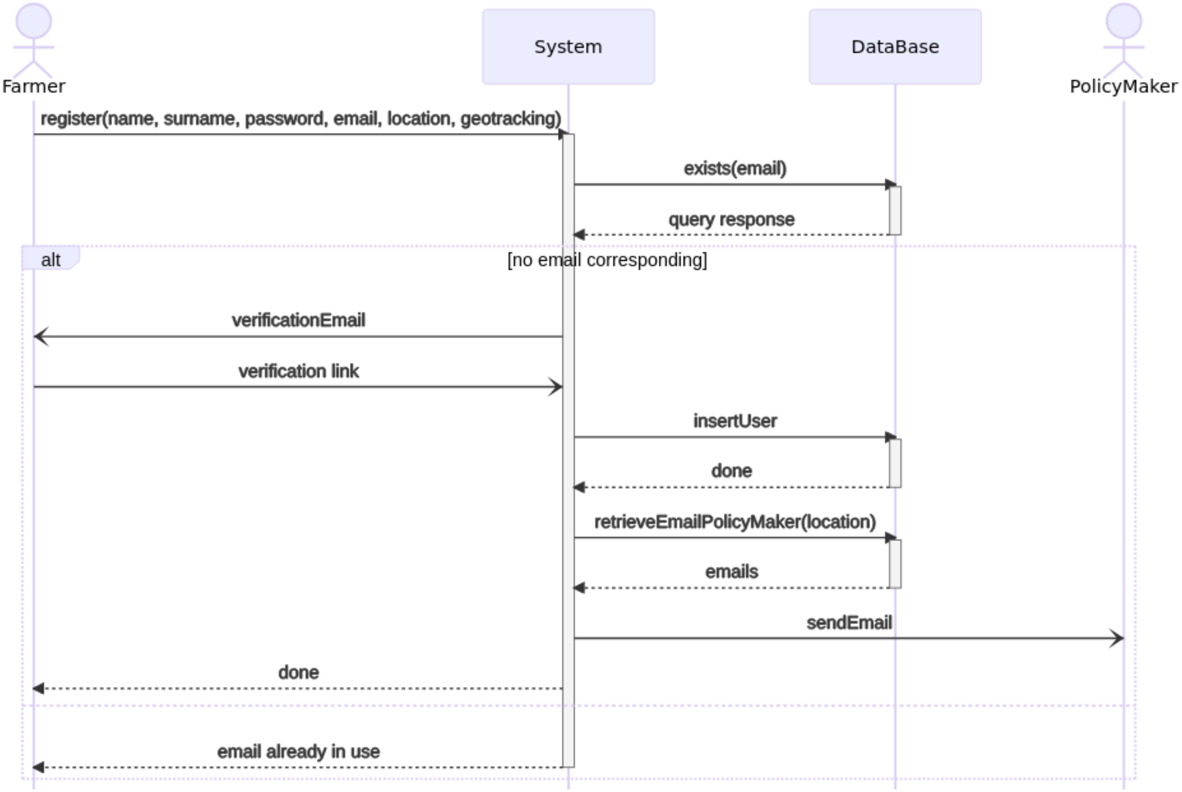


Figure 10: Sequence diagram on the registration of a farmer

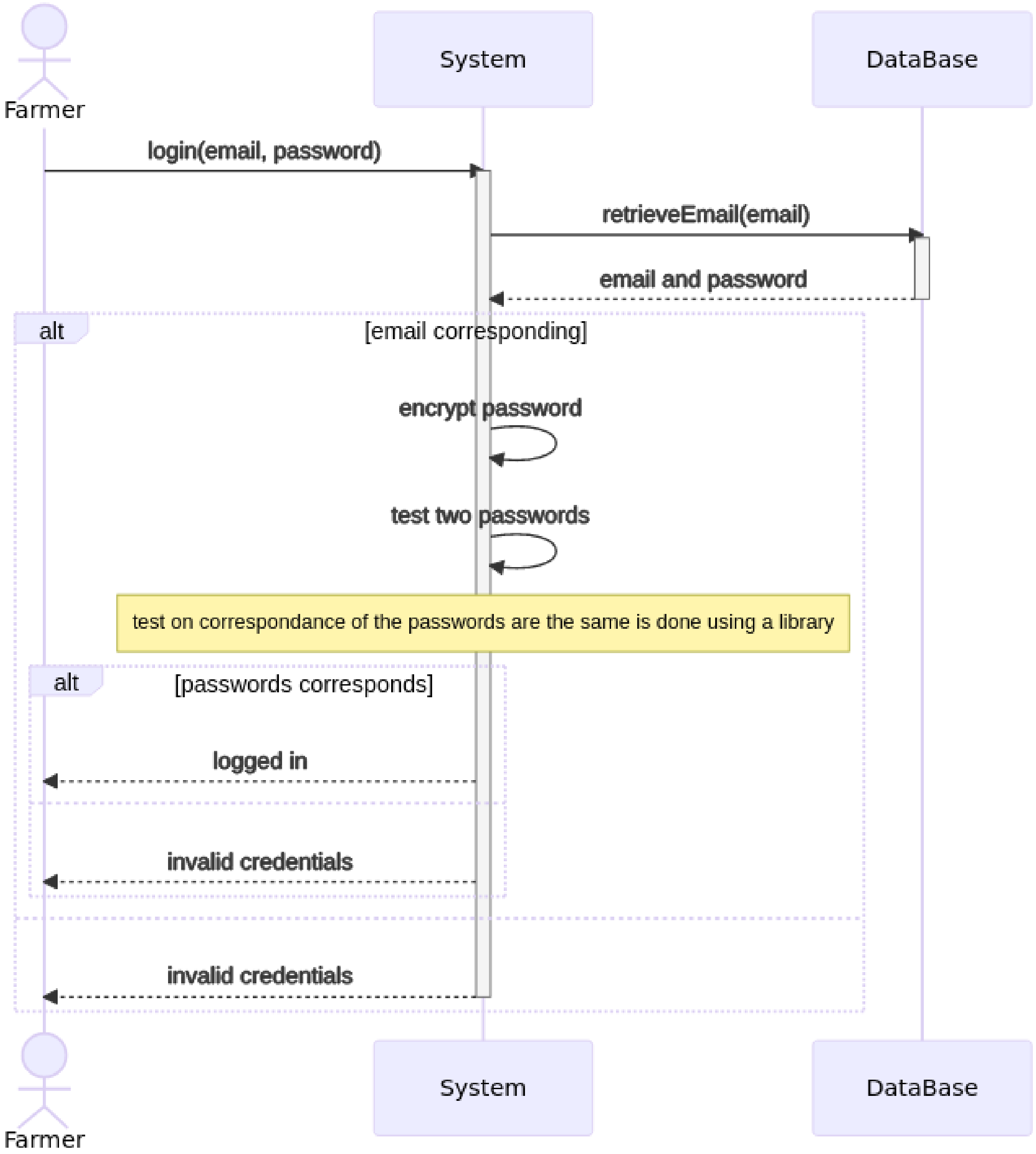


Figure 11: Sequence diagram on the login of a farmer

