1. INTRODUCTION:

1.1 Project overview

Rainfall prediction is important as heavy rainfall can lead to many disasters. The prediction helps people to take preventive measures and moreover the prediction should be accurate. There are two types of prediction short term rainfall prediction and long term rainfall. Prediction mostly short term prediction can gives us the accurate result. The main challenge is to build a model for long term rainfall prediction. Heavy precipitation prediction could be a major drawback for earth science department because it is closely associated with the economy and lifetime of human. It's a cause for natural disasters like flood and drought that square measure encountered by individuals across the world each year. Accuracy of rainfall statement has nice importance for countries like India whose economy is basically dependent on agriculture. The dynamic nature of atmosphere, applied mathematics techniques fail to provide sensible accuracy for precipitation statement. The prediction of precipitation using machine learning techniques may use regression.

1.2 Purpose

Rainfall Prediction is the application area to predict the state of the atmosphere. It is important to predict the rainfall intensity for effective use of water resources and crop production to reduce mortality due to flood and any disease caused by rain.

2. LITERATURE SURVEY:

2.1 Existing problem

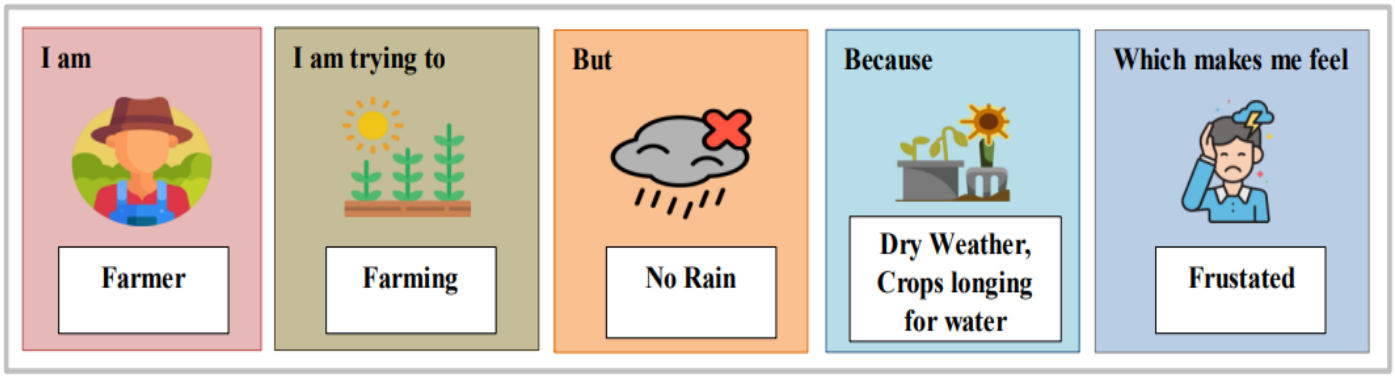
I am	A Farmer	Farmer manages farms, ranches, greenhouses, nurseries, and other agricultural production organizations. Farmers are involved in planting, cultivating, performing post-harvest duties, overseeing livestock, and supervising farm labor depending on the type of farm.
I'm Trying to	Farming with High Yield (Crops)	**Food crops** – for human needs (e.g. wheat, maize, legumes, rice, potatoes, tomatoes). **Feed crops** – for cattle or livestock consumption (e.g. barley, beets, grasses for domestic animals to graze and store as hay or silage). **Oil crops** – for oil manufacturing either for machinery fuel (rape) or food industry (sunflower, olives). **Ornamental crops** – for home decoration and landscape design (garden or pot flowers and bushes). **Industrial crops** – for industrial manufacturing (rubber).

but	No rain	As the climate changes, there may be a inadequate amount of rainfall so farmers are longing for rain.
Because	Dry Weather, Crops longing for water	Most of the Indian agricultural lands are irrigating Crops such as wheat, rice, pulses, which are a staple in Indian diets, need heavy rainfalls to grow.
Which makes me feel	Frustated	When little or no rain falls, soils can dry out and crops can die. So, Farmers feels to be disappointed

