



POLITECNICO
MILANO 1863

SOFTWARE ENGINEERING II

A.Y. 2021/22

DREAM

Data-dRiven prEdictive fArMing

Design Document

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1 Introduction

1.1 Purpose

The purpose of this document is to comprehensively describe the design of the DREAM platform. It will be described the architecture of the system and its characteristics, moreover will be analyzed its components explaining their functionalities.

This document was written following the RASD of the same project, in fact the assumptions and design choices are based on the assumptions already explained, however maintaining independence between the documents. This document focuses on the explanation about the Software-To-Be, its modules, its interfaces and its implementation.

1.2 Scope

The main objective of the platform is to create a support tool and communication channel for farmers in Telangana, leveraging the IT infrastructure of government resources. The platform also aims to be a supervisory and control system for the authorities of the Ministry of Agriculture in Telangana, providing accurate and bulk data of farmers' performance, reducing the overhead due to manual retrieval of this information.

The system will have two separate and exclusive interfaces, one dedicated to PMs in Telangana and one dedicated to farmers in the region. Farmers will be provided with a browser executable web application, it will provide a dashboard to monitor the sensors embedded in their fields, weather forecasts for the local area and summarize the resources obtained and consumed by the plantations. In addition to the monitoring functionality, from the farmer's dashboard it will be possible to compile reports to be sent to the PM responsible for the area, combining data entered manually by the farmer, data created by IoT devices and data retrieved from the internet.

The web application also provides access to the forum dedicated to the Telangana farming community, connecting all participants in the DREAM program through its threads. Farmers will also be able to submit their help requests into the system, which will be automatically forwarded to the PM responsible for the area, who in turn will have a dedicated dashboard exclusively for the administrative side. From his application, the PM will be able to forward responses to help requests, monitor the performance of farmers in his area, all while viewing data from sensors and weather forecasts. From his dashboard, the PM will have the tools to perform end-of-quarter performance evaluations, including direct communication channels to affected farmers.

There is no platform that currently provides these functions, in fact this document refers to the design of a system created from scratch, without any integration of existing systems, but exploiting the IT infrastructure already physically installed in the Telangana region.

1.3 Definitions, Acronyms, Abbreviations

1.4 Revision History

1.5 Reference Documents

1.6 Document Structure

2 Architectural Design

2.1 Overview

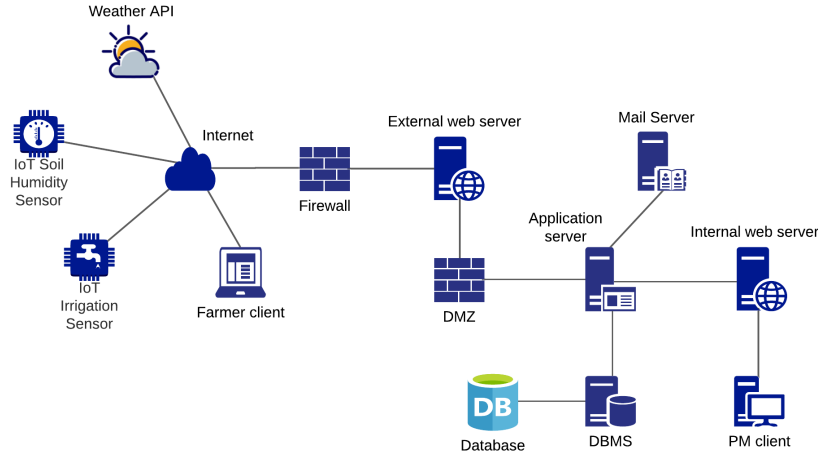


Figure 1: System architecture

The DREAM application is designed with a multitier architecture, the overall system is split into multiple pieces where the database and data management is separate from the application server. We have a three-tier application with web servers, application server, and a database functioning as the three tiers of the application. This application has both external (Farmers) and internal (PMs) users which use a web-based application provided by web servers. This web-based component then communicates back to a common application server. IoT sensors are connected to the internet in order to communicate with the farmers' application, indeed, MQTT communication protocol is used to retrieve sensor data by the farmers' machine. All the weather informations are taken from the weather forecast of Telangana through the system's APIs. Finally, the application server communicate with a database through a Database Management System.

