IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Green Ethics For Farmers Using Machine Learning

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ABSTRACT: Irrigreat currently supports 22 crops. Moreover in the future, fertilizers can also be added accordingly The training was done on 10 pests and with this pesticides are suggested. In future, training can be done on more pests and more pesticides can also be added according to the pests. In Crop Recommendation, values are manually entered by user of temperature, humidity, rainfall. Admin can also use some weather API to fetch the real time parameters by the city and state. In Pesticide Recommendation, the uploaded image should be clear for correct results, otherwise with a blur image, the system sometimes gives wrong results so, further filters can be used to obtain better results. Also the system can use better DL models. In future pesticide code can be integrated with drone code so that it can take live pictures of pests and by email or by mobile the farmers would be notified about the pest along with the pesticides.

KEYWORDS: Portable, convenient, efficient, wireless, innovative.

I INTRODUCTION

"Irrigreat" defines in its slogan, Farm = AI + Crop + Fertilizer + Pesticide, taking care of soil's health. Irrigreathonors the Indian farmer's love, hard work and character. Farmers help to feed a nation whose population is nearly 1.4 billion, however the productivity of farms is threatened by various natural factors that ruin the crops and farmer's livelihood. Irrigreat is a small initiative enhancing agriculture, making smart decisions to consider the demographics of the field, the factors affecting the crop, as well as how to keep the farm healthy for a super awesome yield. This will be implemented in the form of a website providing features of Crop Recommendation, Fertilizer Recommendation and Pesticide Recommendation based on site specific parameters.

1.1 **Project Overview**

Irrigreat is a website made for farmers to help them with crop recommendations based on values of N, P, K, temperature, rainfall, relative humidity and pH. Generally, soil gets degraded and productivity is reduced if the right crop isn't chosen, but Irrigreat makes it really easy by using the ML model to make the real time prediction. Second feature is Fertilizer Prediction. If the farmer opts not to change the crop as per land, he can go with the same crop but use fertilizer which will be recommended by Irrigreat based on N, P, K and crop values. Lastly, a very useful feature implemented is Pesticide Recommendation. Pests are a huge threat but they can be stopped. Farmers simply need to upload a picture which clearly shows the pest and Irrigreat will identify the pest with the help of DL Model which is CNN and recommend the corresponding pesticide along with required dosage to get rid of pests and protect the crop. If the farmer already knows about the pest, then he/she can select the pest and corresponding pesticide will be recommended. Generally it's seen that tests for soil are done by Indian government and results come within a few days but farmers really don't know much on what to do next, so Irrigreat is sort of their next step. A simple, intuitive website will really help farmers to easily know the whereabouts of crops, thus helping every possible bit which Irrigreat can. Hence, the three modules: Crop, Fertilizer, Pesticide really comes handy and a boon for farmers.

1.2 Problem Definition

Irrigreat aims to help Indian farmers and reduce their hardship. The problems faced by Indian farmers are defined as follows:

1. Productivity needs to be increased so that farmers can get more pay from the same piece of land without degrading soil.
2. Indian farmers aren't able to choose the right crop based on their soil requirements depending upon factors like N, P, K, temperature, humidity, rainfall, pH.
3. Farmers are generally unaware about the organic fertilizers or standard fertilizers to use as per soil requirements.
4. Due to inadequate and imbalanced fertilization, soil degradation is occurring, which leads to nutrient mining and the development of second-generation problems in nutrient management.
5. According to a study by the Associated Chambers of Commerce and Industry of India, annual crop losses due to pests amount to Rs. 50,000 crore.

1.3 Problem Objectives

Corresponding to problems cited above, following are objectives that "Irrigreat" is trying to solve:

1. To implement precision agriculture (A modern farming technique that uses research data of soil characteristics, soil types, crop yield data collection and suggests the farmers the right crop based on their site specific parameters to reduce the wrong choice on a crop and increase in productivity).
2. To solve the problem by proposing a recommendation system through an ensemble model with majority voting technique crop for the site specific parameters with high accuracy and efficiency.
3. To recommend organic fertilizer on the basis of N, P, K values and crop.
4. To recognize the pest and recommend particular pesticide available in India as per ISO standards (ISO 9001, ISO 14001, ISO 17025).
5. To design a web application for achieving above objectives

1.4 Novelty of Work

The works done in this field of agriculture are disintegrated and no single platform provides all such facilities of crop recommendation, fertilizer recommendation and pesticide recommendation altogether. "Irrigreat" is one stop solution to all the problems of the farmers and the feedback system really helps to improve and adapt according to the needs of the farmers. The work in the field of pests is only limited to pest detection but "Irrigreat" extends the idea of pest identification to pesticide recommendation as per the corresponding pest identified which is a practical use of pest detection. Along with that, the dataset is more customized w.r.t. Indian farms which are unique in themselves. The fertilizers recommended are natural fertilizers and the pesticides are as per ISO standards.