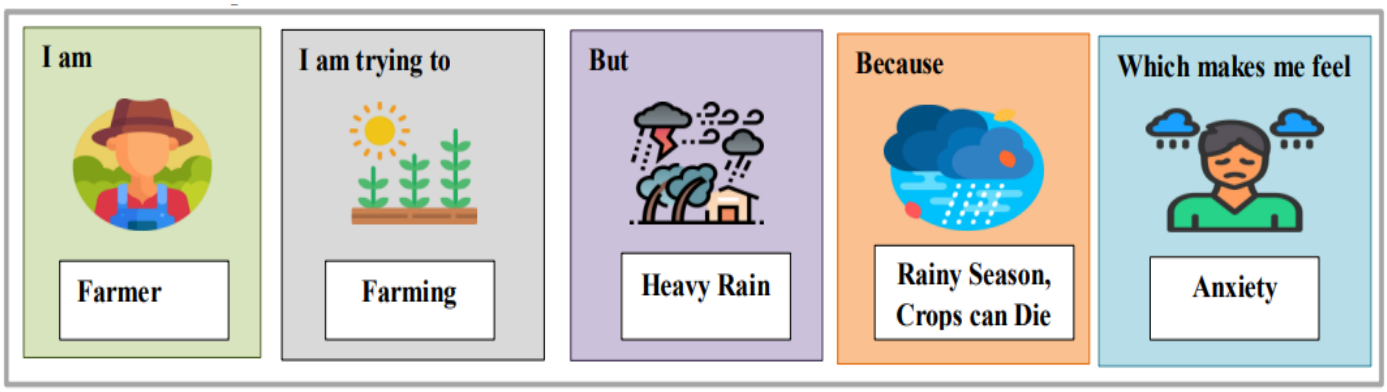
2.2 Reference

Author	Paper Title	Year	Journal	Critics
Jenamani, R. K.	Some evidence of climate change in twentieth-century India.	2007	Springer	The vast size of India and its complex geography, climate in this part of the globe has large spatial and temporal variations. Important weather events affecting India.
D Sengupta	Increasing trend of extreme rain events over India in a warming environment.	2006	Science.org	Significant rising trends in the frequency and the magnitude of extreme rain events
S Gadgil	Monsoon precipitation in the AMIP runs.	1998	Springer	We present an analysis of the seasonal precipitation associated with the Indian monsoon and the circulation models undertaken as a special diagnostic subproject of the Atmospheric Model Intercomparison Project (AMIP).
A Kulkarni	Monsoon rainfall variations and teleconnections over South and East Asia	2001	Wiley Online Library	Understand their interannual and climate characteristics, and to investigate their teleconnections.
Pandey	Initial and Conditional Rainfall Probability Analysis.	1997	Department of Agril.	Understand for crop planning.
Singh S	Applications of Geographical Information System in Agrometeorology.	2009	Springer	This study would be helpful in developing the cropping plan and allied aspects in agricultural and hydrological disciplines.
Babu PN	Rainfall analysis of a dry land watershed.	1997	Indian Water Res soc.	In this study the Markov chain model method has been applied to know the probability during monsoon period over Andhra Pradesh.
Pandharinath N	Short period probability rainfall analysis	1993	Mausam	Identify the rainfall one set of monsoon rains.
V Kuma	Trend analysis of rainfall and temperature data for India.	2012	JSTOR	Sen's non-parametric estimator of slope has been frequently used to estimate by the Mann–Kendall test. Spatial units for trend analysis vary from station data to sub-division to sub-basin/river basins.

Example 1:



Example 2:



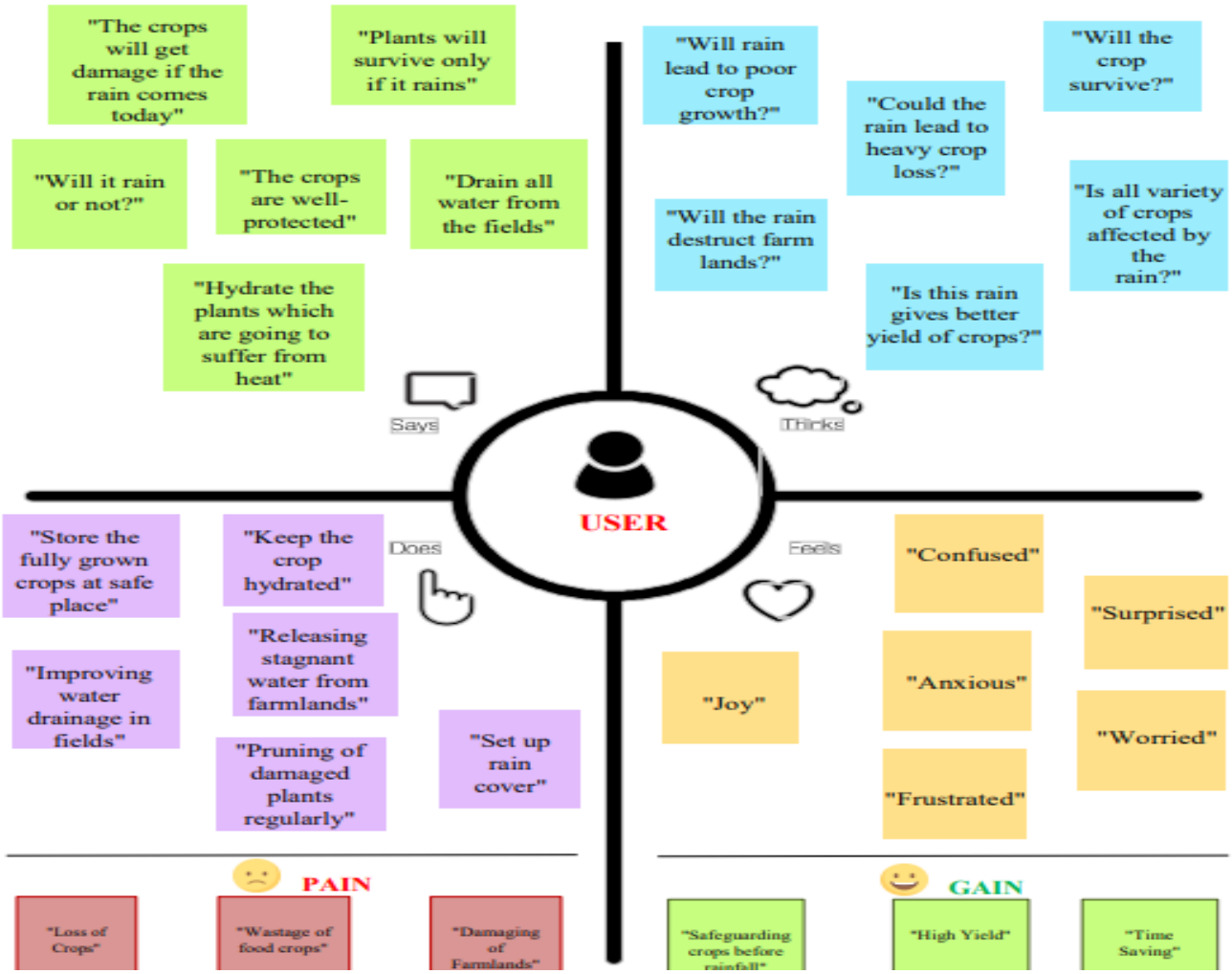
Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	Farmer	Farming with high yield(Crops)	No Rain	Dry Weather, Crops longing for water	Frustated
PS-2	Farmer	Farming with high yield(Crops)	Heavy Rain	Rainy Season, Crops can Die	Anxiety

2.2 Problem Statement Definition

What problem are you trying to solve? Frame your problem as a How Might Westatement. This will be the focus of your brainstorm.