A full description of each component will be given in the following sections.

2.2 Component view

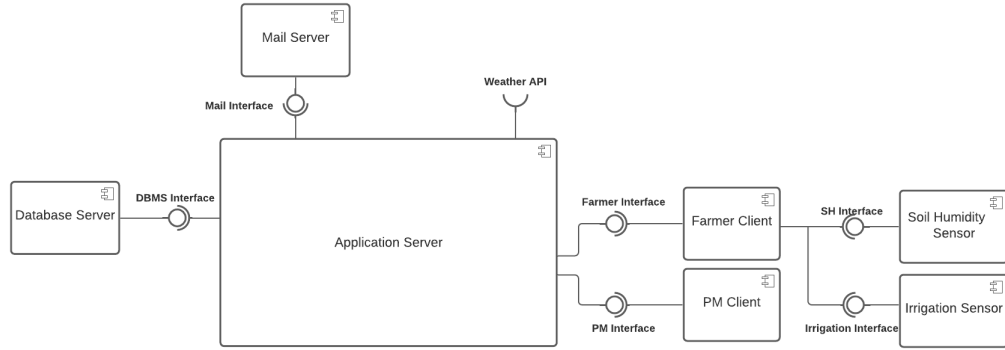


Figure 2: High Level Component Diagram

- **Database server**

This component is responsible for data management, it provides the interface of the Database Management System to the Application Server, in order to deal with the data management, storing and modification process.

- **Mail server**

This component allows the Application Server to create and manage email accounts, send and receive email using standard email protocols. The SMTP protocol is used to send messages and handle outgoing mail requests, The IMAP protocol is used to receive messages and to process incoming mail.

- **Application server**

It's the main component of the system, all the business logic resides in it. This component offers both functionality dedicated to farmers and PMs, interfacing directly with clients. It receives the data entered by the users and sent by the weather forecast system, cross-referencing them and providing for processing, back forwarding and transferring them to the data management system. Its components are described in detail in the following sections.

- **Farmer client**

It is the component thanks to which the farmers can interface with the Application Server. It represents the web application dedicated to farmers that allows them to access the services of DREAM. This component also receives data from the IoT sensors that monitor the farmer's possessions, making them available for sending to the Application Server.

- **PM client**

This is the component thanks to which the Policy Makers can interface with the Application Server. It represents the web application dedicated to them that allows them to take advantage of the services offered by DREAM to monitor and manage agriculture in Telangana. All the functions are accessible thanks to the PM Interface exposed by the Application Server.

- **Soil Humidity and Irrigation sensors**

Sensors for measuring soil moisture and irrigation are internet-connected components responsible for creating and sending data to the Farmer Client. They both expose their own interface, through which clients can retrieve the data of interest.

