

**Farmforce**

**Project Proposal**

**Group Members:**Abrar Saleem (20K-0129)

Arhum

Rohail Shah

**Project Supervisor:**

MS Saeeda Kanwal

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**Abstract:**

The objective of our final project is designing a predictive model of early detection of diseases in the wheat plants and recommending the appropriate course of action. The importance of it lies in its opportunity to make crop management practices reformed, thus increasing the yields and reducing losses caused by diseases. We intend to address early disease detection by using machine learning to analyze different parameters including environment weather, plant health indicators and historical data on disease occurrences. By doing this we hope to understand the traits of the early phase of disease and the patterns through which it spreads so that we can elaborate the model that will diagnose the probability of disease outbreaks and give the proper treatment. The project we are proposing is highly contributive towards increasing sustainability of agriculture and food security by facilitating farmers with the latest insights and practical suggestions to improve crop health.

**Introduction:**

The agricultural sector forms a core component of global food security and serves as a catalyst for food systems resilience globally. Wheat cultivation is just one but a critical element of this sector which has wheat as a staple food to a majority of the world’s population. While the output of wheat crops is subjected to the influence of diseases at all times, which greatly affects the total harvest if not tackled on time.  
Our objective is to address the issue of timely detection and treatment of diseases in wheat plants. The main issue is that there are no perfect and functional methods to find diseases in the initial stages, which caused important losses and consequences for farmers’ economies. Our research question centers on the possibility of adopting machine learning techniques to forecast wheat diseases in early stages and offer suitable treatment plans, so that this will reduce the effects on the crop production.  
Our project is highly crucial and relevant. Due to the projected global population reaching 9 billion by the year 2050, which is expected to cause a considerable rise in the demand for food, including wheat. In this perspective, the wellbeing and productivity of wheat crops become of great importance for the purpose of satisfying the increasing food demand and achieving the goal of food security. Through the development of a model for early disease detection and treatment recommendation, we are targeting at equipping the farmers with necessary tools and insights that will enable them to effectively manage crop health, reduce loses and promote sustainable agricultural practices Thus, the success of our project, besides increasing agricultural productivity, would be an effective driver of farmer’s improved livelihoods and global food security.

**Objectives:**

* Develop a machine learning model that can provide predictions of wheat diseases based on factors such, as environmental conditions, plant health indicators and historical data.
* Implement a recommendation system that can suggest appropriate treatments or interventions based on the specific disease and its severity.
* Evaluate the effectiveness and accuracy of the predictive model and recommendation system through comprehensive testing using real world data.
* Design user friendly interfaces or tools for farmers and agricultural stakeholders to easily access and utilize the predictive model and recommendation system.
* Support farmers by creating resources that offer timely insights and practical recommendations, for proactive disease management leading to improved crop yields and sustainable farming practices.

**Problem Statement:**

The problem of late disease detection and their mismanagement of the wheat crops, especially those in the early stages, is the focus of the problem under consideration. Having reached the peak of innovation in its agricultural practices, the distressing incapacity to sense and treat crop diseases puts the nation at the verge of famine. Our project seeks to address the following research question:   
"What kind of predictive model can be utilized for early detection of wheat diseases and suitable treatments given to be recommended, so as to reduce the impact of wheat diseases on crop productivity?"  
This main issue is worth our attention as it relates directly to agricultural sustainability, food security and economic stability. Wheat is a staple crop adopted worldwide, supplying billions with important nutritional levels. Of course, the common prevalence of diseases such as rusts, blights, and smuts may often result in huge yield losses, causing problems among both the farmers and also the consumer in terms of availability and affordability of food.  
To emphasize the significance of this issue cannot be emphasized more adequately. Timeous diseases diagnosis is useful in that farmers take prompt action to implement suitable interventions such as pesticide, which slows down the spread of the disease and losses are minimized. Through a well-designed predictive model and recommendation system that will advise farmers on treatment, we are geared to equip the farmers with the right tools and insights they need to proactively manage crop health, increase yields, and ensure food security.  
The issue therefore is of special concern to the agricultural and related actors. All the stakeholder in the agricultural industry namely farmers, agronomists, researchers, and policymakers stand to benefit from solutions that improve crop management practices and reduce the risks arising from diseases. In this way, we support the progress of agricultural science and provide the basis of the sustainable practice to ensure they can meet the needs of the current and future populations.