1.5 Need Analysis

Agriculture is one of the biggest sources of earning for Indians. Though the Indian farmers really work hard in their fields, their productivity is threatened by natural factors. The fact cannot be changed that natural factors are uncontrollable so the best way is to take most out of the field despite the natural factors. One of the major problems is soil degradation which can be prevented by growing the crop that is the most suitable as per the land. But even if the farmer chooses to grow a particular type of crop, then the appropriate dosage of fertilizers would help. Another major problem is the pest which can be only treated through suitable pesticides. This will help farmers. Various tests are conducted by the government in India which check the contents of soil but farmers are unaware of what to do with the results of the soil test. Hence Irrigreat makes use of all the values of the tests and helps the farmers with crop recommendation, fertilizer recommendation and pesticide recommendation.

1.6 Project Outcomes and Deliverables

The idea is to create a web application which has three major modules namely

1. Crop Recommendation
   a. The user will input values of N, P, K, temperature (in °C), relative humidity (in %), rainfall (in mm) and pH.
   b. Output: Prescribed Crop
2. Fertilizer Recommendation
   a. The user will input values of N, P, K and crop.
   b. Output: Corresponding organic fertilizer suggestions.
3. Pesticide Recommendation

a. The user will upload the picture which clearly shows the pest.
b. Alternatively, the user can select the pest if the user already knows the pest.
c. Output: Identified pest along with recommended pesticides available in India as per ISO standards (ISO 9001, ISO 14001, ISO 17025).

"Irrigreat" has three different modules namely: Crop Recommendation, Fertilizer Recommendation and Pesticide Recommendation. So this section will define functional requirements for all the modules separately.

II. REQUIREMENTS &ANALYSIS:-

1. Crop Recommendation: The system will recommend the crop as per site specific parameters entered by the user.
2. Fertilizer Recommendation: The system will recommend the organic fertilizers as per the values entered by the user.
3. Pesticide Recommendation

Uploading the image: The user will upload the image which clearly shows the pest. Manual selection of pest: The user can choose to select the pest (alternative to uploading an image).
Pest Identification: The website will identify the pest.
Pesticide Recommendation: Based on the pest identified, the corresponding pesticide (as per ISO 9001, ISO 14001, ISO 17025 standards) will be recommended.

III. METHODOLOGY ADOPTED:-

The following section discusses how "Irrigreat" can be implemented.

3.1 Proposed Solution

"Irrigreat" has three different modules. Methodology for all the modules will be discussed one by one.

3.1.1 Crop Recommendation

This module can be implemented in four steps as discussed below and shown in Figure 1:

Step 1: Data Acquisition

Dataset can be acquired from kaggle. Click hereto have a look at the dataset.

Step 2: Values Input

Users are expected to input the site specific parameters like: N, P, K (all of them in %), temperature (in °C), relative humidity (in %), rainfall (in mm) and pH.

Step 3: ML Model Training and creating .pkl file

Recommendation system is based on the ensemble model with majority voting technique. The constituent models are:

1. SVM
2. Random Forest
3. Naive Bayes
4. kNN

After the model is trained, a .pkl file is created.

Step 4: Crop Recommendation

.pkl file is loaded to recommend the crop based on input.

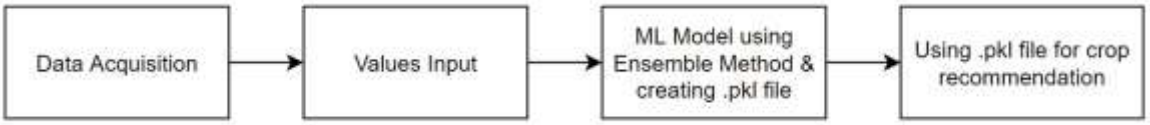

Fig 3.1: Methodology for Crop Recommendation

3.1.2 Fertilizer Recommendation

This module can be implemented in four steps as discussed below and shown in Figure 2:

Step 1: Data Acquisition

Dataset will be created manually after collecting data from verified sources listed below:

1. The Fertilizer Association of India
2. Indian Institute of Water Management
3. Kaggle

The columns of the dataset are: N, P, K (all of them in %) and crop.