3. IDEATION & PROPOSED SOLUTION:

3.1 Empathy Map Canvas



3.2 IDEATION & BRAINSTROMING

Template

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A Team gathering
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B Set the goal
Think about the problem you'll be focusing on solving in the brainstorming session.

C Learn how to use the facilitation tools
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1 Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

Rainfall has been a major concern these days. Weather conditions have been changing for time being. Rainfall forecasting is important otherwise, it may lead to many disasters. Irregular heavy rainfall may lead to the destruction of crops, heavy floods that can cause harm to human life. It is important to exactly determine the rainfall for effective use of water resources, crop productivity, and pre-planning of water structures.

Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

Akshaya V

Look at the weather changes over years

IOT, AI can also be used

Maintains water resource level

It is used for animal lives

Precaution to protect their crop from rainfall.

Defer Judgement: It helps checking rainfall estimation and save field

Fresh water is always a crucial resources of human survival

Priyadharshini J

Emission of green house gas

Weather forecast used to work in their day to day operation.

Predict the amount of rainfall over a region

Support of economic prosperity and quality of life

It can minimize risk to life and property

Defer Judgement: This is used as early planner to show the crop that is to be harvested for profit

Make preventive measures before disaster

Santhini Devi S

It helps farmers manage soil moisture and plant health

Gravimetric method used for soil moisture management

Its providing production against erosion

Facilitates policy decisions regarding the croping pattern

Climate change availability of fresh water is decreased rapidly

Defer Judgement: Conserve of water should be amount of rainfall occurs

The cultivation of trees that are grown on land

Swathika G

Rainfall analysis stabilizing crop production and planning

Using EOSDA crop maintaining software for weather production

Increase in temperature and CO2 can increase some crop yields

It providing drinking water to urban and rural areas

For increasing crop yield suitable land is important

Defer Judgement: This analysis helps people to note the data running and also helps to save water