2.2.1 Application Server

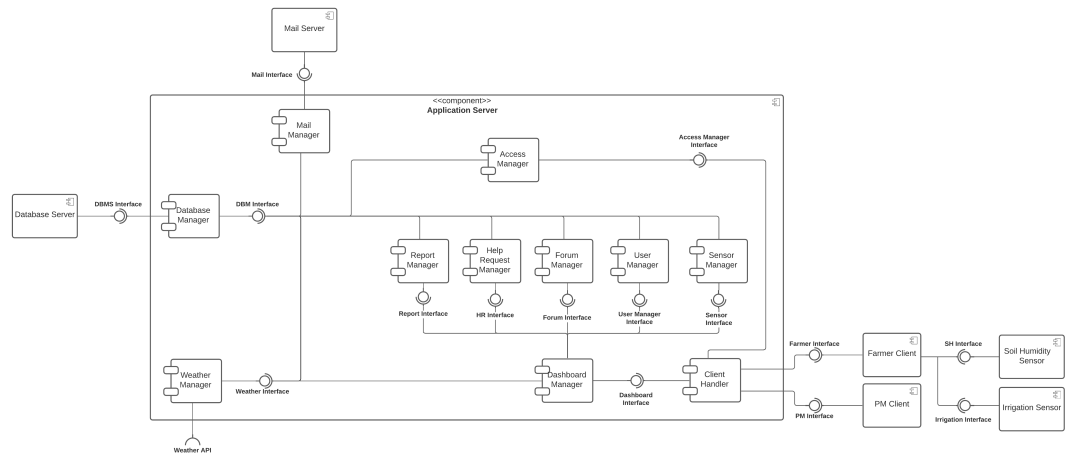


Figure 3: Application Server Component Diagram

2.3 Deployment view

2.4 Runtime view

2.5 Component Interfaces

2.6 Selected Architectural styles and patterns

- 3 tier client-server
- middleware based

- rest api

- **Event based communication for sensors**

The communication protocol chosen to retrieve data created by IoT sensors is Message Queue Telemetry Transport (MQTT), a standard messaging protocol for the Internet of Things that is extremely lightweight and ideal for connecting remote devices with a small code footprint and minimal network bandwidth. MQTT is a publish/subscribe protocol: the MQTT broker will reside directly in the Farmer Client and each farmer's set of sensors will have an exclusive topic. The sensors will publish messages containing data about the measurement only on the topic of their interest, i.e. the one to which the farmer owning the sensors will be subscribed. The data received on the Farmer Client will be available for use on the DREAM platform.

2.7 Other design decisions

- thin client

3 User Interface Desgin

4 User Interface Desgin

The following section describes the user interface of the DREAM webapp. Its goal is to motivate design choices, describe each mockup, its content and the flow between the various pages of the application. The section is divided in three subsections: the first one focuses on the farmer's webapp, the second one on the Policy Maker's webapp and the third on the flow of the webapp.

The first page for both farmers and policy makers will always be the login page, requiring e-mail and password to login into the platform. For farmers, this page will be accessible from any web browser and will also show an option to request an invitation: a simple popup will open up requesting the user to insert his e-mail address, which will be then submitted to the policy makers who will handle the registration request and procedure.

4.1 Farmers User Interface

The first page visualized by the farmer once logged in the platform is the homepage. The farmer's homepage contains a brief overview of weather forecasts and sensor data, and allows users to keep track of their crop in a table containing information about crop's type, eta and comments. The user can add crops to the table by clicking "Add crop", which will open a popup to insert the new crop and its info. The page then allows to navigate to the pages for creating reports and help request, to the forum or to a specific product page by searching the product by its name.