Step 2: Values Input

Users are expected to input the site specific parameters like: N, P, K (all of them in %), and crop

(select from list - only 22 crops supported).

Step 3: Difference between desired and actual

Difference is calculated between desired value of N, P, K as per crop and the farm's actual value, based on it there are 3 outcomes possible for all three nutrients:

1. High
2. Low
3. Upto the mark

Step 4: Fertilizer Recommendation

Based on the outcomes from the above step, a dictionary based solution (organic fertilizers) will be displayed.

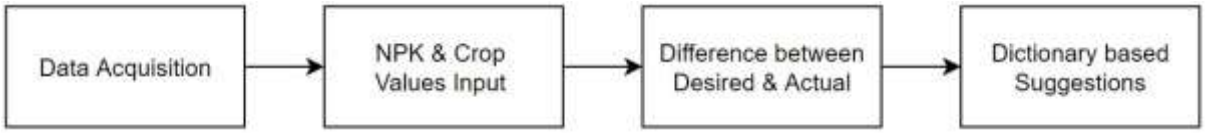

Fig 3.2: Methodology for Fertilizer Recommendation

3.1.3 Pesticide Recommendation

This module can be implemented in four steps as discussed below and shown in Figure 3:

Step 1: Data Acquisition

Dataset will be created by scraping images from Google via automatic script using Selenium and Chrome Driver. Along with that, pest labels will be provided as well.

Step 2: Data Cleaning and Data Augmentation

The data collected from Google needs to be cleaned manually to get rid of non-useful content e.g: In case of scraping images of pest named "beetle" there are also few images of "car called beetle". Later on, the dataset needs to be augmented so as to increase variability.

Step 3: DL Model Creation

This involves model configuration, training configuration and model evaluation. Later on, .h5 file will be created to store the model.

Step 4: Pest Identification and corresponding Pesticide Recommendation

.h5 model will be loaded to identify the pest, later on based on the result, corresponding pesticide will be recommended based on dictionary based solution.

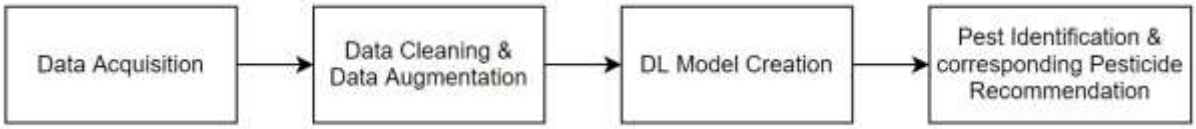

Fig 3.3: Methodology for Pesticide Recommendation

3.2 Work Breakdown Structure

"Irrigreat" has three different modules as shown in Figure 4. All the work breakdown structures are made based on project objectives and deliverables.

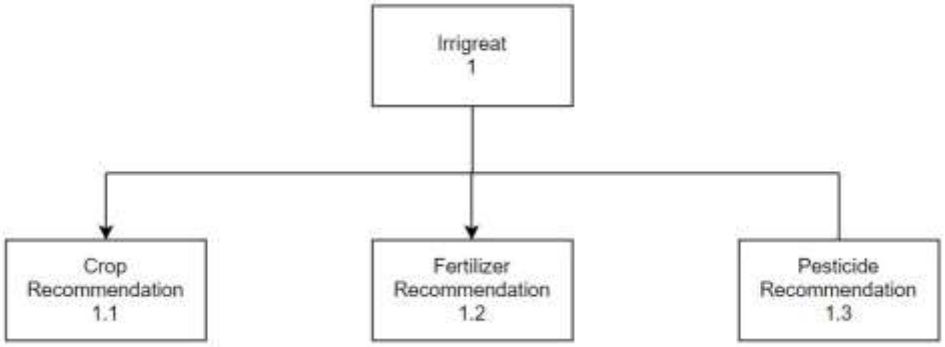

Fig 3.4: Irrigreat WBS

Figure 5 shows in detail, the submodule "Crop Recommendation" and further their submodules.