Determines how fast a crop will grow

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

Ensure sustainability of the farm

Determine harvesting state of a crop

Higher crop yielding because of pre-estimation of rainfall

Damage to food crops are ignored

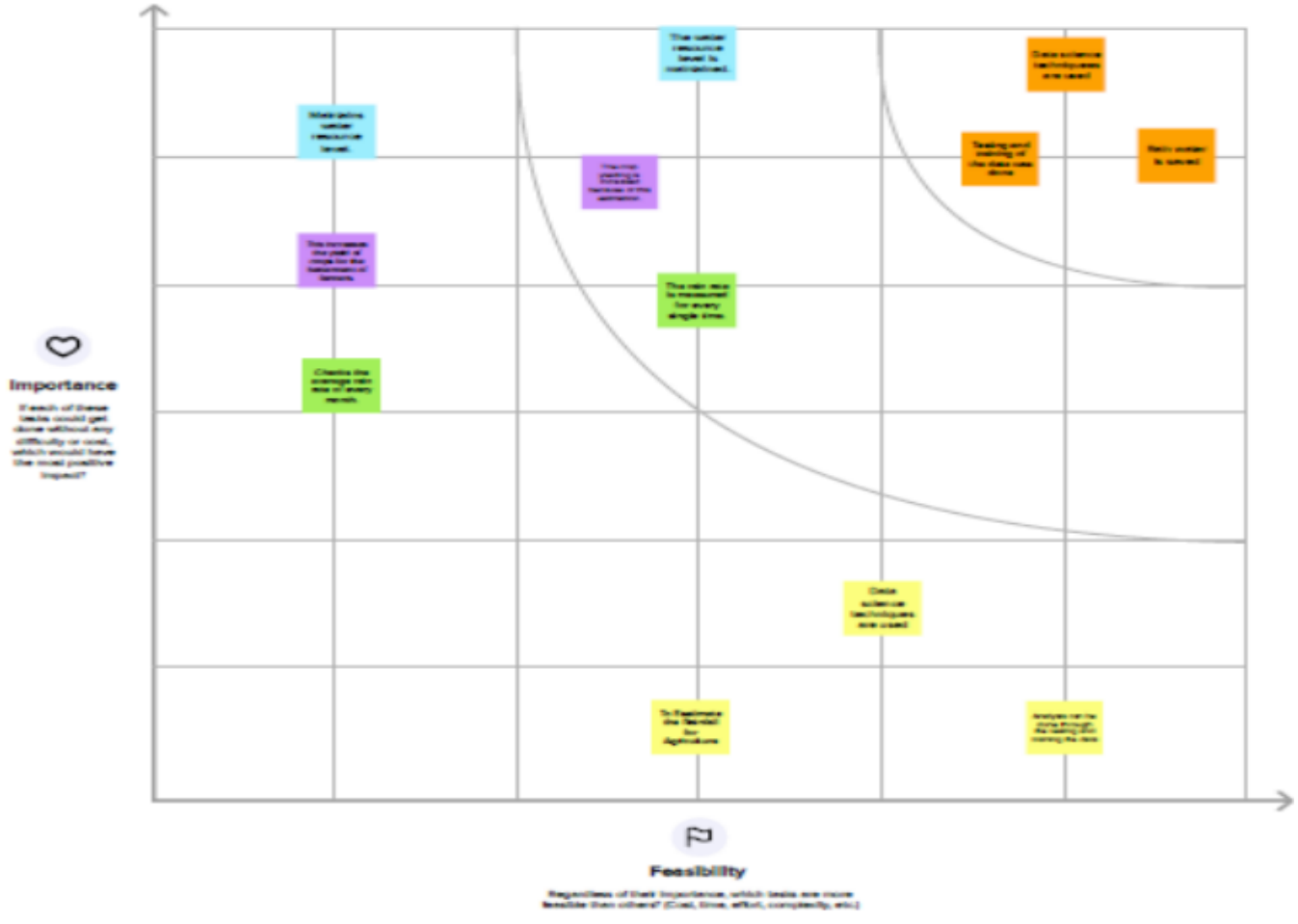
Can tolerate diseases to food crops

By using of our model prediction of climate changes is easy

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes



3.3 PROPESED SOLUTION

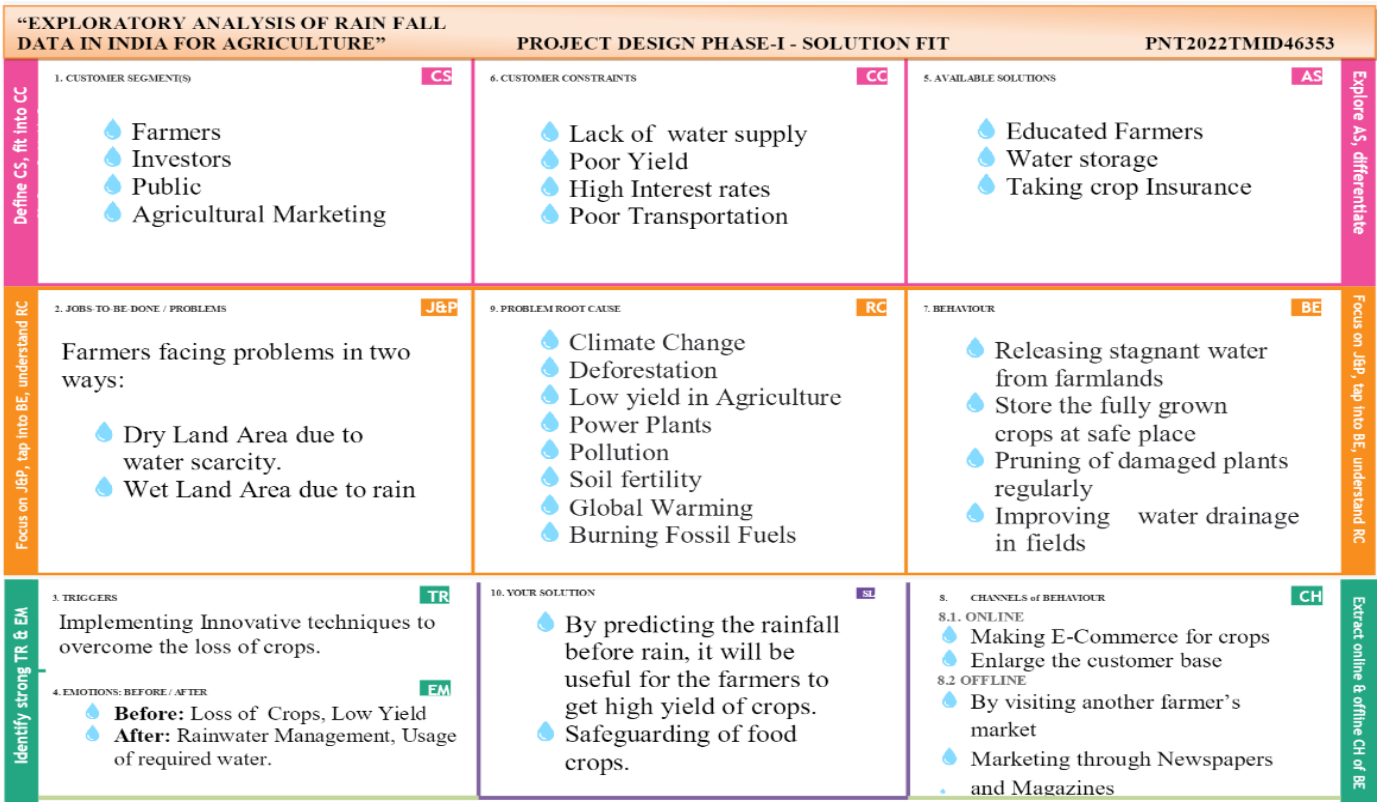
S.No.	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	✓ Now a days, Climate is an important aspect of human life. So, the prediction should accurate as much as possible. ✓ We try to deal with the prediction of the rainfall which is also a major aspect of human life and which provide the major resource of human life which is Fresh Water. ✓ Now climate change is the biggest issue all over the world. People are working on to detect the patterns in climate change as if affects the economy in production to infrastructure.
2.	**Idea / Solution description**	✓ Our solution is for making prediction of rainfall, it acts a challenging task with a good accuracy rate, Making prediction on rainfall cannot be done by the traditional way, so we are using machine learning and deep learning to find out the pattern for rainfall prediction. ✓ Assist the farmers before damaging of the crops.
3.	**Novelty / Uniqueness**	✓ Our solution is useful for the people who are start-up to agriculture. ✓ Analysis will be quiet easy to handle.
4.	**Social Impact / Customer Satisfaction**	✓ Farmers will gain huge yield due to prediction. ✓ Helps in producing food crops widely.
5.	**Business Model (Revenue Model)**	• This comparative study is conducted concentrating on the following aspects: ✓ Modelling inputs ✓ Visualizing the data ✓ Modelling methods ✓ Pre-processing techniques. • On the Expenses area, our solution will give a **"Small Investment with Huge Impact on Farmer's Society"**
6.	**Scalability of the Solution**	Our solution will be differ from others solution because in our model, Prediction of data will be trouble-free

3.4 PROBLEM SOLUTION FIT

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns and recognize what would work and why.

