SUSTAINABLE PRECISION AGRICULTURE - AUTOMATED BLENDING OF MACRO-MICRO NUTRIENTS

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DECLARATION

I declare that this project report entitled “Sustainable Precision Agriculture - Automated Blending of Macro-Micro Nutrients” is the result of my own work except as cited in the references

Signature : ....

Name : NORLINA MOHAMAD NORANI

Date : 20 Jun 2021

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Maintenance)

Signature : ....

Supervisor's Name : NURUL HANIM RAZAK

Date : 19 Jun 2021

DEDICATION

In the name of God, Most Gracious, Most Merciful.

To my late beloved mother, father, and me.

ABSTRACT

Malaysian creation of vegetables, blossoms, and flavours in nurseries has been encountering sped-up development. The more significant part of the nurseries is permitting programmed control of water, composts, and environment frameworks. The immediate conveyance of composts through the dribble water system requests the utilization of solvent manures and siphoning and infusion frameworks to bring the composts straightforwardly into the water system framework. Fertigation permits a precise and uniform use of supplements to the wet region, where the dynamic roots are concentrated. Along these lines, it is feasible to give sufficient supplement amount and fixation to their interest through the developing period of the crop. The supplement inclusion incorporates macronutrients like nitrogen (N), phosphorous (P), potassium (K), sulphur (S), magnesium (Mg), and calcium (Ca). In traditional manual strategy, mechanical buoy and versatile electrical conductivity meter (EC) are utilized to fill water into the blending repository at the required sum and physically check the supplement arrangement fixation separately. Be that as it may, this will need the rancher to do the supplement arrangement focus check and blending each time the arrangement is to be siphoned to the yields. This paper proposes a method to improve and optimize the efficiency of the system for fertigation. An automated blending of macro-micro nutrients system was designed where the hardware includes in this project a programmable logic controller (PLC), a touch system, pH sensor, soil moisture, actuators, and other mechanical equipment to control and manage the supply of water and nutrients based on the fertilizer requirement at tomato's development stages. Also, analysis and develop the schematic diagram by Visio software for the automated blending system where it represents the components of a process, device, or other object using abstract, often standardized symbols and lines. Plus, with the presence of the system, it can settle down the eutrophication problem, reduce fertilizer consumption, optimise the fertilizer used, and reduce the overburden of the farmers. The system only consists of electronic pumps for blending and a programmable logic controller (PLC) board. The controller will monitor and detector the EC level and run the blending process when the EC level achieves the required level.

ABSTRAK

Sejak kebelakangan ini, penciptaan sayur-sayuran, bunga dan rasa di Malaysia di taman telah berkembang pesat. Sebilangan besar taman membenarkan kawalan air, kompos dan kerangka persekitaran yang diprogramkan. Penyampaian kompos dengan segera melalui sistem air deras meminta penggunaan baja pelarut dan kerangka siphoning dan infusi untuk membawa kompos secara langsung ke dalam kerangka sistem air. Fertigasi membenarkan penggunaan makanan tambahan yang tepat dan seragam ke kawasan basah, di mana akar dinamik tertumpu. Sejajar dengan ini, adalah mungkin untuk memberikan jumlah suplemen dan fiksasi yang mencukupi untuk kepentingan mereka melalui tempoh tanaman yang berkembang. Penyertaan baja ini mengandungi makronutrien seperti nitrogen (N), fosfor (P), kalium (K), sulfur (S) , magnesium (Mg) dan kalsium (Ca). Dalam strategi tradisional manual, pelampung mekanikal dan meter EC serbaguna digunakan untuk mengisi air ke dalam repositori pencampuran pada jumlah yang diperlukan dan secara fizikal memeriksa fiksasi susunan tambahan secara berasingan. Walau apa pun yang berlaku, ini memerlukan penanam untuk melakukan pemeriksaan fokus penyusunan makanan tambahan dan penggabungan setiap kali pengaturan itu akan disedari kepada hasil. Maka, dengan mencadangkan kaedah untuk meningkatkan dan mengoptimumkan kecekapan sistem untuk fertigasi, pencampuran sistem nutrien makro-mikro automatik te;ah dirancang di mana perkakasan memasukkan dalam projek ini pengawal logik yang dapat diprogram (PLC), sistem sentuhan, sensor pH, kelembapan tanah, penggerak, dan peralatan mekanikal lain untuk mengawal dan menguruskan bekalan air dan nutrien berdasarkan keperluan baja pada peringkat pengembangan tomato. Juga, dengan analisis dan mengembangkan rajah skematik oleh perisian Visio untuk sistem pencampuran automatik di mana ia mewakili komponen proses, peranti, atau objek lain menggunakan simbol dan garis abstrak, yang sering diseragamkan.Selain itu, dengan adanya sistem ini, ini dapat menyelesaikan masalah eutrofikasi, mengurangi penggunaan baja, mengoptimumkan baja yang digunakan, dan mengurangi beban petani yang berlebihan. Sistem ini hanya terdiri daripada pam elektronik untuk pengadunan dan papan pengawal logik (PLC) yang dapat diprogramkan. Pengawal akan memantau dan mengesan tahap EC dan menjalankan proses pengadunan ketika tahap EC mencapai tahap yang diperlukan.

