

# Development of a Bio-Fertilizer Machine (Holmon Egg) Integrated with NPK Sensor Technology for Enhancing Organic Vegetable Production in Sufficiency Community Enterprises

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## Abstract

*This research paper presents the development of a Bio-Fertilizer (Holmon Egg) Machine with NPK sensor technology in the production process of organic vegetables within community enterprises in the Suphanburi Province area of Thailand, Objectives: 1. To study information and design an egg hormone mixer. 2. To invent an egg hormone mixer. The motor operation control system consists of two parts: an automatic system, commanded by a timer, and operation by manual switch. The motor's speed is adjustable, allowing the blades to mix together and provide microorganisms with oxygen while venting gas bubbles. In Experiment 1, the motor runs for 5 minutes at a speed of 40 rpm, and in Experiment 2, it runs for 10 minutes at a speed of 60 rpm. The system operates on a voltage range of 5-30 V, with an RS485 output signal and a resolution of 1 mg/kg. It has a measuring range of 0-1999 mg/kg and saves data to an SD card every 5 minutes. The results of Experiment 1 showed nitrogen content at 0.955%, phosphorous at 0.81%, and potassium at 0.863%. In Experiment 2, nitrogen content was measured at 1.091%, phosphorous at 0.9%, and potassium at 1.05%. The color of the mixture gradually decreases on day 8 of fermentation, with gas bubbles increasing on days 9-12 before being eliminated. Experiment 1 lasted 18 days, while Experiment 2 lasted 15 days. From the experimental results of producing bio-fertilizer (egg hormone) with this machine, it can reduce human labor and shorten the production time for producing bio-fertilizer from the original 20-30 days*

**Keywords:** Bio Fertilizer, Community Enterprise, Holmon Egg, NPK Sensor, Organic Vegetable

## 1. Introduction

Today's world is changing swiftly especially the adoption of advanced technology in farming, utilizing web applications and mobile devices to handle data and regulate operations, This technology can support and adapt to alterations in the environment [1] Smart sensors are useful in professional farming practices, information gathering and soil physicochemical parameter monitoring are helpful and plants growing in greenhouses, fields, and hydroponic systems control of agricultural

machinery remote control Boost agricultural productivity [2] Agribusiness is accelerating food production to keep up with the growing global population a city or a sizable city at the Chal area level and be ready to switch to an industrial form for the production model development may result in soil degradation, water pollution, and other issues and the climate, which unavoidably affects developing nations [3] Organic material can be recycled from agricultural waste, which is abundant.



Through composting, which is a useful method for getting rid of agricultural waste and to lessen environmental degradation and to maintain the ecological system [4].

Organic farming has becoming popular, organic farming decreases the need for outside inputs and boosts the price of agricultural products, as well as increased government backing in all nations, increase food security for people worldwide, boost global food security for people with rising requirements and government support in all nations. Food is in greater demand every single day. Agriculture systems that produce food and fiber must be integrated into production systems by farmers. sustainably in terms of the environment, society, and the economy [5][6] and [7] There are numerous issues with modern farming practices that seriously jeopardize the safety of the world's food supply, to provide for the dietary requirements of the growing global population. To boost crop productivity, chemical fertilizers and insecticides are frequently used. However, improper usage of agricultural chemicals causes environmental pollution, which negatively impacts people's health. Additionally, the characteristics and physical attributes of agricultural soil, particularly its chemical composition, are constantly lost, the helpful processes for enhancing plant growth include, a rise in the availability of nutrients, adjustment of phytohormones, biological control of phytopathogens, and a decline in biotic and abiotic stress (Bioinoculant) [8].

Thailand is a developing country with its own government having established food policies. The national development plan also addresses agriculture and biotechnology, promoting Thailand as a center for the development of high-quality food and agriculture worldwide. Agriculture production is a significant source of food globally, and Thailand's agricultural sector has both potential for quantity and quality, with a vast variety of agricultural goods

produced there. The popularity of organic farming is skyrocketing, with farmers banding together to create neighborhood businesses focusing on using bio-fermented water to produce agricultural products without the need for chemicals (Liquid biofertilizers). To substitute chemical fertilizers, bio liquid fertilizer is made using traditional knowledge. The global focus is on problem-solving and organic soil regeneration in agriculture, reducing contamination brought on by surface washing and benthic burning [9]. The use of bio-fermented water and soil amendments such as animal waste, biochar, algae, and eggshell has no negative effects on the environment or the health of the farmers themselves and decreases the import of goods from other countries [10]. Bio-fermented water (Liquid biofertilizers) contains essential macronutrients Nitrogen (N), Phosphorus (P), and Potassium (K), necessary for plants to improve soil quality, resulting in improved grain yield, favoring organic farming [11].