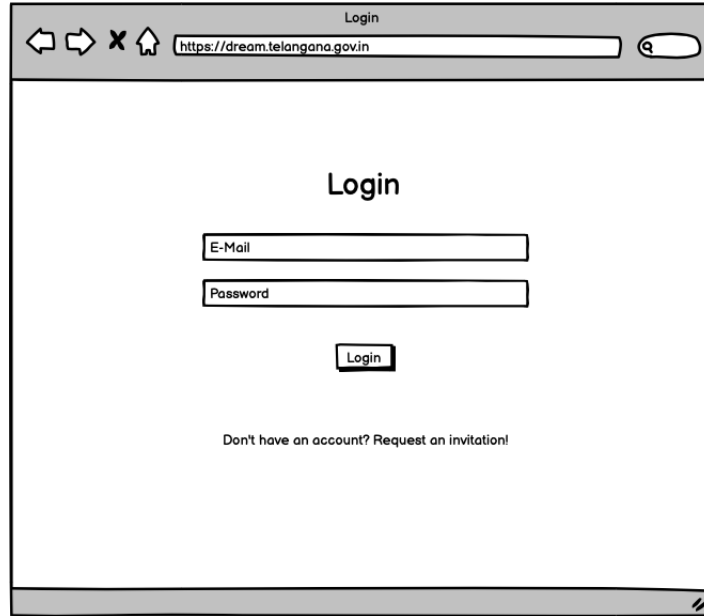


Figure 4: Login page

The report creation page consists of a simple form to insert the harvested products and their quantity. Each product added to the report is visualized on a table, that also allows to edit or delete previously added products. To add a product, the user selects the type of product by an interactive dropdown menu that also allows searching the product, then adds seeds and produced quantity. Clicking on "Auxiliary Products" will open a popup showing the auxiliary products used in the harvesting process, allowing the user to add, edit or remove them. Once the user has inserted all the necessary information, by clicking on "Add product" the product will be added to the report's products. The page also contains a text area where the user can insert the problems encountered during the harvesting process. Once the report is fully compiled, clicking on "Submit" will create the report and send it to the DREAM server. The webapp will then redirect the user to the homepage.

The forum page shows all the open threads, allowing the user to open them and visualize the discussion. A farmer can also create a new thread by clicking "Create thread", which will redirect the user to the thread creation page.

4.2 Policy maker User Interface

The first page visualized by the policy maker once logged into the platform lists the farmers and the latest reports submitted, allowing the user to search farmer-s/reports. The user can then navigate to the farmer/report details. On the top

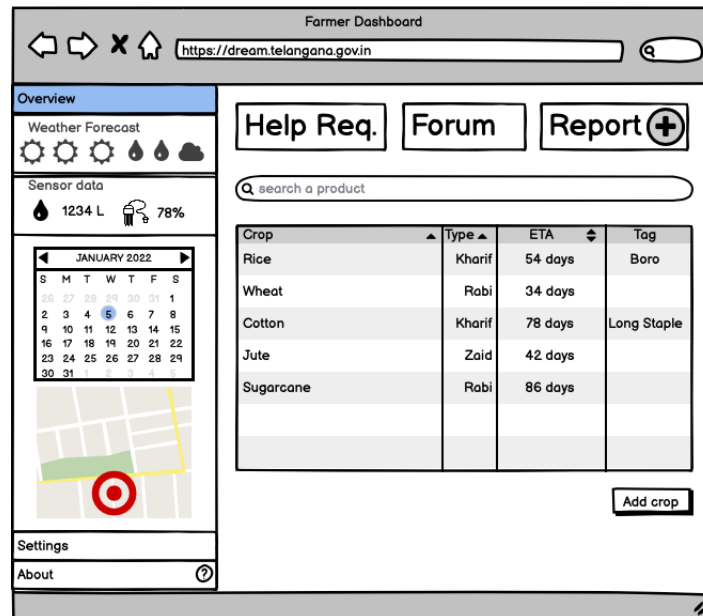


Figure 5: Farmer homepage

of the page there is a navigation bar that allows the user to switch dashboard page.

The forecast page contains basic information about the future weather forecasts. Production forecasts are calculated and then shown to the user through graphs.

4.3 Flow of the User Interface

5 Requirements Traceability

6 Implementation, integration and test plan

7 Effort spent

References

Farmer Dashboard

<https://dream.telangana.gov.in>

Insert report

29/02/2022

Select crop

Seeds Quantity

Produced Kg

Auxiliary products Add product

Product	Edit	Delete
Carrot	Edit	Delete
Wheat	Edit	Delete
Tomato	Edit	Delete

Problems

B I U S style [icons]

Submit

Farmer Dashboard

X

https://dream.telangana.gov.in

Create help request

29/02/2022

Description of the help request

B I U S style [list icon] [link icon] C [image icon] [emoji icon]