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PLC	Programming Logic Controller
EC	Electrical Conductivity
V	Volt
AC	Alternating Current
N	Nitrogen
P	Phosphorus
K	Potassium

CHAPTER 1

INTRODUCTION

This chapter consists of the project background, the problem statement, the objectives, the project's scope, the significance of the project, and an overview of the automated blending of macro-micro nutrients for sustainable precision agriculture.

1.1 Background

Nowadays, the agricultural sector is becoming more challenging. Water and nutrients are two necessary agricultural inputs for higher crop productivity to generate high farm incomes (Abd Rahman et. al., 2018). Nanotechnology has been used in many research fields, such as physics, chemistry, pharmaceutical science, medicine, agricultural science, and material science (Duhan et al., 2017). The art and science of using advanced technology to boost crop production can be described as precision agriculture (Srbinovska et. al., 2015).

Plants are multicellular organisms in the kingdom Plantae that use photosynthesis to make their food. There are more than 300,000 plants; essential instances of plants incorporate grasses, trees, and bushes. Plants have a significant part of the planet's environment. They produce a more significant part of the world's oxygen and are substantial in the natural way of life; the same number of life forms eat plants or eat living beings that eat plants. There are five things or elements to grow: sunlight, proper temperature, moisture, air, and nutrients.

Generally, agriculture is a science, study, and practice framing in the agriculture sector, including growing the soil for crop production and providing food supply, wood, and others. According to (Federal Government Administrative Centre, 2017), agribusiness was the critical improvement in the ascent of stationary human progress. Cultivating tamed species made food excesses that empowered individuals to live in urban communities. In crop production, fertigation is one of the systems or methods to sustain the plant with water and nutrients effectively. This can be advantageous for crop production in the growth stages. This project proposed studying how to sustain plants with water efficiently by controlling the prepared nutrient solution concentration and water resources.

Fertigation is one of the systems or methods to sustain the plant with water and nutrients solutions effectively. In plant production, the soil is a major source of nutrients needed for plant growth. There are three primary nutrients, including nitrogen (N), phosphorus (P), and potassium (K). Together they make up the triplet known as NPK (Rivera et. al., 2020). To ensure crop production continuously gets the water and mixed nutrient solution, some devices are used, such as automated blending systems for the mixing process electrical conductivity (EC) meter and programmable logic controller (PLC) controller.

1.2 Problem Statements

In the modern world, the agricultural sector is more challenge due to the increased population of humans (Figure 1.1). The study by Doering and Sorensen (2018) also found that farming in the 21st century faces numerous difficulties: it needs to create more food and fiber to take care of a developing populace with a more modest rustic workforce, more feedstocks for a conceivably gigantic bioenergy market, add to by and large advancement in the numerous farming ward non-industrial nations, receive more effective and maintainable creation techniques and adjust to environmental change. There are two main elements important for farmers to increase crop productivity in the agriculture sector: nutrients and water to increase earnings.