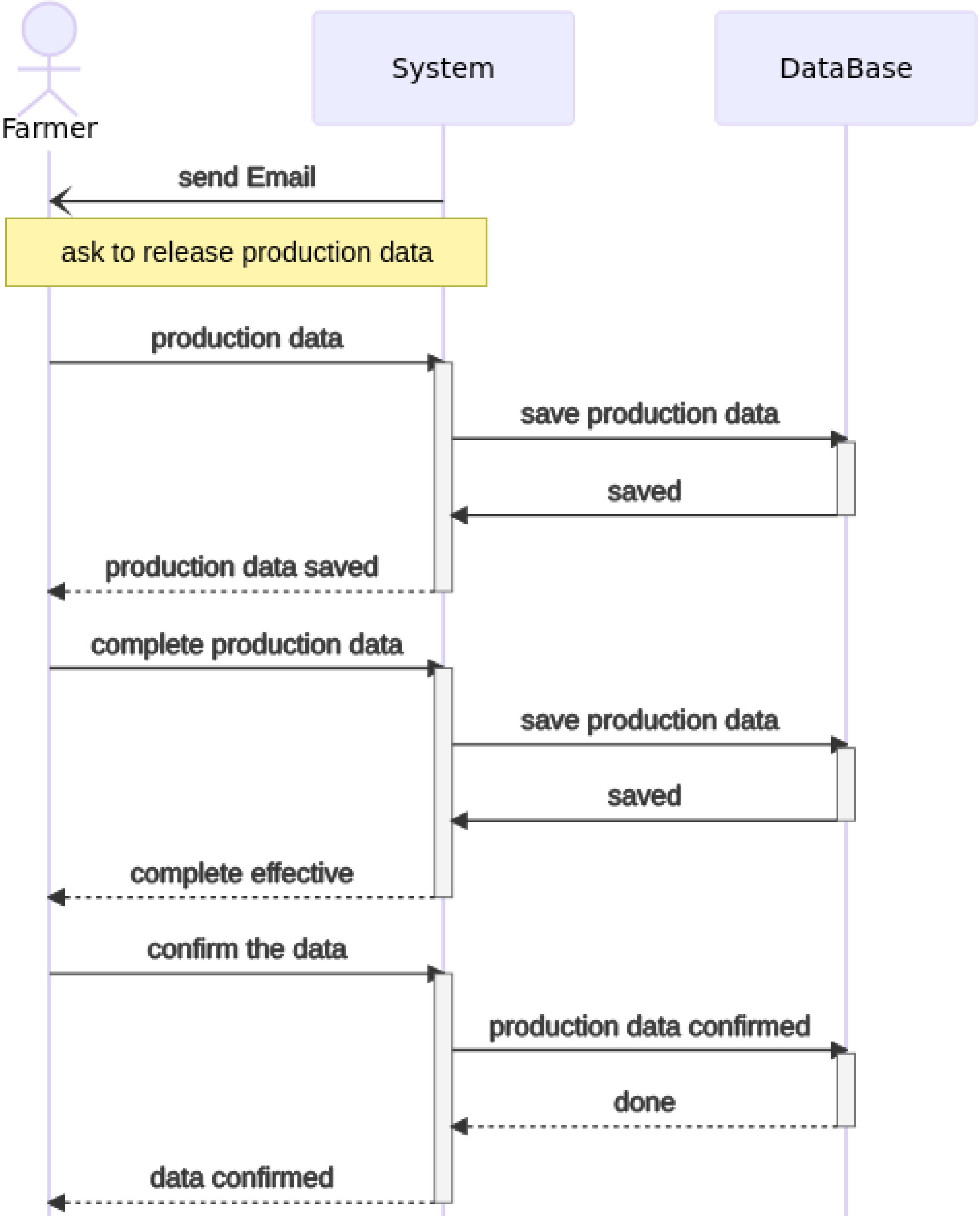


Figure 12: Sequence diagram on the request for production data from a farmer point of view

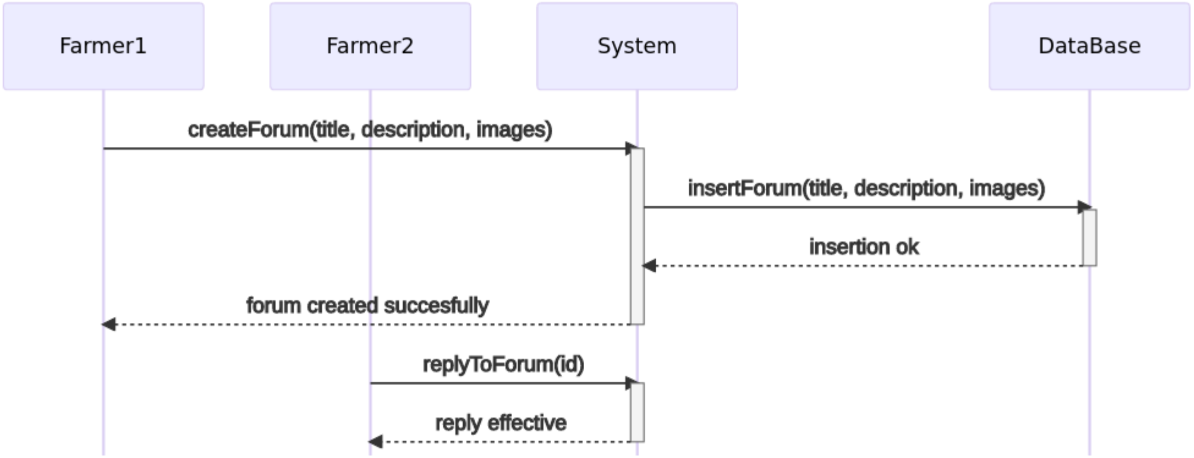

Farmer1
Farmer2
System
DataBase
createForum(title, description, images)
insertForum(title, description, images)
insertion ok
forum created succesfully
replyToForum(id)
reply effective