Submit

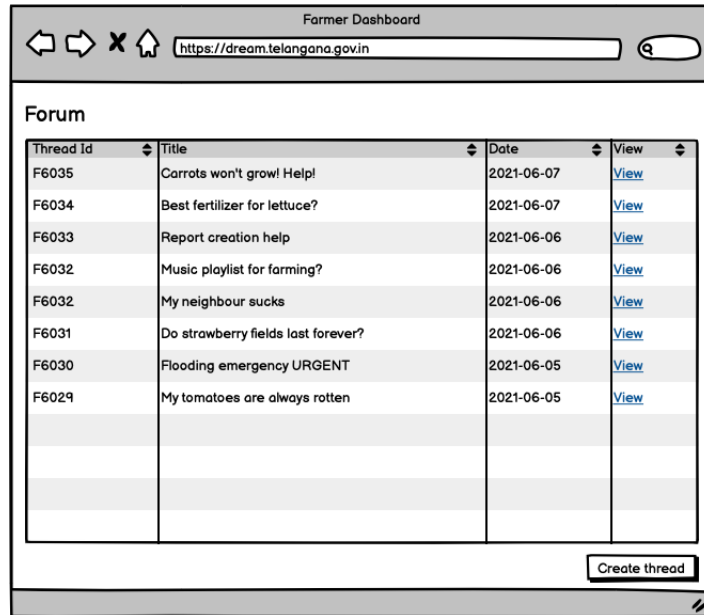


Figure 8: Farmer's forum page

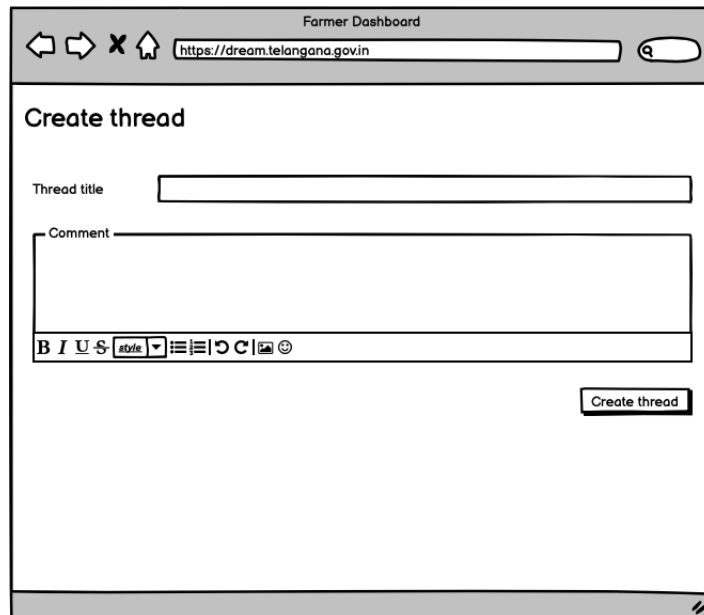



Figure 9: Farmer's thread creation page


Farmer Dashboard

https://dream.telangana.gov.in

Thread: My carrots won't grow! Help!






 Om Harish on date 2021-06-07

I have tried everything, but my carrots won't grow! Any suggestion? Thank you in advance :)

 Dyal Bajpai on date 2021-06-08

Which kind of fertilizer do yo use?

Answer

B I U S *style*     

Submit answer

Figure 10: Farmer's thread page

Farmer Dashboard

https://dream.telangana.gov.in

Product details

Product ID:

Product Name:

Suggestions

Sugg.ID	Date	Suggestion
SG123	2021-05-12	Lorem ipsum dolor sit amet
SG456	2021-07-13	Lorem ipsum dolor sit amet
SG789	2021-08-01	Lorem ipsum dolor sit amet