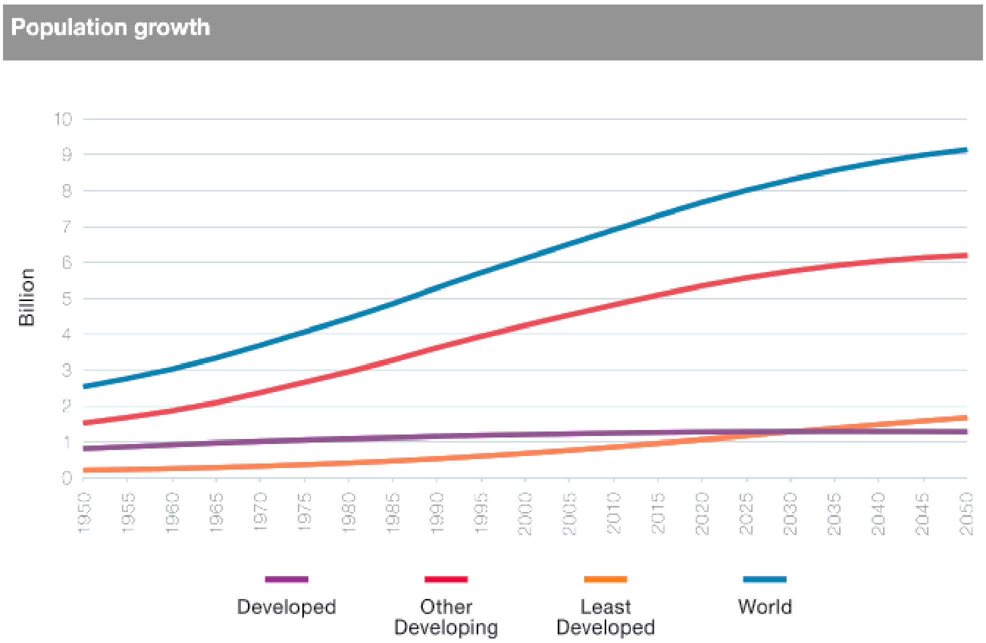


Figure 1.1: Population of world growth found by Doering and Sorensen (2018)

For conventional fertigation (Figure 1.2), farmers need to examine the nutrient solution concentration and mixing every time manually. It also lacks security and requires constant monitoring of plant growth. Unbalanced nutrients solutions to the crop will also increase waste when the plant water demand was small (José et al., 2014). Inefficient management of the crop will increase and lead to losses and unprofitable crop production in terms of money and time. Furthermore, the fertilizer formulation can be different in this traditional method due to unknown knowledge of the nutrient plant required, leading to the excess of nutrients to the plant. This excessive nutrient will cause a high impact to the environment pollution and danger to the aquatic life organism.

Figure 1.2: Traditional method by (Kanal Bali, 2019)

1.3 Objectives

The aim is to keep the project on the right track and well established. As mentioned below, the key objectives of this project are:

a) To investigate the working principle of automated blending system for Solanum Lycopersicum.

b) To prepare the automated blending system for Solanum Lycopersicum consisting of upstream, blending, and downstream parts.

c) To analyse and evaluate the performance of an automated blending system on plant growth for Solanum Lycopersicum.

1.4 Scopes of Project

This project covers developing an automated blending of macro-micro nutrients that will keep an eye on and monitor the crop by an EC sensor and programmable logic controller (PLC).

Table 1.1: Summary of research objectives and their scopes

Obj. No.	Research Objectives	Research Scopes
1	To study the working principle of automated blending system for Solanum Lycopersicum.	The system utilizes an EC meter to measure the dissolved nutrients for the plant in the blending tank. The framework comprises electronic siphons for blending measure and a programmable logic controller (PLC) board as the controller. The PLC receives the EC measurement of the dissolved nutrients solution and gives the signal to the flow valves of tank A, tank B, and water tank to fully closed or fully open.
2	To construct the automated blending system for Solanum Lycopersicum consisting of upstream, blending, and downstream parts.	Build up and setting the automated blending system by mixing tank, preparation tanks, tubing, pumps, control pumps, electrical conductivity (EC), pH meter, moisture content, fertigation system, and sensors.
3	To analyse and evaluate the performance of an automated blending system on plant growth for Solanum Lycopersicum.	Comparing the statistical analysis from secondary data (journal and article) and estimating own expected data.

Table 1.2: The list of parameters

Bil	Parameter	Function
1.	PLC board	Act as a controller to monitor the EC level and run the mixing process.
2.	Analog EC Meter SKU: DFR0300	Measures the potential for an electrical current to be transported through water.
3.	DFRobot M019.00060	pH meter.

4.	DFROBOT M019.00251	Soil moisture.
5.	1887084	Corrosion resistance.
6.	ECDiffThreshold	To show when will the mixing process was done.
7.	MixTime	The mixing time interval to pump the nutrient solution.