Sufficiency Community Enterprises is an establishment aimed at producing organic agricultural products such as Red Lettuce, Green Oak Lettuce, Lettuce, Kai-Lan, and other greens. For instance, growing red salad is one of their examples. During the production phase, farmers must stir the mixture for at least five minutes each time, at least three times each day. It is essential to allow 20 days for microorganisms to digest and ferment. To address these issues, the development of a Bio Fertilizer Machine (Holmon Egg) with NPK SENSOR technology has been undertaken as shown in Figure 1. This technology streamlines the production process of organic vegetables, allowing community enterprises to efficiently supply bio-liquid fertilizers to improve soil quality. Farmers are encouraged to reduce their use of pesticides, which are a contributing factor to global warming, to foster better plant development.



**Figure 1:** Making Bio Fertilizer (Holmon Egg)

## 2. Material and Methods

### 2.1 Related Work

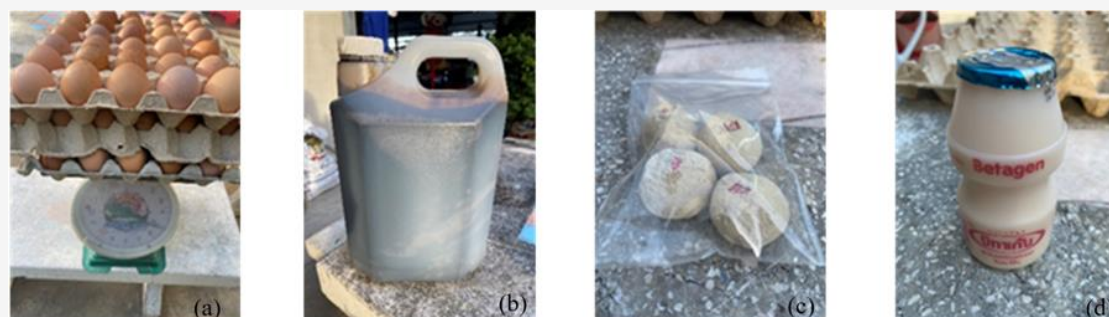
It has been mentioned that biofertilizers, which include live microorganisms and improve soil quality while promoting plant growth and environmental friendliness, exist [12]. The use of bio-liquid fertilizer to promote the growth of chili peppers was investigated, and the results found that bio-liquid fertilizers produce good yields and have less of an impact on the environment, according to studies [13]. The results of the study on the application of biofertilizer and biochar, which have an impact on rice productivity, rice production income, and soil quality, show that the physical characteristics of the soil are improved, leading to increased rice production [14]. A smart sensor network was developed to collect temperature data, pH, soil moisture, electrical conductivity, and NPK levels, communicating via IoT in the farm area [15]. Water management has made use of sensors to assist with internet-based analysis and decision-making regarding irrigation-related employment [16]. Capacitive soil moisture sensors create sensors with four levels to detect soil moisture at depths of 0.25 m, 0.5 m, 0.75 m, and 1.0 m, making the test efficient and simple to use [17].

### 2.2 Materials

In the production process of liquid biofertilizers, there are numerous techniques, and the materials used vary as well, including fish, pineapple, molasses, and star fruit [18]. The research team of the study chose a molasses-derived substance for the trial, and the primary material that is easily accessible locally is eggs. The materials used are depicted in Figure 2 and detailed in Table 1, which also lists production and inspection tools.

### 2.3 Experimental Equipment

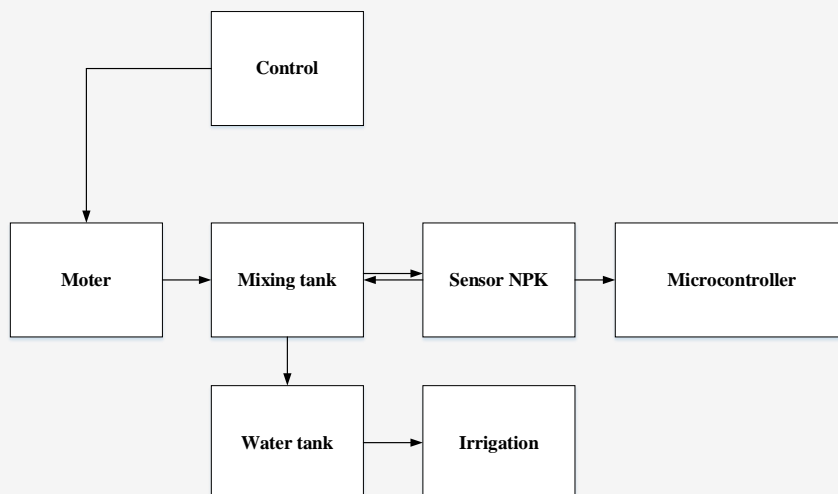
The development of the Bio Fertilizer (Holmon Egg) Machine with NPK sensor technology in the production process of organic vegetables is undertaken by community enterprises. The panel designs the flow chart of the system, as shown in Figure 3. The system's flow chart for the Bio Fertilizer (Holmon Egg) Machine with NPK sensor technology includes the motor operation control system. There are two parts to the system: the automatic system, commanded by a timer, and manual operation via a switch. Motor speed is adjustable, allowing for rotation, with an output signal RS485, a resolution of 1 mg/kg, and a measuring range of 0–1999 mg/kg. Data is saved to an SD card every 5 minutes. When microorganisms exceed the gas spitting and complete digestion, the fertilizer is applied by mixing with water systems at the right rate for each plant.