Purpose:

- Solve complex problems in a way that fits the state of your customers.
- Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behavior.
- Sharpen your communication and marketing strategy with the right triggers and messaging.
- Increase touch-points with your company by finding the right problembehavior fit and building trust by solving frequent annoyances, or urgent or costly problems.
- Understand the existing situation in order to improve it for your target group.



4. REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS:

Following are the functional requirements of our proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	**Download and load the dataset**	Download and load the appropriate dataset.
FR-2	**Pre-processing of data**	Preparation of raw data and make it suitable for building of machine learning model.
FR-3	**Building machine learning model**	✓ Exploring the data and choose the suitable algorithm. ✓ Prepare and clean the dataset. ✓ Split the prepared dataset and make cross validation. ✓ Perform machine learning optimisation. ✓ Deploy the model.
FR-4	**Train the data**	Train the model using training set.
FR-5	**Test the data**	At last, test the model for evaluation of final model.

4.2 NON-FUNCTIONAL REQUIREMENTS:

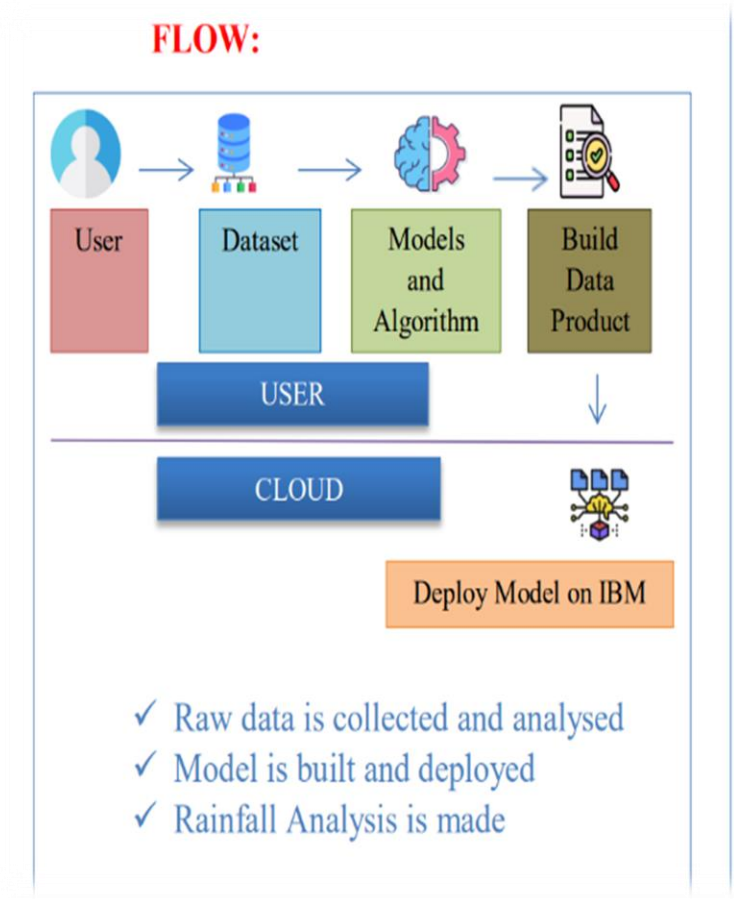
Following are the non-functional requirements of our proposed solution.

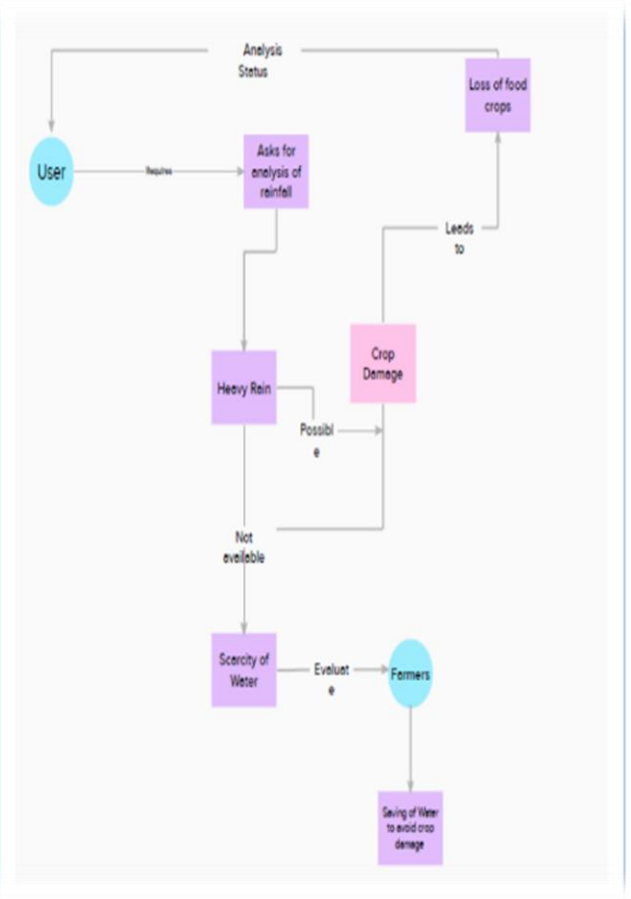
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Local presence/traceability of WIS source in the farming community.
NFR-2	**Security**	Providing secure system networks then determine authenticity, originality and security.
NFR-3	**Reliability**	System will operate without failure for a specific period of time.
NFR-4	**Performance**	Our model predictions are same as the true values. So, the performance is higher.
NFR-5	**Availability**	Available to different groups of farmers including women, older persons, etc.
NFR-6	**Scalability**	In our model, Prediction of data will be faultless.