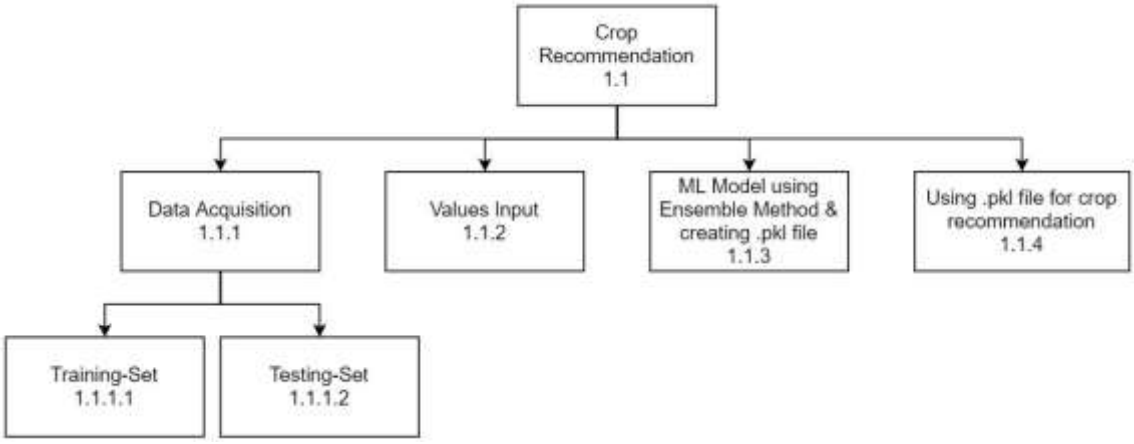

Fig 3.5: Crop Recommendation WBS

The second submodule is Fertilizer Recommendation, it's submodules are shown in Figure 6 while for the third and last submodule which is Pesticide Recommendation, its submodules are shown in Figure 7.

