Synergetic Innovation in Gherkin Cultivation

Project Proposal Report

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DECLARATION

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
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The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor: Date

ABSTRACT

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Abbreviation	Description
API	Application program interfaces
IoT	Internet of Things

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1 INTRODUCTION

1.1. Background and literature survey

The importance of fertilizer maintenance in gherkin cultivation cannot be overstated. Fertilizers play a crucial role in ensuring the healthy growth and yield of the crop.

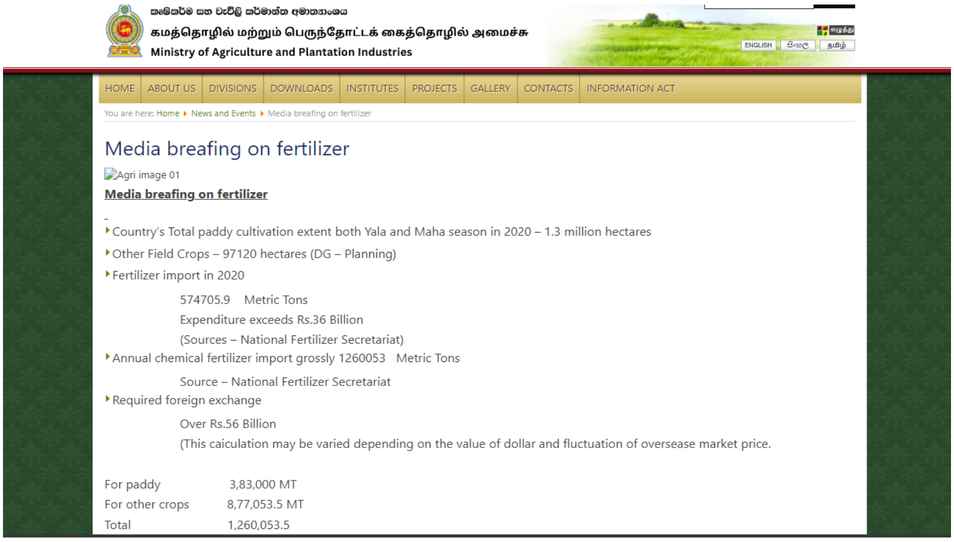

Figure 1.1Meadia briefing of Ministry of Agriculture and Plantation Industries

Nevertheless, unwise handling or over-fertilization may cause serious problem and raising the production costs. In conclusion, proper management of fertilizers is a must, not only to enhance the sustainability and profitability of such practices but also to guarantee a better future for generations to come.

Historically, the agriculture in Sri Lanka including the gherkin farming used to be based predominantly on the human skills and know-how, especially when chemical fertilizers used to be the unknown and vague technique for the people [1]. The measurement of fertilizer in the soil was not done before applying it to the crop. This is a situation that results in either there being more fertilizer in stock each season, or there being an inadequate amount of fertilizer [1]. The inaccuracy of measuring instruments and the sheer chance of setting fail techniques lead to waste of resources and low yield of output production [2].

Moreover, the variable that would be required would constantly depend on different climate situation. Nevertheless, what is however not to be overlooked is that the inability of farmers to forecast weather patterns through the lack of advanced technology and deep understanding has made farmers unable to withstand sudden changes [3]. On the other hand, it is possible that large amounts of fertilizer may be applied to crops or the lack of them, worsening the existing problem of inefficient resource use [3].

In spite of the challenges associated with the gherkin crop, it has nonetheless played a dominant role in Sri Lanka's agricultural sector, constituting the country's export of pickle-type gherkins [1]. The production of this industry is well known to many ecological areas, from the dry-land low country to the intermediate mid-country zone [1]. Calypso also has a specific agro-ecological zone where commercial growers are able to cultivate, and most times they use the variety, Calypso, only [1].

On the other hand, the same pattern of gherkin farming in Sri Lanka has been undergoing a dramatic turn. Along with new and modern agricultural techniques and technologies, it is now possible for farmers to precisely determine the proportion of fertilizers in the crop before applying them. The yield efficiency has thus been enhanced and consequently the production of food crops has increased. Technological progress in weather forecasting has enabled farmers to play safe for variations in weather conditions, which has resulted in more uniform and steady crop yields.

Moreover to these ameliorations in the farming methods, the exporting business of gherkins in Sri Lanka has also made impressive expansion. Several businesses make and export the product, using it as a source of income for the country. The country's well-favorable growing conditions and the high-increasing international demand for gherkins have made gherkin cultivation and export a profitable industry for the country.