5. PROJECT DESIGN

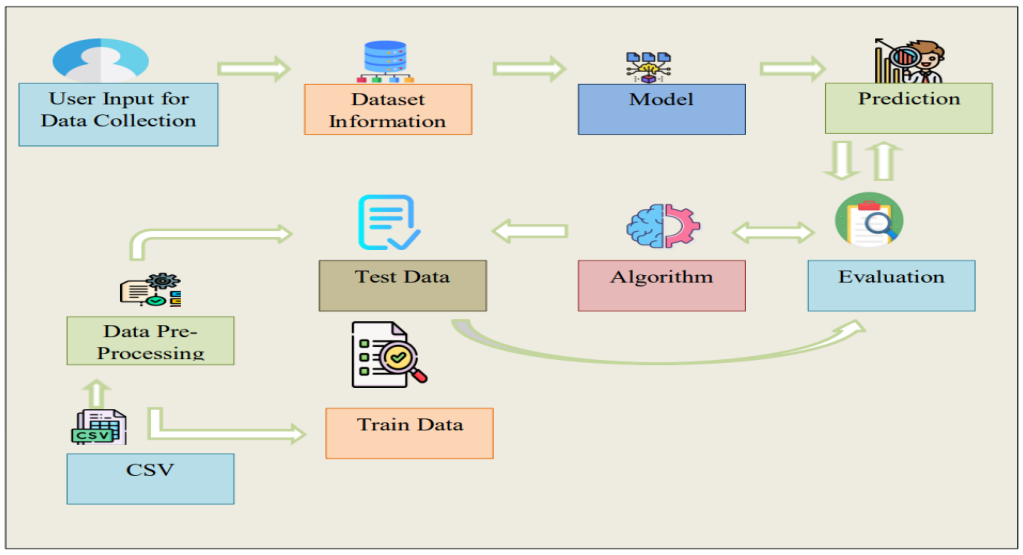
5.1 Data Flow Diagrams

Data Flow Diagram: A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system.