Figure 11: Farmer's product page

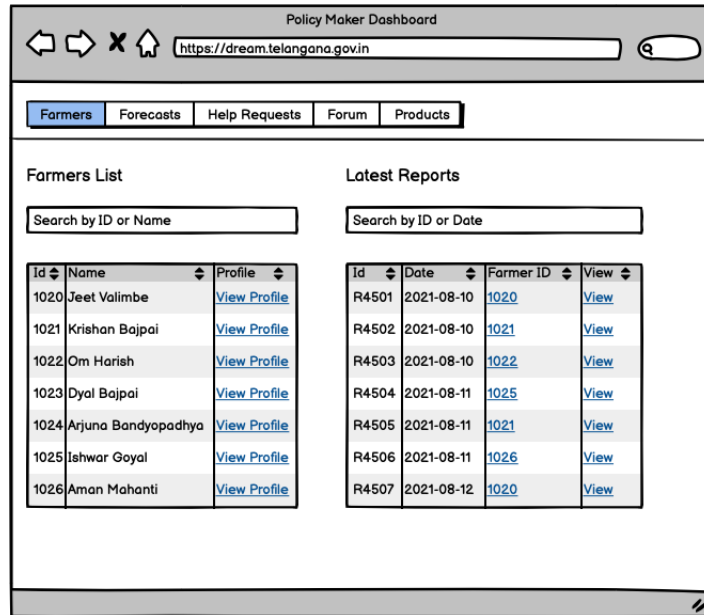


Figure 12: Policy maker's farmers page

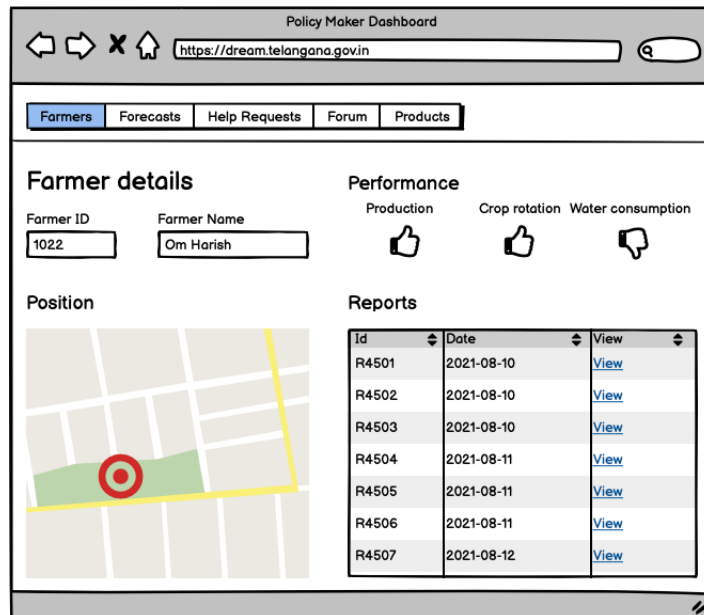


Figure 13: Policy maker's farmer detail page

Policy Maker Dashboard

https://dream.telangana.gov.in

Farmers Forecasts Help Requests Forum Products

Report - ID: R4501

Farmer ID: 1020 Farmer Name: Jeet Valimbe Date: 2021-08-10

Prod.ID	Product	Quantity	Details
P1555	Carrots	15kg	View
P1302	Tomatoes	5kg	View
P1001	Wheat	50kg	View

Sensor Data Weather Data View farmer

Figure 14: Policy maker's report page

Policy Maker Dashboard

https://dream.telangana.gov.in

Farmers Forecasts Help Requests Forum Products

Report - ID: R4501 - Product details

Product ID: P1555 Product Name: Carrot Quantity: 15kg

Auxiliary products

Prod.ID	Product	Quantity
P1201	Fertilizer	0.2kg
P1002	Water	30lt
P1403	Pesticide	0.1kg