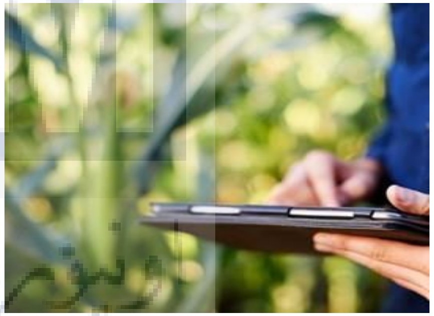
1.5 Significances of the study

Tomato is one of the vegetables that have been chosen to be monitor by using an automatic fertigation system. Tomato is a prominent vegetable family and rich in nutrition plus, they also have a great flavour. There are four aspects needed to monitor surrounding temperature, watering schedule, light, and humidity. The tomato crop will be located in a closed area (F5 at Fakulti Kejuruteraan Mekanikal faculty laboratory) to ensure the crop gets all it is needed.

This system will make farmers efficiently manage their crops and produce good crop yields as the farmer can constantly monitor plant growth. Nitrogen pollution from manures and different sources has become a significant natural issue that compromises human wellbeing and government assistance severally. This precision agriculture can reduce nitrogen pollution, unharmful aquatic life organisms and preserve the soil from contamination. Last but not least, it can reduce the cost by using proper and apply accurate fertilizer, reduce manpower, and increase the profit of the farmer.

Table 1.3: Comparison between traditional, smart, and precision fertigation

Bil.	Criteria	Traditional fertigation	Smart fertigation	Precision fertigation
1.	Definition	It depends on treating the dirt and plants with probably harmful items and almost certainly artificially created in a research centre.	The use of data and information advancements for streamlining complex cultivating frameworks.	The ideal root-zone the board instrument conveying the perfect mix of water and supplements straightforwardly to the foundations of each plant, as indicated by your yield advancement cycles.
2.	Devices/ Implement	Use manpower and manual farming.	Use mobile devices such as smartphones and tablets to access real-time data about the condition of soil and plants, terrain, climate, weather, resource usage, manpower, funding,	Use software and technologies devices such as remote sensors, GPS, Wireless Sensor Networks (WSN), etc. (Cisternas et al., 2020).
3.	Benefit of fertigation	The crops are pure without fertilizer; hence, they can be sold at a higher price as they are pure, and the crops' waste can be used as fertilizers.	Have the data expected to settle on educated choices dependent on solid information instead of their instinct.	Have better returns, better-quality harvests, diminished draining, decreased instability and spill over, and a superior profit for your compost speculation.
4.	Disadvantages of fertigation	It requires some investment to gather, subsequently being offered more	It requires a limitless or constant web association to be effective.	It might require quite a while before you have adequate information to

		costly costs to procure back the time taken to develop the yields. Ranchers in traditional cultivating need to go through for the most part, around 15 hours to gather the yields contrasted with cutting edge cultivating.	This implies that in-country networks, particularly in the agricultural nations where we have mass yield creation, it is challenging to cultivate strategy. In spots where web associations are frustratingly moderate, brilliant cultivating will be a difficulty.	execute the framework and request work especially gathering and afterward dissecting the info.
5.	Gallery	 PBworks by (Anonymous, 2008)	 Cropaia by (Guy Sela, 2021)	 Argocares by (Anonymous,2021)

1.6 Research Framework

This report consists of three chapters discussing the idea and concept of the project, all activities in achieving the final product. The explanation of each chapter will be in the paragraph as follows:

Chapter 1 briefly explains about fertigation method to increases crop production and general agriculture. Then, also stated the problem statements, objectives, and scope of this project in this chapter. Chapter 2 discusses on literature review, comparing the last journal and articles that related to this project. This chapter reviews the concept operation of the system, devices used, and nutrient solution concentration in this project more simply and cheaply.

Chapter 3 focuses more on the project's methodology from the beginning to the end of this project. The method consists of hardware development and software development. The hardware development includes the diagram or layout and architecture of the automated blending of macro-micro nutrients, programmable logic controller (PLC) board, and electrical conductivity (EC) meter. On the other hand, in software development, the measured values from the sensor-controlled by a Programmable Logic Controller (PLC) controller.

Chapter 4 focuses on the process of automated blending system through schematic diagram, the arrangement parameter of each component and the operation of the system. In this chapter also analyses the automated blending of macro-micro nutrients by referring the theoretical and experimental results that are done by other researchers. Chapter 5 will be the overview of the project, including the conclusion and recommendation.