**Literature Review:**

**Methodology**

Our methodology comprises several key steps designed to achieve the objectives of our project effectively:

* **Data Collection:**
* We will collect a diverse range of data from the Sindh Agriculture University, Tandojam, including environmental variables (such as temperature, humidity, and rainfall), plant health indicators (such as leaf color, growth patterns, and presence of lesions), and historical records of wheat diseases.
* The dataset will be carefully curated to ensure relevance and accuracy, covering a representative sample of wheat fields across different regions and seasons.
* **Data Preprocessing:**
* Prior to analysis, we will preprocess the collected data to address any inconsistencies, missing values, or outliers.
* This preprocessing step may involve data cleaning, normalization, and feature engineering to enhance the quality and usability of the dataset.
* **Machine Learning Model Development:**
* We will employ various machine learning algorithms, such as decision trees, random forests, and support vector machines, to develop a predictive model for early detection of wheat diseases.
* The choice of algorithms will be based on their suitability for handling the characteristics of the dataset and their ability to provide accurate predictions.
* **Treatment Recommendation System:**
* In parallel with model development, we will design an algorithm to recommend suitable treatments or interventions based on the identified disease and its severity.
* Treatment recommendations will be tailored to align with local agricultural practices and available resources, ensuring practicality and effectiveness.
* **Model Evaluation:**
* The performance of the predictive model and treatment recommendation system will be evaluated using standard metrics such as accuracy, precision, recall, and F1-score.
* We will conduct rigorous testing and validation using cross-validation techniques and real-world datasets to assess the robustness and generalization capabilities of the models.
* **Software and Tools:**
* We will utilize various software packages and tools for data analysis, model development, and visualization, including Python programming language, libraries such as scikit-learn and TensorFlow for machine learning, and data visualization tools like Matplotlib and Seaborn.

**Justification and Appropriateness:**  
  
**Data Availability:** Sindh Agriculture University, Tandojam has an extensive collection of agricultural data which we can safely rely on for our dataset.  
**Machine Learning Capabilities:** Applying machine learning tools, we can do a well-focused analysis of various patterns and relationships within the data which will result in correct disease prediction and treatment recommendations.  
**Practical Relevance:** The approach is grounded on giving solutions that are implementable for farmers and a user-friendly system that is readily adaptable to current farming practices.  
**Rigorous Evaluation:** We conduct thorough testing and validation to guarantee the reliability and performance of the models we use and therefore, increase their usefulness and credibility in the actual scenarios.  
  
In the end, methodology that selected is a systematic and comprehensive approach to tackle the research problem and to use the available resources at Sindh Agriculture University, Tandojam.

**Picture should be included**

**Expected Outcome:**

• **Development of a Predictive Model:** The anticipated result of our work will be a highly accurate machine learning model that will be able to identify wheat diseases in their early stages through various parameters including the environmental conditions, plant health indicators, and previous data. This model will provide the farmers with a tool to forecast disease incidences and take immediate actions to avert the losses.

• **Treatment Recommendation System:** The goal of our initiative is to develop an algorithm that would recommend suitable treatments/interventions, depending on the nature of the diagnosed disease and its severity. Through the implementation of practical suggestions, farmers will be able to control the crop health and decrease the damage of diseases on produce and quality.

• **Enhanced Crop Management Practices:** We are expecting noticeable enhancements in agronomy practices via our predictive model and treatment recommendations system deployment. Farmers will receive timely information and order to assist in disease management therefore production will be enhanced, losses reduced, and farm profitability improved.

• **Contribution to Agricultural Science:** Machine learning methods are our contribution to the advancement of the field of agricultural science, by tackling crop health management with a critical issue. We help to close the knowledge gaps by combining data-based approaches and traditional agricultural practices. This also provides creative solutions to increase crop resilience and sustainability.

• **Empowerment of Stakeholders:** The outcomes from our project enable farmers, agronomists, and agricultural professionals with the capabilities and information needed for decision making about disease management. Through the facilitation of collaboration and knowledge transfer, we achieve a robust culture of resilience and creativity within the agricultural community.

**Scope:**

The main aim of our project is early identification of diseases in wheat plants and offering prescriptions by using the predictive modeling techniques. undefined

* **Data Collection and Analysis:** Data collection from relevant sources such as environmental factors, plant health indicators, and historical disease occurrence for model training and validation purposes.
* **Model Development:** Designing and developing machine learning algorithms to train a model capable of diagnosing wheat in its early stages of disease.
* **Treatment Recommendation:** Designing the algorithm that make treatment or intervention recommendation depending on the disease and its level of severity.
* **Evaluation:** Reliability of the predictive model and recommendation system should be tested and validated using real world dataset through rigorous testing.
* **User Interface:** It is necessary to make it user-friendly, an interface or tool for farmers and other stakeholders to be able to access and use the predictive model and recommendation system.