In the view of the research topic, our primary goal is to integrate the automated farming technology with the traditional methods of farming. The project is focused on the 'IoT device' development for measuring the fertilizer percentage of the soil and the development of a mobile application that employs Machine learning algorithms for Fertilizer Stock Prediction, Optimization, and Maintenance.

The initial stage of this process goes through the manufacture of the IoT gadget. The machine equipped with a sensor to track the fertilizer percentage of a farm soil in a particular farm will be our first device. The next phase is to foretell the weather by means of the weather API. These tuned inputs, soil's fertilizer percentage and weather prediction, shall be used to run a machine learning algorithm that will subsequently provide a fertilizer stock for a particular season and a specific farm. The choice of algorithm shall be based on the efficiency of the model whether SGD classifications, lasso regression, or random forest will be used.

This prediction will help in determination of the exact quantity and type of fertilizers needed. Lastly, the overall fertilizer cost will be determined by the type of fertilizer, amount per plant, number of plants and the percentage of seed plantation.

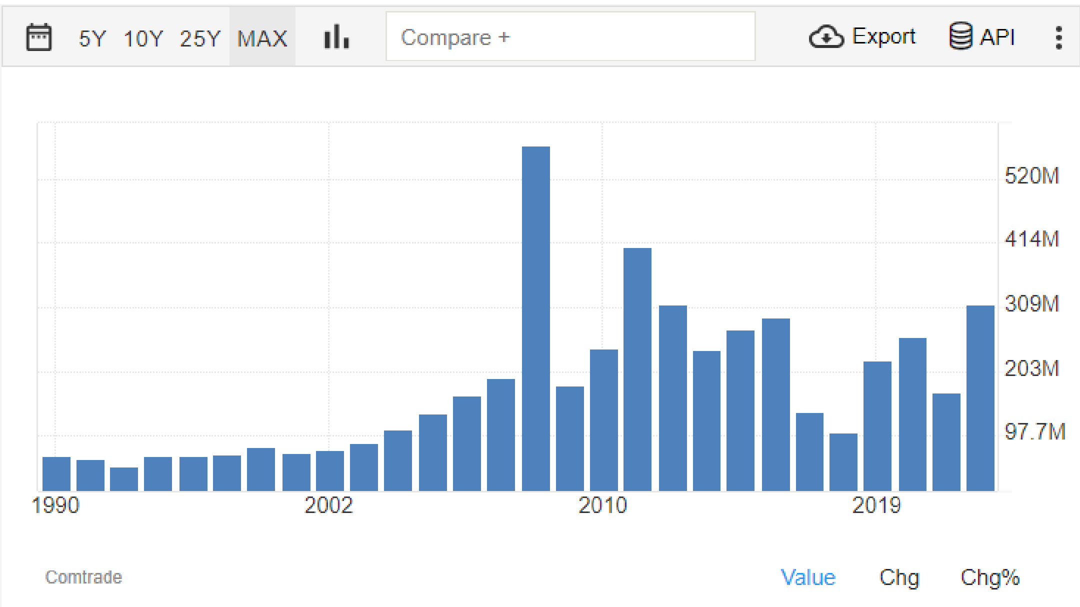

Figure 1.2 Chart of Importing Fertilizer to Sri Lanka 1990 - 2022

The literature for this project sheds light on the methodologies and technological aspects of similar project. For example, a research paper discussed with a hybrid machine learning system[4] that does crop yield prediction and fertilizer recommendation. It will give a clue to choosing the right algorithms for the project.

Alternative thesis focus on the model of [2]machine learning for forecasting of the crop yield. The materials and conclusions of this article are undoubtedly helpful in building the prediction model.

Another example is made that the case study of the dynamic demand in fertilizer stock is a situation of. It could exclusively bring to attention how to respond to the task on the changing conditions and the other one introduces [4]a smart system for crops and fertilizer prediction.

Another thesis highlights the application of [1]regression and deep learning algorithms in the domain of crop fertilizer prediction. These techniques employed in this project may be an avenue for conducting stock prediction for the fertilizer component.

The integration of IoT and Machine Learning in agriculture is actually a great deal in modern agriculture. Through accurate forecasting and smart fertilizer usage, the efficiency and sustainability of the gherkin farming are improved.

However, Sri Lanka’s conventional method of growing gherkins experienced numerous difficulties, but the initiation of modern agricultural innovations and technologies resulted in numerous upgrades. Such development, coupled with the increasing worldwide demand for gherkins, makes Sri Lanka a notable actor in the global gherkin trade.