5.2 Solution & Technical Architecture



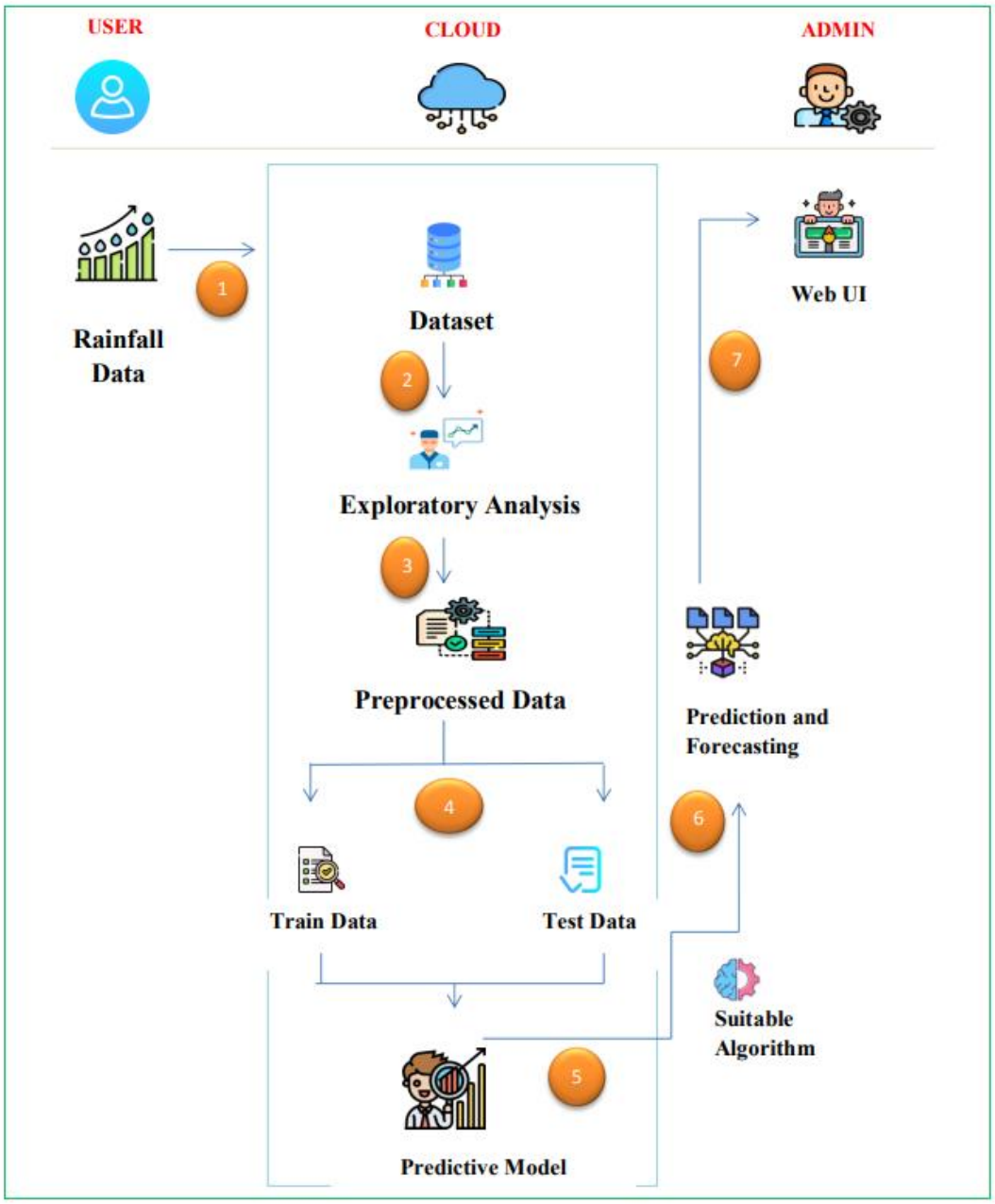

USER
CLOUD
ADMIN
Rainfall Data
1
Dataset
2
Exploratory Analysis
3
Preprocessed Data
4
Train Data
Test Data
5
Predictive Model
6
Suitable Algorithm
Prediction and Forecasting
7
Web UI

Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	**User Interface**	How user interacts with application e.g. Web UI, Mobile App, Chatbot etc.	HTML, CSS, Python Flask
2.	**Application Logic-1** **Login**	Logic for a process in the application	Python
3.	**Application Logic-2**	Logic for a process in the application	Python
4.	**Application Logic-3**	Logic for a process in the application	Python Flask
5.	**Database**	Data Type, Configurations etc.	MySQL
6.	**Cloud Database**	Database Service on Cloud	IBM DB2, IBM Cloudant etc.
7.	**File Storage**	File storage requirements	Local Filesystem
8.	**External API-1**	Purpose of External API used in the application	IBM Weather API
9.	**Machine Learning Model**	Purpose of Machine Learning Model	Predictive Modelling
10.	**Infrastructure (Server / Cloud)**	Application Deployment on Local System / Cloud Local Server Configuration: Built on Flask Web Server	Local Server

Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	**Open-Source Frameworks**	List the open-source frameworks used	Micro-web Framework using Python
2.	**Security Implementations**	List all the security / access controls implemented, use of firewalls etc.	Flask Security
3.	**Scalable Architecture**	Justify the scalability of architecture (3 – tier, Micro-services)	Three-Tier Architecture
4.	**Availability**	Justify the availability of application (e.g. use of load balancers, distributed servers etc.)	Load Balancers
5.	**Performance**	Design consideration for the performance of the application (number of requests per sec, use of Cache, use of CDN's) etc.	High Performance by Load Balancers

5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Mobile User (Farmers)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account	High	Sprint-1

		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
	Login	USN-3	As a user, I can log into the application by entering email & password	After giving correct login information, it proceeds further	High	Sprint-2
	Dashboard	USN-4	Displaying of user Credentials	User can access details in dashboard	Medium	Sprint-2
	Rainfall Prediction	USN-5	User can enter the temperature condition of the environment	User have to enter their environment conditions	High	Sprint-3
		USN-6	Prediction of rainfall and displaying of result	Using algorithms, prediction is made	Medium	Sprint-3
	Testing	USN-7	Test the model	Testing of model	High	Sprint-4
	Deploying	USN-8	Deploy the model	Successful prediction of rainfall by deploying model in IBM Cloud	High	Sprint-4

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	5	High	Team Lead Team Member1
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	5	Low	Team Member1 Team Member2
Sprint-1	Login	USN-3	As a user, I can log into the application by entering email & password	5	High	Team Member1 Team Member3
Sprint-2	Dashboard	USN-4	Displaying of user Credentials	8	Low	Team Lead Team Member2

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3	Rainfall Prediction	USN-5	User can enter the temperature condition of the environment	5	High	Team Lead Team Member3
Sprint-3		USN-6	Prediction of rainfall and displaying of result	5	High	Team Member1 Team Member3
Sprint-4	Testing	USN-7	Test the model	10	High	Team Member2 Team Member3
Sprint-4	Deploying of model	USN-8	Deploy the model in IBM Cloud	10	High	Team Lead Team Member2

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	30 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	06 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	13 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	20 Nov 2022