Figure 13: Sequence diagram on the creation of a forum and the reply by another farmer

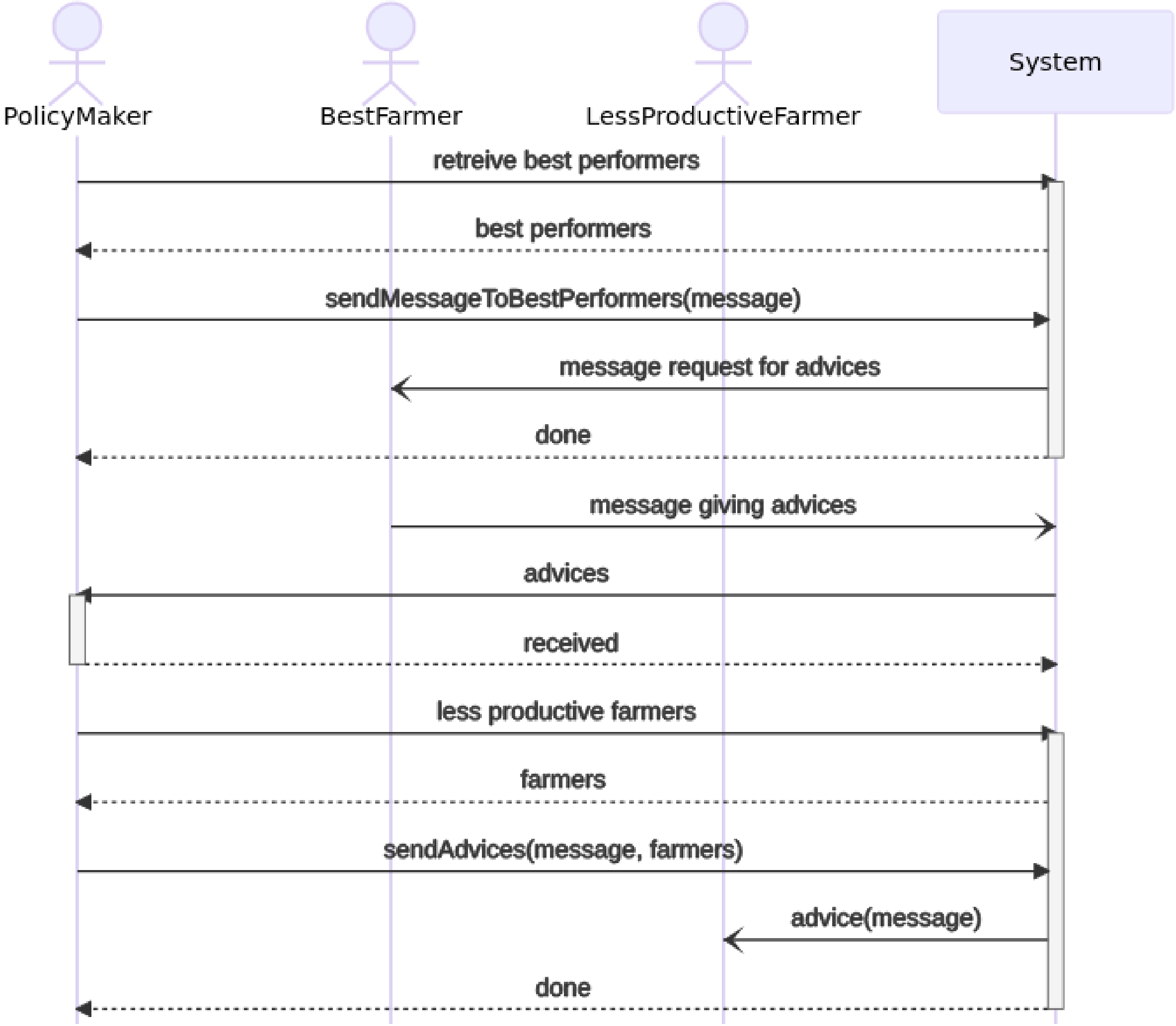


Figure 14: Sequence diagram showing a policy marker reaching out best performing farmers for advises and send them to less productive farmer