1.2. Research Gap

In order to verify the research gap, I selected three as key thesis of my research component which had some similar research areas and functionalities.

Application reference	Research 01	Research 02	Research 03	Proposed System
Getting real-time inputs by a soil meter.	No	No	No	Yes
Recommending fertilizer types.	Yes	Yes	Yes	Yes
Predicting the fertilizer according to the weather forecast.	No	No	Yes	Yes
Optimize the fertilizer amounts	No	Yes	No	Yes
Predict the fertilizer stock for the season for a specific plantation.	No	No	No	Yes

Table 1.1 : Comparison with existing researches

The advent of machine learning and deep learning has revolutionized numerous fields, including agronomy. Several studies have been conducted to leverage these technologies for crop yield prediction and fertilizer recommendation. However, a careful analysis of the existing literature reveals some gaps that need to be addressed.

The research paper 01 is about predicting fertilizers using machine learning algorithms [1]. The proposed system trying to predict fertilizers using a different machine learning algorithm to increase the accuracy of the model.

Research paper 02 was done a crop yield prediction and [2]fertilizer recommendation system using hybrid machine learning algorithms. While it recommended fertilizer types and optimized fertilizer amounts, it did not incorporate real-time soil data, weather forecasts, or seasonal fertilizer stock predictions.

Research paper 03 employed deep learning for agronomic forecasting. It recommended fertilizer types and predicted fertilizer needs based on weather forecasts [5]. However, it did not use real-time soil data, optimize fertilizer amounts, or predict seasonal fertilizer stock.

An analysis of these studies suggests that more research is needed in the following areas: real-time soil data, weather-based fertilizer prediction, seasonal fertilizer stock forecast, and fertilizer optimization.

The weather, crop development, agricultural techniques, and other events can all have an impact on the dynamic properties of soil throughout time. The phrase "real-time soil data" refers to the continuous, instantaneous collection of data regarding the pH, moisture content, and nutrient content of the soil using sensors. These data allow for far more accurate crop output estimates and fertilizer recommendations by providing a timely and accurate understanding of the current state of the soil. However, none of the studies you mentioned incorporated real-time soil data in their models.

The weather has a big influence on crop growth and fertilizer requirements. Rainfall, for example, has the potential to remove nutrients from the soil, while temperature and sunlight have an impact on how quickly crops absorb nutrients. Thus, estimating fertilizer requirements from weather forecasts can aid in making sure crops get the nutrients they require at the appropriate time. Only Paper 3's fertilizer prediction model included weather forecasts out of all the research you cited.

This is the process of figuring out how much of each form of fertilizer is best applied in order to optimize crop yield while lowering costs and having the least negative effects on the environment. While under fertilization can result in nutrient deficits that impair crop health and productivity, over fertilization can cause nutrient runoff that contaminates water bodies.

This entails projecting how much of each type of fertilizer will be required overall for a given planting season. With the aid of these forecasts, farmers may better organize their stock purchases and storage, guaranteeing they have enough for the season and avoiding the expense and trouble of last-minute purchases or the waste of extra stock. Nevertheless, seasonal fertilizer stock was not anticipated by any of the research you mentioned.

By combining real-time soil data, forecasting fertilizer demands based on weather, optimizing fertilizer levels, and projecting the seasonal fertilizer stock for a particular plantation, the suggested method seeks to close these gaps. The suggested system can greatly improve crop production forecast and fertilizer recommendation systems' efficacy and efficiency by filling in these gaps.

There are still holes that need to be filled, even if previous research have made great progress in using machine learning and deep learning for agronomic forecasting and fertilizer recommendation. The goal of the suggested system is to close these gaps and advance the state of the art in this subject. By filling in these gaps, the suggested method may be able to provide farmers with suggestions for fertilizer and crop yields that are more precise and effective, maximizing both production and sustainability.

1.3. Research Problem

In contrast to the numerous technological advances in farming that are present, gherkin cultivation in Sri Lanka is rooted n historical customs which is primarily based on the knowledge and instinct of farmers. Plentiful difficulties crop up in the passage of time such as the problem of managing fertilizers although it stands out as a very vital influence on crops for yielding reasons and overall agricultural sustainability. Under the traditional approach, without the service of specific meters and the use of intuition for the cases of fertilizer application, there are ineffective utilization of resources and the output doesn’t satisfy the expectations. This problem is also compounded by weather conditions that are dynamic in nature and this means, that my fertilizer stock can be affected by sudden changes which demand abrupt alterations. On top of that, the effect of the fertilizer application changes leads to fertilizer resource wastage as well as frustrating the crops' optimal productivity. Besides, the high prices of fertilizers are super challenging for farmers which also make a revolution in the agricultural production methods from more accurate, cost-effective and sustainable ones necessary.