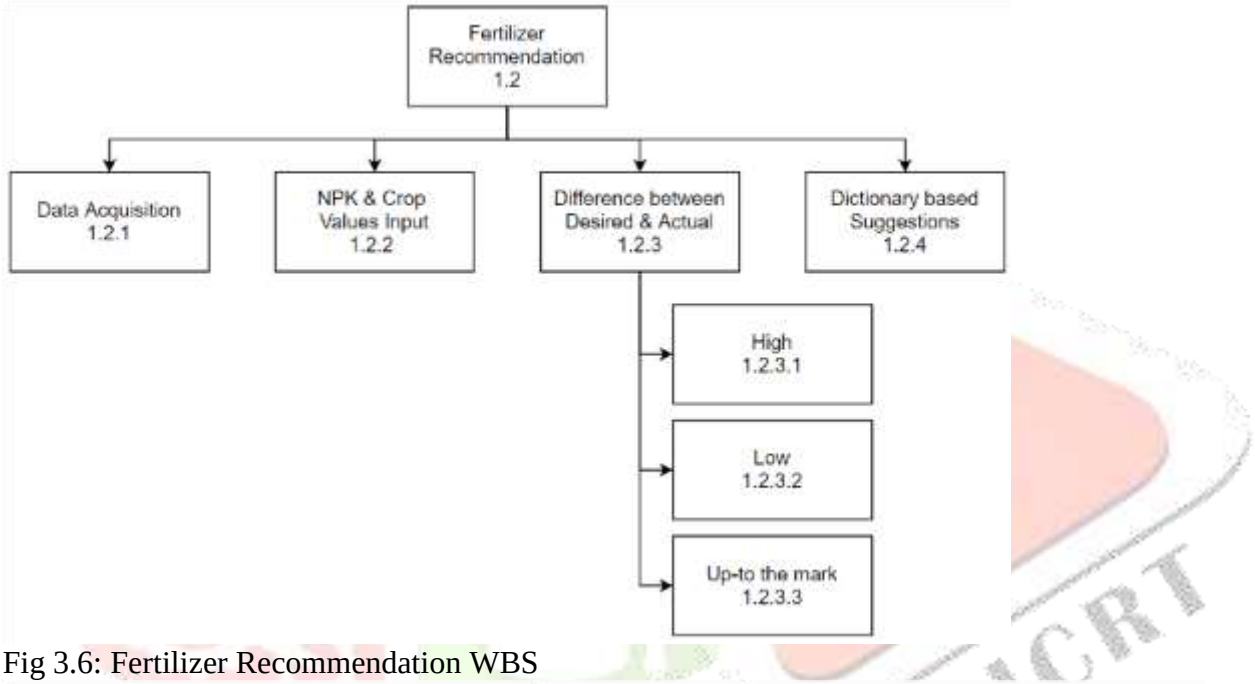

Fig 3.6: Fertilizer Recommendation WBS

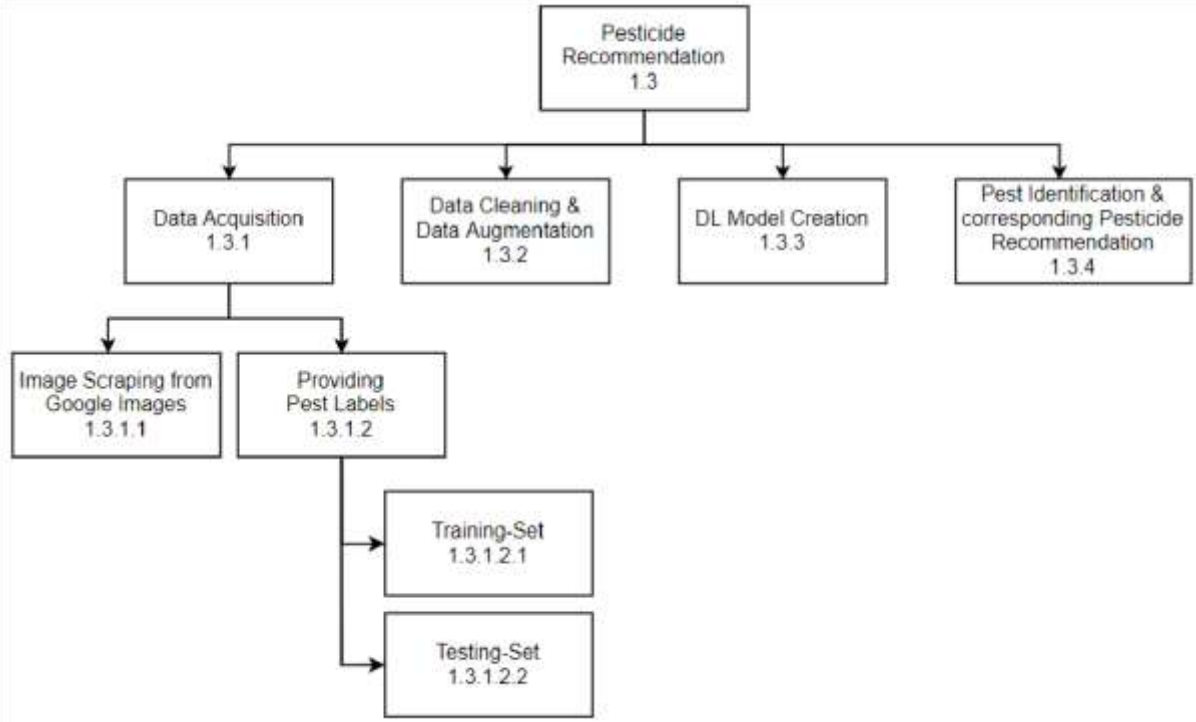

Fig 3.7: Pesticide Recommendation WBS

3.3 Gantt Chart

Following Gantt Chart (Figure 8) shows tentative project timeline, start date and end date of project and along with task dependencies. The tasks and subtasks can be identified through Gantt Chart Table only. To just see the table and not the timeline, refer to Table 4. Total Slack and Free Slack, Resource Assignment can also be added for more details. This Gantt Chart is as per 10th May, 2021.