Back to report

Figure 15: Policy maker's report production detail page

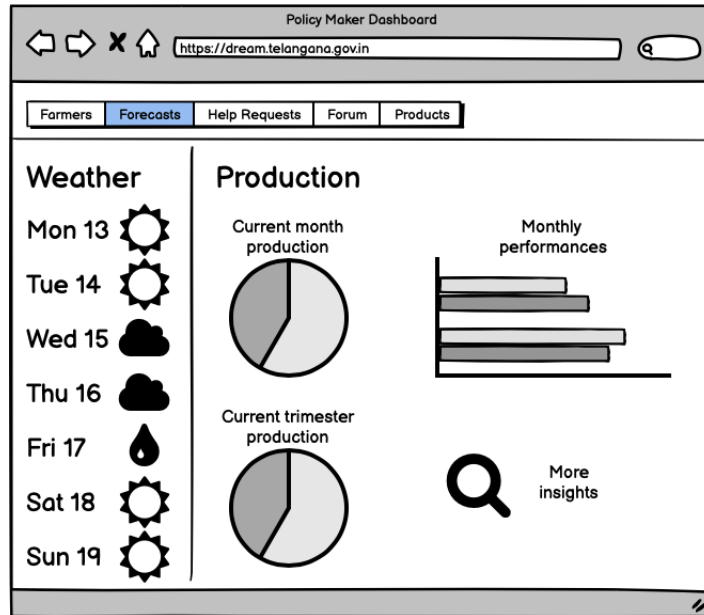


Figure 16: Policy maker's forecasts page

Policy Maker Dashboard

https://dream.telangana.gov.in

Farmers Forecasts Help Requests Forum Products

Help Requests

Id	Farmer ID	Date	Status	View
H6035	1022	2021-06-07	Pending	View
H6034	1026	2021-06-07	Open	View
H6033	1022	2021-06-05	Open	View
H6032	1023	2021-06-01	Closed	View
H6031	1021	2021-05-29	Closed	View

Figure 17: Policy maker's help requests page

Policy Maker Dashboard

https://dream.telangana.gov.in

Farmers Forecasts **Help Requests** Forum Products

Help Request - ID: H6035

Farmer ID: 1022 Farmer Name: Om Harish Date: 2021-06-07 Severity: High

Help Request

Hello,
I am Om Harish. The last week bad weather...
...
Sincerely, Om Harish

[Open help procedure](#)

Figure 18: Policy maker's help request detail page

Policy Maker Dashboard

https://dream.telangana.gov.in

Farmers Forecasts Help Requests **Forum** Products

Forum

Thread Id	Title	Date	View
F6035	Carrots won't grow! Help!	2021-06-07	View
F6034	Best fertilizer for lettuce?	2021-06-07	View
F6033	Report creation help	2021-06-06	View
F6032	Music playlist for farming?	2021-06-06	View
F6032	My neighbour sucks	2021-06-06	View
F6031	Do strawberry fields last forever?	2021-06-06	View
F6030	Flooding emergency URGENT	2021-06-05	View
F6029	My tomatoes are always rotten	2021-06-05	View