Thus, these hurdles lead to several sub-problems that actually announce in a holistic research scheme. The small sub-problems arise besides the complexity of the entire fertilizer management. This also provides the inventive solutions which are aligned with the broader aim of farming sustainability.

This research aims to address focusing five sub problems;

- How to maintain the stock according to the requirements.
- How to predict the fertilizer stock according to the future weather forecast.
- How to reduce the cost by avoiding excess or deficiency.
- How to optimize the applied amounts of fertilizer for the plantation
- How to give a farmer friendly real-time solution using machine learning techniques

The first problem is about the smart fertilizer regime in accordance with the special requirements of growing-indoor climatic conditions. Conventional application process very often overfeeds or underfeeds thus wasting and overall poor yields. To deal with this issue, an elaborate and precise system that apportions just the appropriate stock to the crop should be developed. This system will optimize the use of resources and consequently lead to improved productivity.

Precisely this role by weather factor in the fertilizer requirement of crops. The second sub-issue looks for the way-out technologies that allow weather prediction for the coming weather events. Through integrating the weather condition forecast into the fertilizer management system, farmers can be in a position to anticipate any changes which come up that may affect their plan on purchase of fertilizers. Consequently, a proactive mode of resource optimization; not only achieve efficient usage but also strengthens the adaptability of gherkins to sudden weather change.

The highly expensive fertilizer represents an obvious problem that the farmers are facing. On the other hand, the third sub-theme of the problem establishes cost-reducing techniques to prevent excessive and deficient application of fertilizers. The proper balance of fertilizer input ensures the optimum crop balance with the minimum requirement of unnecessary expenditure, which in turn enhances the economic sustainability of gherkin cultivation.

Fertilizer is placed at the head of the next sub-problem, which is about optimizing fertilizer applied to the field. This means an approach that is flexible enough to take into account all these elements as for example soil condition, crop type, and weather forecasts. The target is to apply the fertilizers in accordance to the different conditions, in a way that will not only enhance the efficiency of use in resources availability but also lead to the preservation of environmental health.

Another component of the problem involves the application of modern technologies, and it is machine learning that are going to provide real-time solutions for farmers.

An attempt is being made to build a human interface that is simple and powerful by using machine learning algorithms to develop a working system of fertilizer management. The interface offers accurate, timely, and easily understandable insights to the farmers. This kind of thinking encourages farmers and technologies to interact in a smooth way in order to guarantee that agri-innovation benefits are available in technology and are applicable to the field of agriculture.

In conclusion, this comprehensive discussion of research problems is an indication of the multiplex situation of fertilizer usage in gherkin production. It also hopes to not only save on energy input and costs but also to create a cleaner and technologically more robust agricultural landscape via this approach. Subsequent to this introduction, the subsequent sections will expound relevant methodologies, models, and outcomes related to each sub-crisis in a manner that will enrich the broader narrative on synergetic innovation in gherkin cultivation.

2 OBJECTIVES

2.1 Main Objective

The main objective of this is the introduction of a universal scheme, which includes assigning the fertilizer stocks, prediction, and optimization for the gherkin production. Synergy of these vital components will aim at simplifying agricultural processes, thereby improving the efficiency of resource usage as well as yield.

2.2 Specific Objectives

Following sub objectives should be achieved in order to achieve the main objective.

1. Recommending the suitable fertilizers to the soil
2. Predicting the crop-yield fertilizer stock
3. Predicting the fertilizers according to weather forecast
4. Design and implement alternative suggestion algorithms
5. Create a farmer-friendly application with user friendly interfaces

3 METHODOLOGY

In the proposed system, fertilizer prediction, recommendation and optimization component has two subcomponents.

1. IOT based soil nutrient monitoring
2. Fertilizer stock prediction

IOT based soil nutrient monitoring

The creation of an IoT device is a catalyst for an agricultural revolution in which data-and-information focused farm system is created in the pursuit of accurate and precise gherkin growth. The apparatus that is fabricated for calculating the important fertilizer rate in the soil contains the needle-nose sensors to capture all chemical and physical processes. Capacitive Soil Moisture Sensor provides for the real-time tracking of the soil moisture level within which the level of moisture plays a key role in the growth of the crop. In order to take an accurate measure of the soil temperature, the device is armed with the waterproof DS18B20 Temperature Sensor; this enables the farmers to understand the thermal conditions of their farming environment. The Soil NPK sensor has also been incorporated onto the system as a part of which nitrogen, phosphorous, and potassium levels in the soil that are main influencers of the crop yield are measured. With such an adding up of sensors farmers not only obtain actual, useable and real-time information, but also establish the operating basis for the system of intelligent fertilizer recommendation and optimization, that makes a part of the system of comprehensive innovation in the cultivation of gherkins.