Table 4: Gantt Chart Table

		Name	Duration	Work	Free Slack	Total Slack	Start	Finish	Actual Finish	Predecessors
1		Irrigreat	124.333 day...	552.5 hours	0 days	0 days	19/3/21 8:00 AM	28/5/21 2:00 PM		
2	✔	Research on project	7 days?	57 hours	57 days	57 days	19/3/21 8:00 AM	23/3/21 2:00 PM	23/3/21 2:00 PM	
3	✔	Studying Research papers	7 days?	21 hours	7 days	7 days	19/3/21 8:00 AM	23/3/21 2:00 PM	23/3/21 2:00 PM	
4	✔	Requirement Analysis	5 days?	15 hours	2 days	59 days	19/3/21 8:00 AM	22/3/21 4:00 PM	22/3/21 4:00 PM	
5	✔	Study on crops, fertilizers, pests and pesticides	7 days?	21 hours	0 days	57 days	19/3/21 8:00 AM	23/3/21 2:00 PM	23/3/21 2:00 PM	
6	✔	Research Summary	0 days?	0 hours	57 days	57 days	23/3/21 2:00 PM	23/3/21 2:00 PM	23/3/21 2:00 PM	3;4;5
7		Project Documentation	24 days?	72 hours	36.333 days	36.333 days	27/4/21 8:00 AM	10/5/21 8:00 AM		
8		Analysis Modelling, Design Modelling etc	24 days?	72 hours	0 days	36.333 days	27/4/21 8:00 AM	7/5/21 5:00 PM		
9		Project Report	0 days?	0 hours	36.333 days	36.333 days	10/5/21 8:00 AM	10/5/21 8:00 AM		8
10	✔	Crop Recommendation	9 days?	27.5 hours	14 days	14 days	27/4/21 8:00 AM	30/4/21 11:00 AM	30/4/21 11:00 AM	2
11	✔	Data Acquisition	4 days?	12 hours	0 days	14 days	27/4/21 8:00 AM	28/4/21 1:00 PM	28/4/21 1:00 PM	
12	✔	Values Input	0.167 days?	0.5 hours	6.833 days	20.833 days	27/4/21 8:00 AM	27/4/21 8:30 AM	27/4/21 8:30 AM	
13	✔	ML Model using Ensemble method & creating .pkl file	3 days?	9 hours	0 days	14 days	28/4/21 12:00 PM	29/4/21 2:00 PM	29/4/21 2:00 PM	11
14	✔	Using .pkl file for crop recommendation	2 days?	6 hours	0 days	14 days	29/4/21 2:00 PM	30/4/21 11:00 AM	30/4/21 11:00 AM	12;13
15	✔	Crop Recommendation Module	0 days?	0 hours	14 days	14 days	30/4/21 11:00 AM	30/4/21 11:00 AM	30/4/21 11:00 AM	14
16	✔	Fertilizer Recommendation	10.167 days?	31 hours	12.833 days	12.833 days	27/4/21 8:00 AM	30/4/21 3:30 PM	30/4/21 3:30 PM	2
17	✔	Data Acquisition	3 days?	9 hours	0 days	12.833 days	27/4/21 8:00 AM	28/4/21 9:00 AM	28/4/21 9:00 AM	
18	✔	Values Input	0.167 days?	0.5 hours	2.833 days	15.667 days	27/4/21 8:00 AM	27/4/21 8:30 AM	27/4/21 8:30 AM	
19	✔	Difference between desired and actual	0.167 days?	0.5 hours	0 days	12.833 days	28/4/21 9:00 AM	28/4/21 9:30 AM	28/4/21 9:30 AM	17;18
20	✔	Dictionary based solutions	7 days?	21 hours	0 days	12.833 days	28/4/21 9:30 AM	30/4/21 3:30 PM	30/4/21 3:30 PM	19
21	✔	Fertilizer Recommendation Module	0 days?	0 hours	12.833 days	12.833 days	30/4/21 3:30 PM	30/4/21 3:30 PM	30/4/21 3:30 PM	20
22	✔	Pesticide Recommendation	23 days?	69 hours	0 days	0 days	27/4/21 8:00 AM	7/5/21 2:00 PM	7/5/21 2:00 PM	2
23	✔	Data Acquisition	4 days?	12 hours	0 days	0 days	27/4/21 8:00 AM	28/4/21 1:00 PM	28/4/21 1:00 PM	
24	✔	Data Cleaning and Data Augmentation	3 days?	9 hours	0 days	0 days	28/4/21 12:00 PM	29/4/21 2:00 PM	29/4/21 2:00 PM	23
25	✔	DL Model Training	6 days?	24 hours	0 days	0 days	29/4/21 2:00 PM	4/5/21 2:00 PM	4/5/21 2:00 PM	24
26	✔	Pest Detection & corresponding Pesticide recommendation	6 days?	24 hours	0 days	0 days	4/5/21 2:00 PM	7/5/21 2:00 PM	7/5/21 2:00 PM	25
27	✔	Pesticide Recommendation Module	0 days?	0 hours	0 days	0 days	7/5/21 2:00 PM	7/5/21 2:00 PM	7/5/21 2:00 PM	26
28		End to End Deployment	37.333 days?	336 hours	0 days	0 days	7/5/21 2:00 PM	28/5/21 2:00 PM		10;16;22
29		Flask Coding	37.333 days?	112 hours	0 days	0 days	7/5/21 2:00 PM	28/5/21 2:00 PM		
30		Front end design	37.333 days?	112 hours	0 days	0 days	7/5/21 2:00 PM	28/5/21 2:00 PM		
31		Integrating all three modules	37.333 days?	112 hours	0 days	0 days	7/5/21 2:00 PM	28/5/21 2:00 PM		
32		Deployment	37.333 days?	0 hours	0 days	0 days	7/5/21 2:00 PM	28/5/21 2:00 PM		
33		Web Application	0 days?	0 hours	0 days	0 days	28/5/21 2:00 PM	28/5/21 2:00 PM		29;30;31;32