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**Limitations:**

* Disease Coverage: Our project concentrates on a limited number of common wheat diseases. The project is centered on these diseases and hence it may not cover all potential wheat diseases that can affect wheat crops.
* Data Availability: The good of model prediction and recommendation system depends on the existence and quality of relevant data. Biased or insufficient data might affect the precision of forecasts and tips.
* Environmental Factors: Although our design considers environment factors, it may not include all the elements which could influence the disease development such as localized microclimates or soil conditions.
* Treatment Recommendations: The directions of our system are based on the existing data and might not harmonize with farm's conditions or local practices sometimes. Farmers need to show good judgement and adequately consult with agricultural experts bearing in mind treatment recommendations.
* Implementation Constraints: We expect the deployment and adoption of our system to come with practical challenges, e.g. limitations/constraints on the infrastructure, technology, and user acceptance barriers.

**Project Key Milestones:**

|  |  |  |
| --- | --- | --- |
|  | **Milestone** | **Deliverable** |
| Month 1 |  |  |
| Month 2 |  |  |
| Month 3 |  |  |
| Month 4 |  |  |
| Month 5 |  |  |
| Month 6 |  |  |
| Month 7 |  |  |
| Month 8 |  |  |

Grant Chart should be there?

**Core Technology:**

The core technology for this project is machine learning which is implemented in Python as the programming language. In addition, Python boasts of a rich ecosystem of libraries and tools designed with the machine learning in mind. This means that Python is the most preferable programming language in building the predictive models and also recommendation systems. Some key libraries we will utilize include: Some key libraries we will utilize include:  
• **Scikit-learn:** An advanced machine learning library offering many easy to use implementations of many algorithms that are suitable for data classification, regression, clustering, and also dimensionality reduction. It provides simple user interfaces for training and also evaluation the models, and making the predictions.  
• **TensorFlow:** Google-developed an open machine learning framework for the construction and training of the deep neural networks. TensorFlow has the flexibility and the scalability in developing the complex models, especially in the tasks that include large-scale data and deep learning architectures.  
• **Pandas:** A flexible data manipulation and analysis library that offers data storage, as well as the processing tools for the structured data. Pandas simplifies the functions like data scrubbing, preprocessing, and also feature engineering which are very critical to transform the data sets before they are used for machine learning exercises.  
• **Matplotlib and Seaborn:** Libraries for the exploitation that help to construct intelligent plots and also visualization for exploring data patterns, model performance, and also insights. They often play the role of making the sense from the research to communicating effectively

Through the integration of Python and its libraries, we can utilize the capabilities of the machine learning for the development of reliable predictive models for early diagnosis of wheat diseases and also propose treatment intervention solutions. Thus, this core technology gives us the ability to find the answer to our research question appropriately, positively impact the progress of the agricultural science, and also provide farmers with useful guidelines on how to improve the crop management practices.

**Resources Required:**

* **Data Sources:**
* Access to agricultural data from Sindh Agriculture University, Tandojam, including environmental variables, plant health indicators, and historical records of wheat diseases.
* **Hardware:**
* Desktop Computer: High-performance computer for data analysis, model training, and development.
* GPU (Graphics Processing Unit): Graphics card for accelerating computation tasks, particularly for deep learning models.
* External Hard Drive: Storage for datasets, model checkpoints, and other project-related files.
* **Software:**
* Python: Programming language for machine learning model development and data analysis.
* TensorFlow: Machine learning framework for building and training deep neural networks.
* Scikit-learn: Machine learning library for implementing traditional machine learning algorithms.
* Pandas: Data manipulation and analysis library for preprocessing and handling structured data.
* Matplotlib and Seaborn: Visualization libraries for creating plots and visualizations.
* Jupyter Notebook: Interactive computing environment for developing and testing code.
* **Internet Connectivity:**
* Reliable internet connection for accessing online resources, downloading datasets, and collaboration.
* **Miscellaneous:**
* Cables, Power Backup: Various cables and power backup solutions to ensure uninterrupted operation of equipment.
* Office Supplies: Stationery, notebooks, and other office supplies for documentation and project management.
* Special Facilities or Access Requirements:
* Access to the agricultural research facilities and databases at Sindh Agriculture University, Tandojam, for collecting relevant data.
* Collaboration with agricultural experts and researchers for domain-specific knowledge and guidance.
* Access to cloud computing platforms or high-performance computing clusters for large-scale data processing and model training, if required.

**Project Equipment Details:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Item (Name)** | **Type** | **No.of.Cost** | **Per-Unit Cost** | **Total (in RS)** |
| Computer | Hardware | 1 | 60,000 | 60,000 |
| GPU | Hardware | 1 | 80,000 | 80,000 |
| Internet Connectivity | Service | 1 | 1500 | 1500 |
| Cables, Power, Backup | Miscellaneous | N/A | 10,000 | 10,000 |
|  |  |  | Total | 151,500 |

**References:**