Fertilizer stock prediction

The fusion of the data from the IoT device and the future weather forecasts via the Weather API will always be the foundation for the estimation and optimization of stock fertilizer for gherkins cultivation. This system utilizes machine learning algorithms to process the data which the IoT machine collects providing soil moisture, temperature, and soil NPK values. The incorporation of real-time weather broadcasts strengthens forecasting baseline, permits for advance act in view of the forthcoming climatic aspect. This machine learning algorithm is modulated to suit the specific conditions of a particular farm for the given season, which in turn increases accuracy of fertilizer stock prediction. After that, the system produces an overall fertilizer inventory for each kind of fertilizer similar to what has been produced before and later supplies farmers with useful information on the amounts and kinds of fertilizers they need for next season. In addition to this, this worldview will lower the cost of production and the management of the resources, thereby promoting sustainable and cost-effective farming in pickles.

3.1 System Architecture

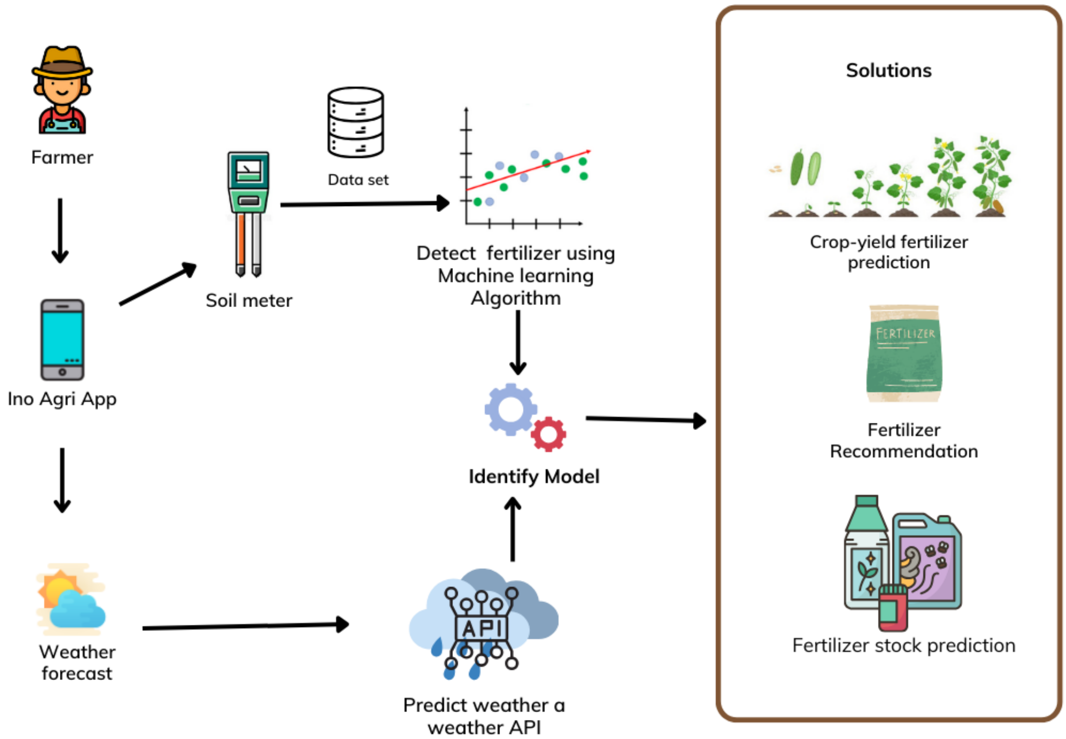

Figure 3.1 High level system diagram

3.2 Software Solution

Functional requirements

User Requirements

Non-functional requirements

- Performance
  - System should be able generate expected outcomes within minimal amount of time
- Usability
  - Core functionalities of the system should be easy to learn
  - Improved user experience
- Reliability

3.3 Work Breakdown Structure

Figure 3.2 : Work break down structure

3.4 Gantt Chart

Figure 3.3 : Research timeline

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5 APPENDICES