# Section 1: Project Plan

## Project Title:

A Machine Learning approach to Optimize Pesticide Usage Without Compromising Yield

## RQ:

1. What machine learning models most effectively predict optimal pesticide levels for maximizing crop yields based on historical data?
2. Are there significant differences in crop yields between countries using an Analysis of Variance (ANOVA)?

## Objectives

1. To identify and compare multiple Machine Learning algorithms like Support Vector Machines, Linear Regression, XGBoost, and Decision Trees to compare their performance in predicting optimal pesticide usage for maximizing crop yields.
2. Evaluating the above-mentioned algorithms using multiple performance metrics such as RMSE (Root Mean Squared Error) and R-Squared.
3. To develop a python pre-processing pipeline to clean and pre-process data to enrich the quality for predictive modelling.
4. To test the trained model on a holdout dataset that mimics the real-world data.

## Background and Summary

In the present age the usage of pesticide is very common in agriculture. But there are many pros and cons in using pesticides on plants and agriculture. While they control a lot of insects and pests thereby increasing productivity, they also pose a risk to environment. Mainly polluting the water and land, also meddling with other species that don’t cause harm to agriculture. To avoid such scenarios ideal usage of pesticide is a major requirement. To address this issue this research can be of great help.

This project aims to tackle the prediction challenge of optimizing pesticide usage such that crop yields are maximized. Present methods are old and don’t take into account multiple factors and can’t handle complex conditions. This is where Machine Learning can be used to use its potential of handling complex patterns (*Machine learning: learn, develop, and evolve from data sets*, 2021) in the data with multiple factors affecting a single variable.

This project will explore many ML algorithms to funnel the best performing and most effective algorithm for predicting the optimal usage of pesticide. This project will also delve into the statistical analysis to understand the variability in crop yields across various factors using a statistical method called ANOVA (Singh, 2018).

## Reference List

Rajkumar, N. and Mukunthan, M. A. (2023) “Efficient crop yield analysis prediction in modern agriculture system using machine learning algorithm,” in *2023 International Conference on Data Science, Agents & Artificial Intelligence (ICDSAAI)*. IEEE, pp. 1–4.

<https://ieeexplore.ieee.org/document/9711853>

Ranjani *et al.* (2021) “Crop yield prediction using machine learning algorithm,” in *2021 4th International Conference on Computing and Communications Technologies (ICCCT)*. IEEE, pp. 611–616.

<https://ieeexplore.ieee.org/document/10452646>

Rashid, M. *et al.* (2021) “A comprehensive review of crop yield prediction using machine learning approaches with special emphasis on palm oil yield prediction,” *IEEE access: practical innovations, open solutions*, 9, pp. 63406–63439. doi: 10.1109/access.2021.3075159.

<https://ieeexplore.ieee.org/document/9410627>

# Section 2: Task List and Time Line

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Task** | | **10-Jun** | **25-Jun** | **10-Jul** | **25-Jul** | **09-Aug** | **24-Aug** | **29-Aug** |
| **Data Collection and Project Plan** | |  |  |  |  |  |  |  |
| **Literature Review** | |  |  |  |  |  |  |  |
| **Model Development** | |  |  |  |  |  |  |  |
| **Model Tuning** | |  |  |  |  |  |  |  |
| **Statistical Analysis** | |  |  |  |  |  |  |  |
| **Comparison and Results** | |  |  |  |  |  |  |  |
| **FPR** |  | |  |  |  |  |  |  |

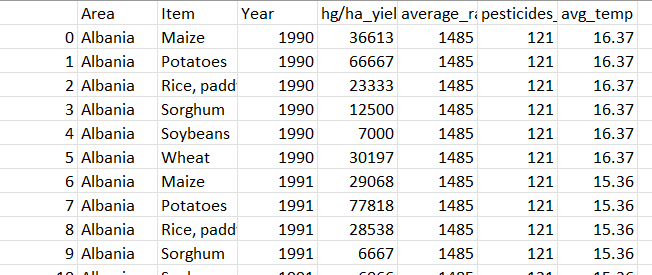
In the above Gantt Chart, all the major modules responsible for the completion of this research report are given along with their expected time limits.

* Data Collection and Project Plan – Collect the required data and curate a project plan to systematically achieve set goals.
* Literature Review – Try to explore other research in the field and fill in the gap that the previous research is missing.
* Model Development – Using python programming language to train multiple machine learning algorithms.
* Model Tuning – After training the models, take the best performing models and tune them further to increase their efficiency.
* Statistical Analysis – Use statistical tests like ANOVA to answer the research questions posed in the above section.
* Comparison and Results – Make sense of the results and create tabular data with performance metrics.
* FPR – Develop a research report encompassing each step in this process with proofs and research results with a critical discussion.

# Section 3: Data Management Plan

## Dataset Overview

The dataset used in this research provides an overview of agricultural yields along with other factors such as pesticide usage, rainfall, and temperature data over the years for multiple countries. The crops this dataset features are rice, potatoes, wheat, soybeans and more. This dataset contains almost 29k records spread across multiple years and countries along with 7 columns that contain geographical, rainfall and other features. Below is the image that shows the sample records in the data.



The data is taken from an open-source dataset website called Kaggle. All the datasets available in this website are free to use for non-commercial and purposes. Hence, ethical approval from any source is not needed.

## Data Collection

Source: <https://www.kaggle.com/datasets/patelris/crop-yield-prediction-dataset?select=yield_df.csv>

## Document control

GitHub Repository:

Data ethics:

1.     Does the data meet GDPR requirements? - Yes

2.     Does the project conform to UH ethical policies? – Yes

3.     Do you have permission to use the data for your proposed research project? - Yes

4.     Are you assured that the data was collected ethical (i.e. by the original people who gathered/collected/ collated/made the data)? - Yes

# References

Singh, G. (2018) *What is Analysis of Variance (ANOVA)?*, *Analytics Vidhya*. Available at: https://www.analyticsvidhya.com/blog/2018/01/anova-analysis-of-variance/ (Accessed: June 12, 2024).

*Machine learning: learn, develop, and evolve from data sets* (2021) *Brunel*. Available at: https://www.brunel.net/en/management-guide/machine-learning (Accessed: June 12, 2024).