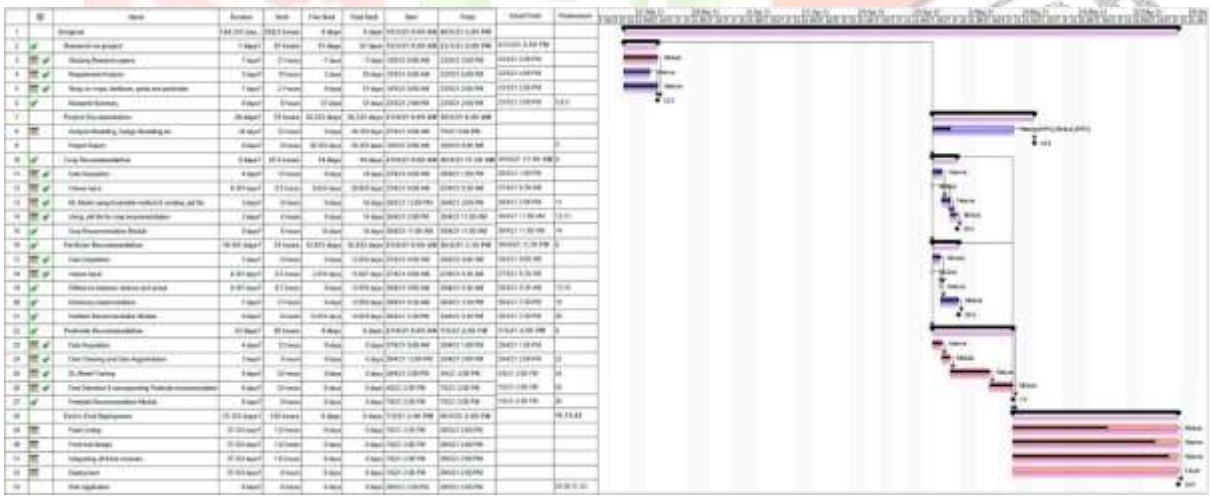

Figure 8: Gantt Chart for Irrigreat

Identification of Tasks and Subtasks

Following are listed the tasks and subtasks for the system "Irrigreat". The Figure for the same (major tasks only) is shown in Figure 9.

1. Research on project
   a. Studying Research Papers
   b. Requirement Analysis
   c. Study on crops, fertilizers, pests, pesticides
2. Project Documentation
   a. Analysis Modelling, Design Modelling etc.

3. Crop Recommendation
    a. Data Acquisition
    b. Values Input
    c. ML model using ensemble method and creating. pkl file
    d. Using .pkl file for crop recommendation
4. Fertilizer Recommendation
    a. Data Acquisition
    b. Values Input
    c. Difference between desired and actual
    d. Dictionary based solution
5. Pesticide Recommendation
    a. Data Acquisition
    b. Data Cleaning and Data Augmentation
    c. DL model training
    d. Pest Identification and corresponding Pesticide Recommendation
6. End to End Deployment
    a. Flask Coding
    b. Front End Design
    c. Integrating all three modules
    d. Deployment