3.3 Performance Requirements

3.4 Design Constraints

3.4.1 Standards compliance

There is no data protection law yet. But the personal data protection bill is under discussion in Parliament House (see [7]). To anticipate its ratification, the system should comply with its basic recommendations:

- identify sensitive data
- control data movement
- respect the least-privilege principle

Users should also be able to delete their personal data if they don't use DREAM anymore. In that case, their production data could be used anonymously for statistical purposes.

To access to geo-tracking functionalities, the system should ask the user.

3.4.2 Hardware limitations

- Phones and Tablets

  apps for Android and IOS

  but also accessible from a modern browser

- Computers

  all modern browsers should be supported

3.5 Software System Attributes

3.5.1 Reliability

The system should be tolerant to missing data from the rainfall data conditions and previsions. Production releases should be redundant to prevent data losses and ensure the core function of the system, which can't be easily replaced by another service, as soil, weather data access or the discussion forums can be.

3.5.2 Availability

The system should be available all the time with a real necessity around the end and the beginning of a season.

Since a 2 minutes of downtime per day seems acceptable to the system, a 99,9% availability is a good target.Furthermore, As this article [1] explains, a third of downtime is planned one. Since there are important timelapses with little or no traffic on some parts of the platform, it is possible to optimise the planned downtime schedule to reach the 3 9s target.

3.5.3 Security

The main security concern is about protecting the production data, which are sensitive ones as they concern the business of farmers. The data should thus be encrypted. In order to prevent SQL injections, the queries that farmers and policy makers can execute should be parametrized. Some basic rules shouldn't neither be forgotten. The system should ensure that farmers and policy makers choose strong passwords.

3.5.4 Maintainability

Since our platform is very likely to be subject to changes (we didn't integrate agronomists), different components should be implemented independently to facilitate their mutation and easily identify and correct their errors.

3.5.5 Portability

The software should be designed to be supported by both mobile and desktop devices. The mobile version should run similarly with different version. The system should be reliable as its goal is to be the main instrument for farmers. Policy maker will also rely on the system to provide true data on the farmers to improve the general performance in the state.

4 Formal Analysis Using Alloy

Our Alloy analysis focuses on the production data release and analysis and what they involve. The main goals of the model are the following :