6.2 Sprint Delivery Schedule

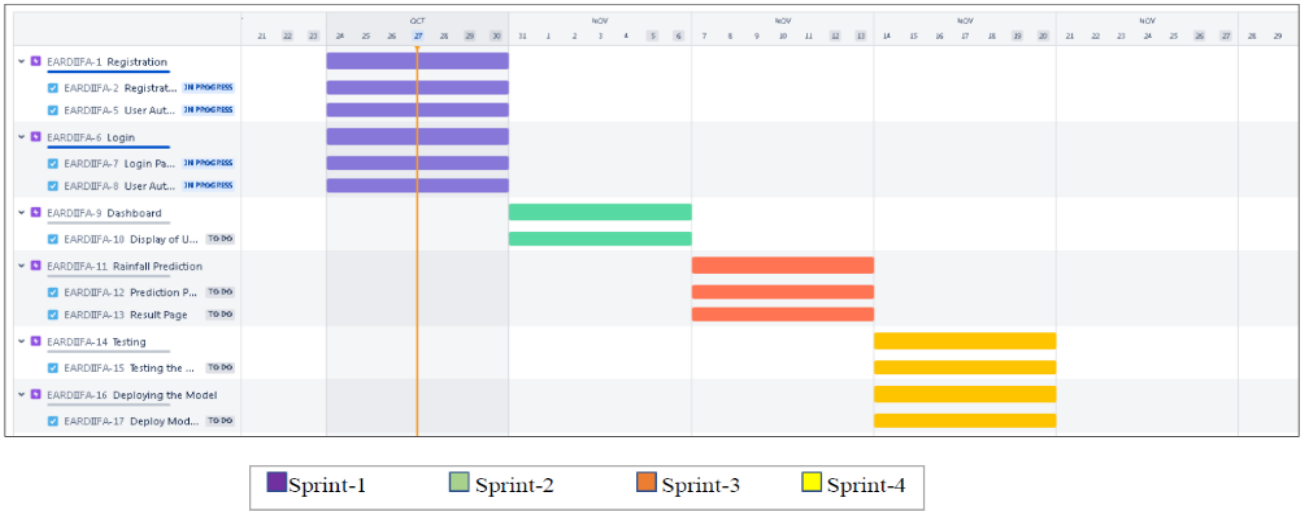
Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

Sprint	Average Velocity
Sprint-1	5
Sprint-2	8
Sprint-3	5
Sprint-4	10
Total Average Velocity	7

6.3 Reports from JIRA

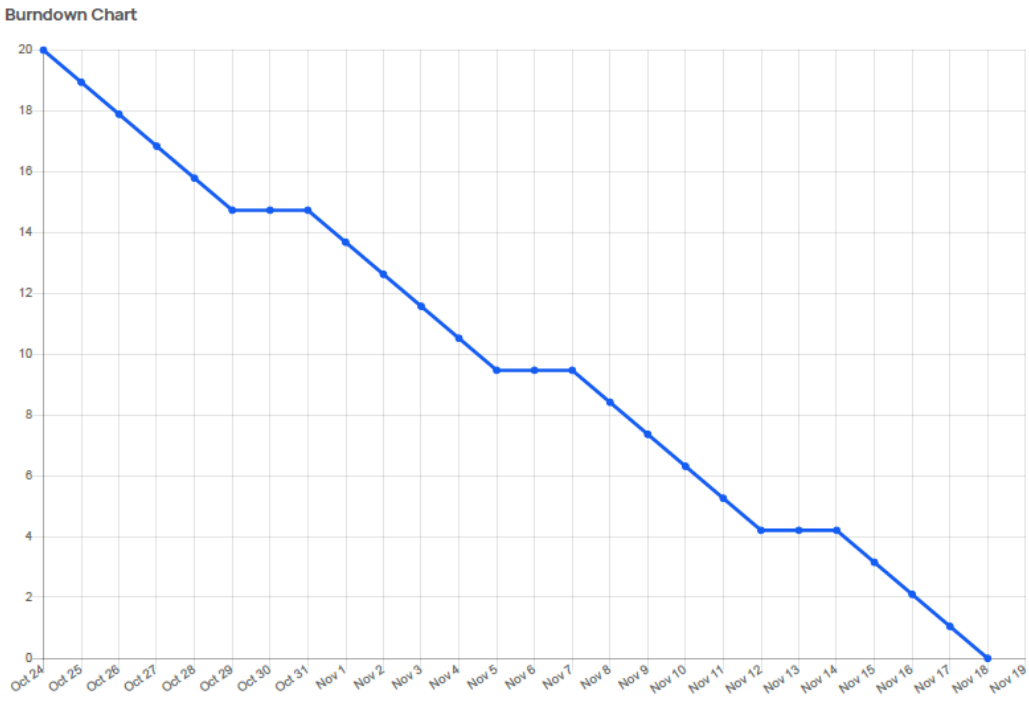
Roadmap (Using Jira Software):



Roadmap Link: https://rainfallanalysis.atlassian.net/jira/software/projects/EARDIIFA/boards/1/roadmap

Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.



10. ADVANTAGES & DISADVANTAGES

Advantage

- Farmers can know when to plant or harvest their crops
- People can choose where and when to take their holidays to take advantages of good weather
- Surfers known when large waves are expected
- Regions can be evacuated if hurricanes or floods are expected
- Aircraft and shipping rely heavily on accurate weather forecasting

Disadvantage

- Weather is extremely difficult to forecast correctly
- It is expensive to monitor so many variables from so many sources
- The computers needed to perform the millions of calculations necessary are expensive
- The weather forecasters get blamed if the weather is different from the forecast

11. CONCLUSION

The weather prediction has become one of the most essential entities now a days. To improve the risk management systems and to know the weather in coming days in an automatic and in scientific way, many models have been emerging to assist in weather Prediction. In this paper, we have seen building a Weather Prediction Web Application from scratch by making use of 6 different ML algorithms namely Cat Boost Classifier, Random For set Classifier, Logistic Regression, Gaussian NB, KNN and XGB Classifier. In the result section, the results from the all the six models and its results such as Accuracy, Error rate, mean absolute error, Root mean squared error, Relative squared error, Root relative squared error and time taken to build the model are tabulated. The results show that the Cat Boost Classifier and XGB Classifier has output the results of high accuracy than all the other classifiers that were used. When coming to the time taken to build the model, The Cat Boost Classifier outperforms all the other classifiers in solving the Problem under scrutiny.

12. FUTURE SCOPE

In upcoming future updates, the WEATHER FORECASTING application will have additional features such as:

- Live Location tracking
- News on Live Disasters
- Weather Forecast for next one week
- Will deploy as android app
- Help in predicting which crop will be best suited according to weather conditions