A short statement of the problem and background. Explain why the problem you picked is important or interesting to your team and why you are interested in solving it. (10 points)

Statement of the Problem and Background

Impact of Agricultural Practices on Climate Change

Agriculture is and always has been one of the most important life-sustaining practices for mankind. It has been practiced for centuries and is still one of the primary sources of income and GDP in developing nations. In a country like India, where a majority of the population still resides in rural areas, it has provided livelihoods and incomes to most people here for generations on end.

It had always been an extremely sustainable practice since its advent in society, however, in recent times, owing to the growing population and urbanization, the implementation of modern technology and techniques for better crop yield and faster output have become rampant. Farmers in these countries, despite their lack of education, are often forced to adopt certain practices to make ends meet, unaware of the impact they can have on the quality of crops and the health of the soil.

To make matters worse, in India, the government continually imposes laws on the farmers, putting their lives and livelihoods in jeopardy, causing unrest and mass suicides, and leaving people desperate for measures. Among the lack of awareness and the strenuous situations, with no form of respite in sight, the farmers continue to practice unsustainable forms of agriculture, which leads to more harm.

A few of these practices are as follows.

1. Growing the wrong crops: When crops that are not suited to the local climate or soil conditions are grown, it often requires additional inputs like water, fertilizers, and pesticides to maintain productivity. This can lead to an increased carbon footprint as more energy is required to maintain the conditions these crops need. Wrong crop choices can lead to poor soil management practices. Certain crops, when grown in inappropriate conditions, can deplete the soil's organic matter faster, leading to increased CO_2 emissions.

2. Overgrowing crops on the same soil (Monocropping): Overgrowing the same crops on the same soil year after year, a practice known as monocropping, leads to the depletion of specific nutrients from the soil. This depletion makes the soil less fertile over time, necessitating the use of more chemical fertilizers, which contribute to greenhouse gas emissions, and disrupt the soil structure. As soil quality deteriorates, more intensive farming practices are needed to maintain yields, further exacerbating environmental impacts.

Monocropping also makes crops more susceptible to pests and diseases, leading to increased use of pesticides and herbicides, contaminating water sources and releasing greenhouse gases. The overuse of fertilizers to compensate for nutrient depletion can lead to the leaching of nitrates into water bodies, contributing to water pollution and further greenhouse gas emissions.
Monocropping reduces agricultural biodiversity, which weakens ecosystems' resilience to climate change. With fewer crop varieties, entire fields can be more vulnerable to extreme weather events, pests, or diseases, potentially leading to crop failures that necessitate more drastic measures to sustain production.

3. Excessive Use of Chemical Fertilizers: To restore soil fertility after it has been depleted by overgrowing the same crops, farmers often resort to the excessive use of chemical fertilizers. While these fertilizers can temporarily boost crop yields, they contribute significantly to greenhouse gas emissions.

4. Over-Irrigation and Soil Degradation: To support soil fertility after overgrowing crops, some farmers over-irrigate their fields, which can lead to waterlogging and salinization. They also practice over-tilling or deep plowing, for new crops after overgrowing can lead to soil erosion. These issues degrade the soil and reduce its productivity, making it necessary to use even more water and fertilizers, thus creating a vicious cycle of environmental harm.

These are the different problems leading to climate change in agricultural practices.

A short description of background research and literature reviews that your team did. What have others done in the past to try to solve the problem, what advantages and disadvantages are there to different approaches? List all the references you used. (15 points)

Keeping in mind our aim of bridging the literacy gap between the farmers and the accessible solutions, to deal with the aforementioned problems, we have designed a platform for the ease of farmers to understand better about the types of crops which can be grown on the land based on the nutrient level of the area, to make sure farmers have a better idea about which practices to follow. We have also used it to predict the rainfall levels in the area in the coming years. More details about it will be mentioned in the next point ahead.

Keeping the issues of farmers in mind, there are several start-up ideas which popped up in India. A few of them are as follows:

1. **Cropin:** Founded in 2010, it is an agritech company that provides data-driven solutions to enhance agricultural productivity and sustainability. Founded in

2010, Cropin leverages artificial intelligence (AI), machine learning (ML), and big data analytics to offer a suite of products aimed at digitizing farming practices, improving farm management, and optimizing crop yield. The advantages were improved productivity and yield, introduce climate-smart practices, and empower farmers. However, the main disadvantages in this technology is the initial cost required to digitize farms, which would prohibit small-scale farmers from implementing them, and hence further widen the gap.
(Reference: Cropin | SaaS-based AgTech | Smart Farming App | Agriculture Technology)

2. **Fasal:** Founded in 2018, it is an agritech company that provides farm-level solutions using data-driven insights. It focuses on precision agriculture to help farmers make informed decisions about their crops, leading to improved productivity and sustainability. It does IoT based monitoring on the field with devices installed on the fields, and then further using AI and ML to optimize the problems. Here too the advantages are several but the disadvantage is similar to the previous one, the initial costs borne by the farmers.
(Reference: Fasal - Grow more, grow better)

3. **The Saagu Baagu Project:** It is an initiative in India aimed at transforming traditional agriculture through the use of digital technologies and data-driven solutions. The project primarily focuses on small and marginal farmers, helping them adopt modern farming practices to improve crop yields, reduce costs, and increase their income. Saagu Baagu provides a digital platform that integrates various agricultural services. This includes weather forecasts, crop planning, pest and disease management, soil health monitoring, and market information. The platform uses data analytics and machine learning to offer tailored advice to farmers. This seems like a great solution, and has offered advantages as well, however, the biggest drawback here is, being a government project, the main problem of freedom of the farmers from the control of the government bodies is further deepened instead of being resolved. It is highly possible for these bodies to then inflate the outcomes and exploit the low income farmers for the same.
(Reference: Saagu Baagu 2.0 – Department of Information Technology, Electronics & Communications (telangana.gov.in))

Describe how AI or Quantum methods can be used to help solve your problem. Give a detailed description of the algorithms involved and how they work. Discuss any results that you obtained or that you read in your literature review. Also, comment on the computational resources needed to run your solution. What kind of advantages does AI or quantum provide? (25 points)

There are two algorithms that I have used in my model.
The first part is rainfall prediction of India. Here I have taken one dataset that contains the month wise rainfall of the districts of India. Using this dataset i have trained the model which uses the random forest regressor model. Along with that I have used pandas, numpy and sklearn to get the randomforest regressor, mean square error, and the test_train_splitting(for testing the model prediction with prelabeled values).

For the crop yield prediction, here the deep learning model is picked from tensorflow to create a neural network. The other libraries used here are numpy, pandas optree, sklearn, matplotlib and seaborn. This model is saved in the crop-predict-backend folder. The model is used by the backend flask application to expose an API endpoint that is used by the next frontend application.

If your team has time, work towards developing a small demo app of the method. You can use existing code and data if needed. If the problem is too big to run on the hardware you have access to, that's ok! (+15 points)

The small app that we have developed is using Next.js for the frontend and Flask for the backend. The backend exposes a REST API endpoint that is used by the frontend to get the predicted crop which would best yield for the provided parameters. The Next app uses Tailwind css for the styling.
The instructions to execute the code are.
In the crop-predict-backend can be used run by following the commands:
Pip install requirements.txt
Python app.py

The frontend can be run by going to the folder crop-yield-and-rainfall-predict and following the commands:
Npm install
Npm run dev
If you run the CropYield-predict.ipynb on the Jupyter notebook it will save the new model to the backend folder and then can be used by the application.(not required as i have already generated the model.