- Define correct rules for (in)complete productions releases and (not) confirmed batches, so that the list of farmers with "confirmed"status is up-to-date.
- Define rules to get this list of farmers full at the end of the croping season.
- Define rules to provide help to every farmer who performed badly during the previous season.

```
//Sig
sig Email, Location {}

abstract sig User {
email : Email
}

sig PolicyMaker extends User {
area : some Location,
well : lone WellPerformingFarmers,
poor : lone PoorlyPerformingFarmers,
farmersWithConfirmation : set Farmer //Set of farmers who confirmed their batch of
    ↪ production release. We want to keep it up-to-date
}

sig Farmer extends User {
policyMaker : lone PolicyMaker,
location : Location,
production : lone Batch
}

abstract sig Release {}

sig CompleteRelease, IncompleteRelease extends Release {}

abstract sig Batch {
batch : some Release, // A batch is a non empty set of releases. It can gather releases
    ↪ from different types or dates
}

sig ReleaseBatch extends Batch {}
sig ConfirmedBatch extends Batch {}
{
not (IncompleteRelease in batch)
}

sig WellPerformingFarmers { // Gather all well performing farmers of a given policy maker
farmers : some Farmer
}

sig PoorlyPerformingFarmers {
farmers : some Farmer
}

sig BestPractice {
wellToPm : Farmer -> PolicyMaker,
}

sig HelpRequest {
farmerToPm: Farmer -> PolicyMaker
}

sig Suggestion {
pmToFarmer: PolicyMaker -> Farmer
}
```

```
//Functions
fun farmersInArea [pm:PolicyMaker] : set Farmer {  // Gives the set of farmers in the pm
    ↪ area
policyMaker.pm
}


//Facts
fact uniqueEmail {
all disj u1, u2: User |
u1.email ≠ u2.email
}

fact noAreaIntersection {
all disj pm1,pm2 : PolicyMaker | pm1.area & pm2.area = none
}

fact farmerInPmArea {
all f: Farmer |  f.policyMaker ≠ none implies f.location in f.policyMaker.area
}

fact noBatchIntersection {
all disj rb1,rb2 : Batch| rb1.batch & rb2.batch = none
}

fact noBatchDoubleOwnership {
all disj f1,f2 : Farmer| f1.production ≠ f2.production
}

fact noBatchAlone {
all b:Batch | some f:Farmer | f.production = b
}

//fact noReleaseAlone {  //Commented to test the 'AddIncompleteRelease' predicate
//all r:Release | some b:Batch | r in b.batch
//}

fact confirmedBatchContainCompleteRelease {
all ir:IncompleteRelease | all cb: ConfirmedBatch | not(ir in cb.batch)
}

fact farmersWithConfirmation {
all f: Farmer | all pm: PolicyMaker | f in pm.farmersWithConfirmation iff ((some cb:
    ↪ ConfirmedBatch | cb = f.production)
and f.policyMaker = pm)
}

fact BestPracticeExistence{
all bp:BestPractice | (some f:Farmer|some pm:PolicyMaker|  f.(bp.wellToPm) = pm)
}

fact HelpRequestExistence{
all hr:HelpRequest | (some f:Farmer|some pm:PolicyMaker|  f.(hr.farmerToPm) = pm)
}

fact SuggestionExistence{
all s:Suggestion | (some f:Farmer|some pm:PolicyMaker|  pm.(s.pmToFarmer) = f)
}


fact WellExistBecauseOfPm {
all wpf: WellPerformingFarmers | (some pm:PolicyMaker | pm.well = wpf)
}

fact WellPoorExistBecauseOfPm {
all ppf: PoorlyPerformingFarmers| (some pm:PolicyMaker | pm.poor = ppf)
}

fact noWellPoorIntersection{
all pm: PolicyMaker | pm.well.farmers & pm.poor.farmers = none
}
```

```
fact WellAndPoorReferToTheirPm{
all f: Farmer | all pm:PolicyMaker | ( f in pm.well.farmers or f in pm.poor.farmers)
    ↪ implies f.policyMaker = pm
}

fact WellAndPoorHaveBatch{
all f: Farmer|( f in f.policyMaker.well.farmers or f in f.policyMaker.poor.farmers)
    ↪ implies (f.production ≠ none)
}

fact bestPracticeWellToPm {
all bp:BestPractice | all f:Farmer| all pm:PolicyMaker | f.(bp.wellToPm) = pm implies f
    ↪ in pm.well.farmers
}

fact helpRequestFarmerToPm {
all hr:HelpRequest | all f:Farmer| all pm:PolicyMaker| f.(hr.farmerToPm) = pm implies pm
    ↪ = f.policyMaker
}

fact suggestionPMToFarmer {
all s:Suggestion | all f:Farmer| all pm:PolicyMaker| pm.(s.pmToFarmer) = f implies (pm =
    ↪ f.policyMaker and
(some bp:BestPractice|some f:Farmer| f.(bp.wellToPm)=pm ) and (some hr:HelpRequest|f.(hr.
    ↪ farmerToPm) = pm))
}


//Predicates
pred completeRelease {
all r: Release | r = CompleteRelease
}

pred confirmBatch {
all b: Batch | b = ConfirmedBatch
}

pred PoorRequestHelp {
all f:Farmer| f in (f.policyMaker).poor.farmers implies (some hr:HelpRequest| f.(hr.
    ↪ farmerToPm)=f.policyMaker)
}

pred PmSuggestWhenHelpRequest {
all pm:PolicyMaker | all f:Farmer| (some hr:HelpRequest | f.(hr.farmerToPm) = pm) implies
    ↪ (
some s:Suggestion | pm.(s.pmToFarmer) = f)
}

pred WellGiveBestPractices {
all f:Farmer| all pm:PolicyMaker |  f in pm.well.farmers implies (
some bp:BestPractice| f.(bp.wellToPm)= pm)
}

pred AddIncompleteRelease[f:Farmer,ir:IncompleteRelease] {
f.production.batch = f.production.batch + ir
}

pred definePoorWell {
#PoorlyPerformingFarmers >0 and
#WellPerformingFarmers >0
}

pred produce{
all f:Farmer | f.production ≠ none
}

//Assertions

//Given that the farmers produced, complete their release and confirm their batch, the
    ↪ policy makers have all farmers with confirmed data releases (at the end of the
    ↪ release period)
assert EndOfReleasePeriod {
```