Figure 19: Policy maker's forum page

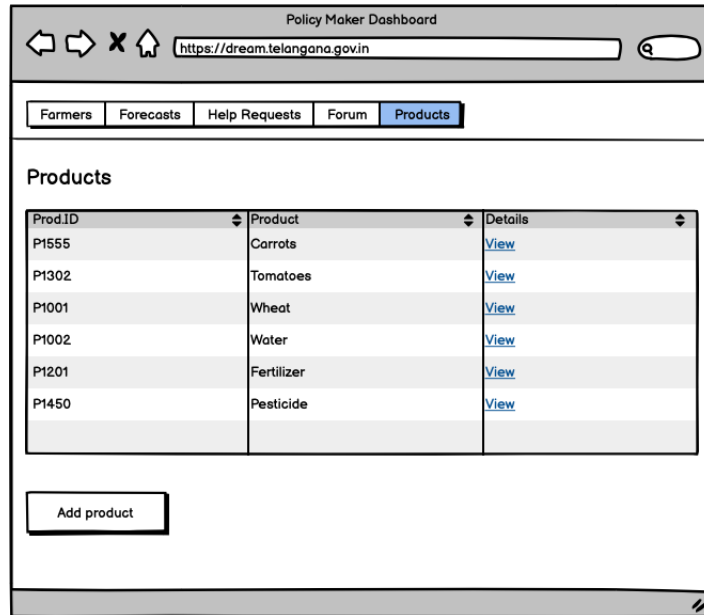


Figure 20: Policy maker's products page

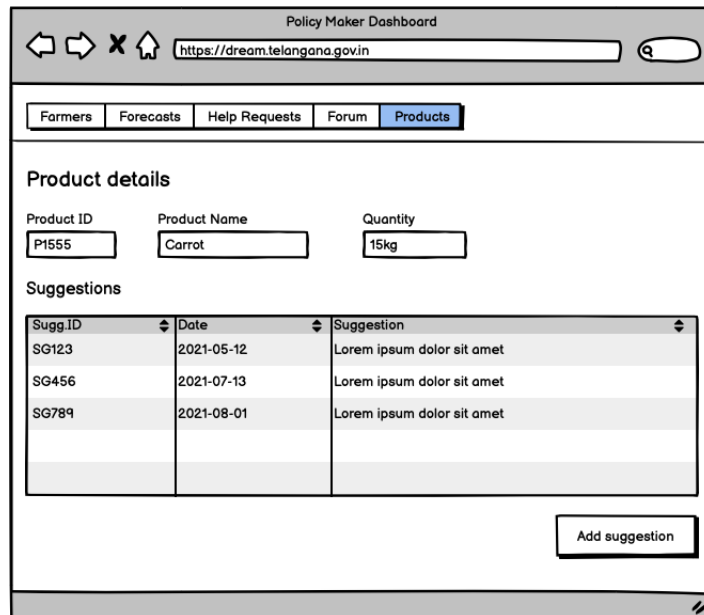


Figure 21: Policy maker's product detail page

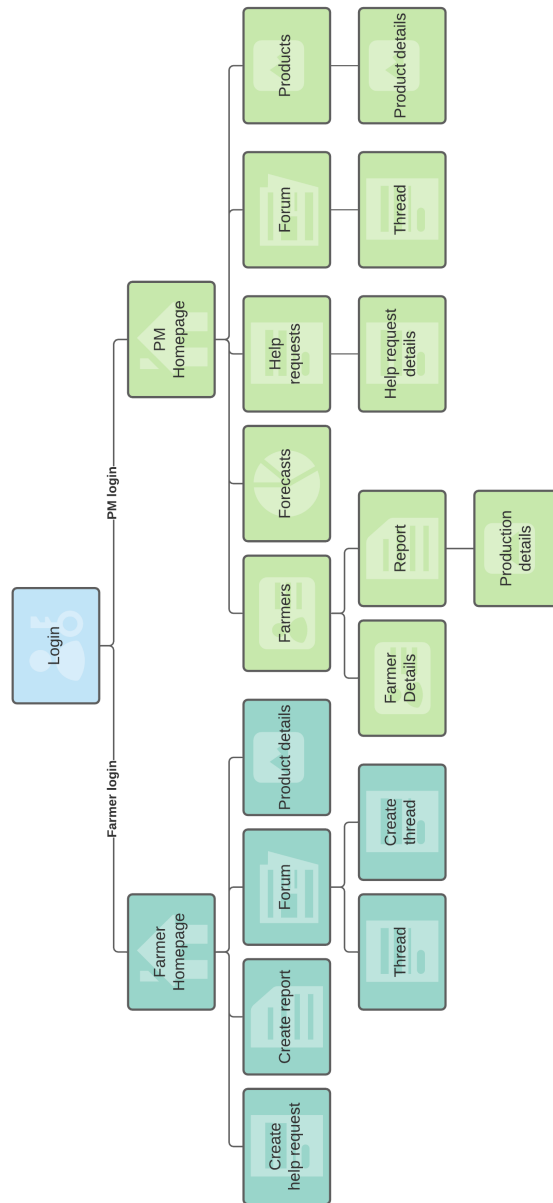


Figure 22: User interface flow