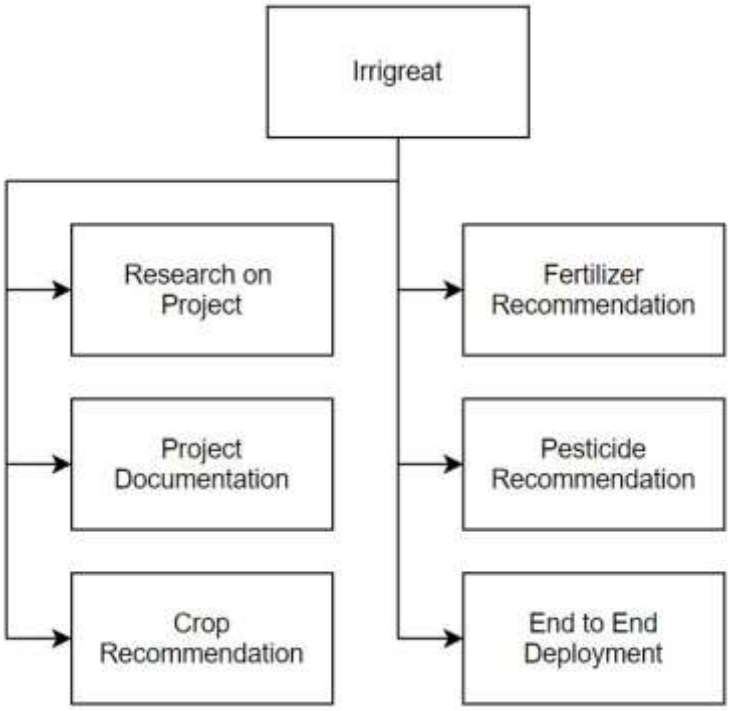

Figure 9: Major Tasks for Irrigreat

3.4 Tools and Technology Used

Following is the list of tools and technology used while making the “Irrigreat”:

1. numpy
    a. working with arrays
2. pandas
    a. working with csv files
3. flask
    a. app routing
    b. web application
4. pickle
    a. saving ML model
5. neural networks (keras, tensorflow, CNN)
    a. for classification and training
6. vscode
    a. python offline coding

7. OS
    a. for manipulating files
8. matplotlib.pyplot
    a. plotting graphs for training and testing accuracy
    b. plotting graphs for training and testing loss
9. h5
    a. storing DL model
10. sklearn
    a. classifiers

IV CONCLUSION AND FUTURE SCOPE

4.1 Conclusion

India's farmers are hard at work. They help to feed a nation whose population is nearly 1.4 billion. However their productivity is threatened by some natural factors that can ruin their crops and their livelihoods.

So, this solution (Irrigreat) will benefit farmers to maximize productivity in agriculture, reduce soil degradation in cultivated fields, and have informed advice on organic fertilizers/ other fertilizers and also know about the right crop by considering various attributes. This would provide a comprehensive prediction and hence benefit both farmers and the environment. Not only this, but pest control would also be a major issue to be solved via this project.

4.2 Environmental/ Economic/ Social Benefits

Irrigreat suggests the crops based on soil characteristics, thereby preventing soil degradation which saves the environment. Natural fertilizers also benefit the environment. Pesticides that are recommended are as per ISO standards. Social benefits include that it will be helping that section of India to feed the nation of 1.4 billion, which means Indian farmers. Economic benefits are abundant because availing services of Irrigreat just requires the user to have an account on the website which is absolutely free.

4.3 Reflections

The whole journey of building "Irrigreat" has been a valuable experience, starting with the discovery of possible opportunities to think of the idea to the phase where the same idea was actually deployed. The team gained insight into the field of software development and now in the future, members shall feel more confident in the process of project development. Furthermore, it was learnt how to analyze the existing frameworks and perform literature surveys and utilize that analysis to identify the problem statement, research gaps and come up with the solution ideas. It was a learning of how to incorporate and take care of the user requirements. It was the time when the importance of documentation was realized and what are techniques involved in being organized about it. One of the takeaways was how to manage the resources in an efficient manner and most importantly to use common sense and build a viable and efficient model, but the best takeaway was development of analytical skills while working in the team and discussing each point of the assigned task in detail. The whole project helped us in exploring the skills as a computer engineer and improved confidence levels, ability to work under pressure and helped in learning project management techniques. It aided the members to be familiarized with the working and delivering of projects and how to build an entire product from just an idea.

4.4 Future Scope

"Irrigreat" is not limited to current usage, it can be extended to many features as discussed below":

1. Irrigreat currently supports 22 crops that are apple, banana, blackgram, chickpea, coconut, coffee, cotton, grapes, jute, kidney beans, lentil, maize, mango, mothbeans, mungbean, muskmelon, orange, papaya, pigeon peas, pomegranate, rice, watermelon. Later on, the admin can add other crops. Moreover in the future, fertilizers can also be added accordingly. The training was done on 10 pests: aphids, armyworm, beetle, bollworm, earthworm, grasshopper, mites, mosquito, sawfly and stem borer and with this pesticides are suggested. In future, training can be done on more pests and more pesticides can also be added according to the pests.
2. In Crop Recommendation, values are manually entered by user of temperature, humidity, rainfall. Admin can also use some weather API to fetch the real time parameters by the city and state.
3. In Pesticide Recommendation, the uploaded image should be clear for correct results, otherwise with a blur image, the system sometimes gives wrong results so, further filters can be used to obtain better results. Also the system can use better DL models.

4. In future pesticide code can be integrated with drone code so that it can take live pictures of pests and by email or by mobile the farmers would be notified about the pest along with the pesticides.