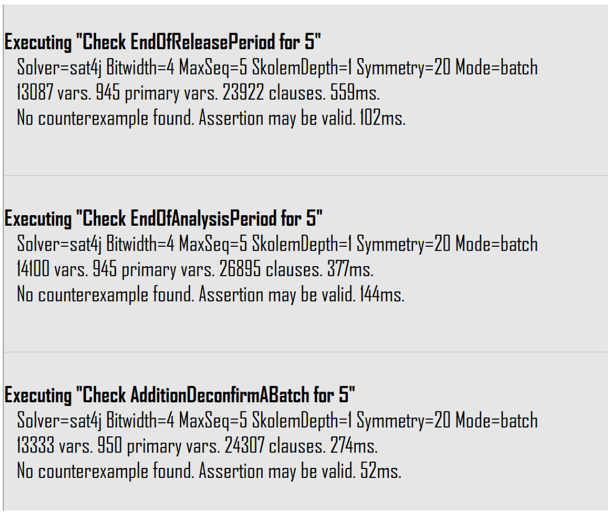
```
produce and completeRelease and confirmBatch implies (
all pm:PolicyMaker|farmersInArea[pm]=pm.farmersWithConfirmation)
}


//Given that poorly performing farmers ask for help, well performing ones give their best
    ↪  practices and policy makers make suggestions when required, all poorly performing
    ↪  farmers get advices at the end of the analysis period.
assert EndOfAnalysisPeriod {
definePoorWell and PoorRequestHelp and PmSuggestWhenHelpRequest and WellGiveBestPractices
    ↪  implies (
all f:Farmer | f in PoorlyPerformingFarmers.farmers implies(
some s:Suggestion| (f.policyMaker).(s.pmToFarmer) = f)
)
}

//When a farmer makes a new release, he/she should be dropped out of the list of farmers
    ↪ who confirmed their batch
assert AdditionDeconfirmABatch {
all f:Farmer | all ir:IncompleteRelease | (all f2:Farmer| ir not in f2.production.batch)
    ↪ implies (AddIncompleteRelease[f,ir] implies f not in f.policyMaker.
    ↪ farmersWithConfirmation)
}

//Commands

//run {} for 5
check EndOfReleasePeriod for 5
check EndOfAnalysisPeriod for 5
check AdditionDeconfirmABatch for 5
```



```
Executing "Check EndOfReleasePeriod for 5"
  Solver=sat4j Bitwidth=4 MaxSeq=5 SkolemDepth=1 Symmetry=20 Mode=batch
  13087 vars. 945 primary vars. 23922 clauses. 559ms.
  No counterexample found. Assertion may be valid. 102ms.

Executing "Check EndOfAnalysisPeriod for 5"
  Solver=sat4j Bitwidth=4 MaxSeq=5 SkolemDepth=1 Symmetry=20 Mode=batch
  14100 vars. 945 primary vars. 26895 clauses. 377ms.
  No counterexample found. Assertion may be valid. 144ms.

Executing "Check AdditionDeconfirmABatch for 5"
  Solver=sat4j Bitwidth=4 MaxSeq=5 SkolemDepth=1 Symmetry=20 Mode=batch
  13333 vars. 950 primary vars. 24307 clauses. 274ms.
  No counterexample found. Assertion may be valid. 52ms.
```

Figure 15: Results of the check commands

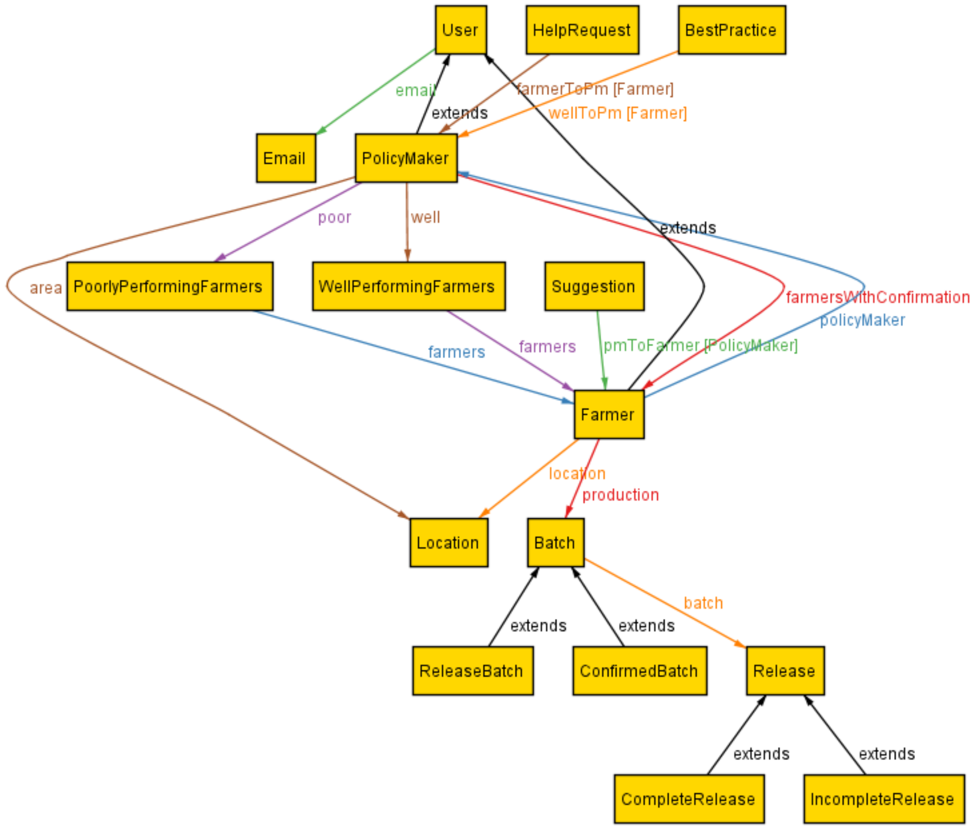


Figure 16: Meta Model

5 Effort Spent

We had a reunion every week on Wednesday morning.

5.1 Baudouin De Parcevaux

Task	Time spent
introduction	5h
phenomena	2h
scenarios	4h
requirements	3h
use cases	6h
diagrams	1h
Alloy	8h
RASD	8h
Total	37h

5.2 Glen Pouliquen

Task	Time spent
introduction	5h
phenomena	2h
scenarios	2h
requirements	3h
use cases	1h
diagrams	7h
User interface	6h
RASD	10h
Total	36h

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[1] Rajkumar Buyya Caesar Wu. Planned downtime. 2015.

[2] SEED CELL. Seed rolling plan 2022-2023 of telengana state. https://seednet.gov.in/PDFFILES/Breeder_Seed_Indent_Recommendation.pdf.

[3] Cooperation Department of Agriculture, Ministry of Agriculture Farmers Welfare, and Government of India Farmers Welfare. Recommended system of breeder seed indent and supply. https://seednet.gov.in/PDFFILES/Breeder_Seed_Indent_Recommendation.pdf.

[4] Food and Agriculture Organization of the United Nations. Fertilizer use by crop in india. https://www.fao.org/3/a0257e/A0257E02.htm#ch1, 2005.

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[6] Nguyen Xuan Thinh Mathias Schaefer and Stefan Greiving. How can climate resilience be measured and visualized? assessing a vague concept using gis-based fuzzy logic.

[7] Minister of Law Shri Ravi Shankar Prasad, Communications Justice, Electronics, and Information Technology. The personal data protection bill, 2019. Bill No. 373 of 2019.