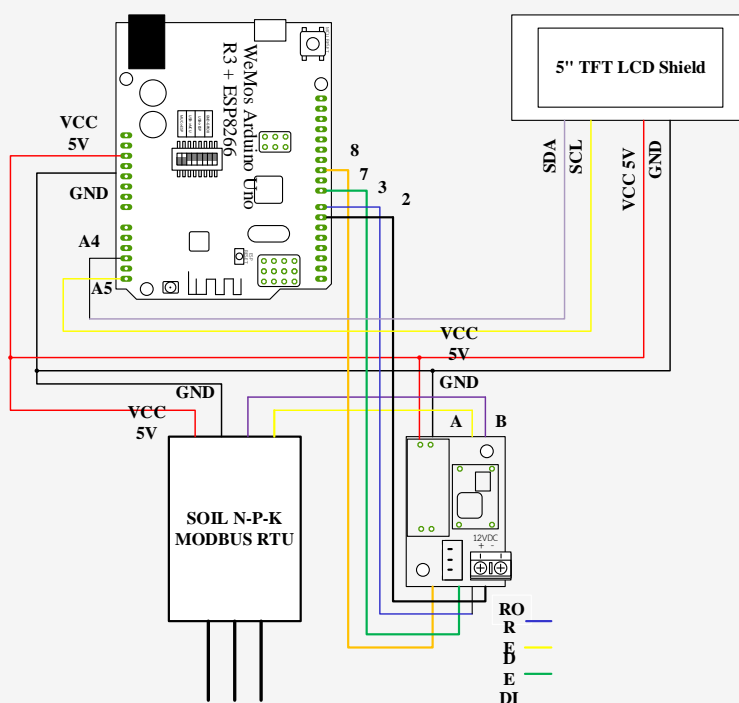
**Figure 2:** Materials of bio fertilizers (a) 5 kg of egg (b) 5 liters of molasses (c) starter and (d) fermented milk

**Table 1:** Component specifications

Component	Specifications
Arduino Uno R3	5 V, 40 mA, 19 mA power consumption, 14 Digital output pins, 6 Analog input.
Soil NPK sensor	5-30 V, output signal RS485, resolution 1 mg/kg, 0–1999 mg/kg measuring range
Digital Timer	220VAC, Operation 17 Program
Asynchronous motor	220VAC Input, 60Hz 90 – 1400RMP Speed adjustment game.
AC-DC Converter	220VAC Input, 0-30 Output



**Figure 3:** Holmon egg fertilizer machine diagram

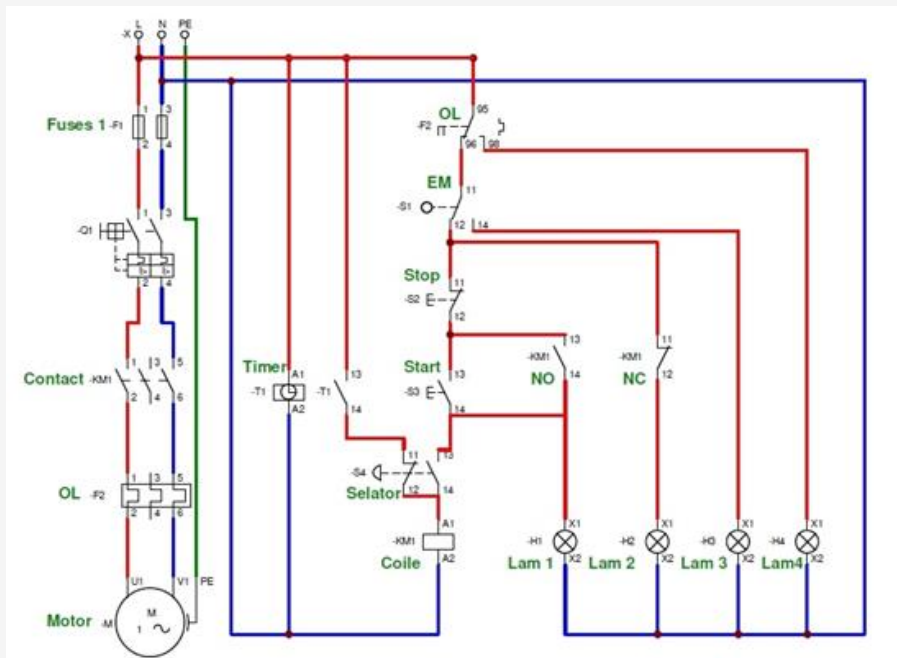


**Figure 4:** Interfacing schematic of SOIL N-P-K MODBUS RTU to microcontroller

#### 2.4 Design of NPK Sensor

Figure 4 and Figure 5 illustrate the interfacing schematic for SOIL N-P-K MODBUS RTU to Microcontroller (ESP8266). It is connected via a serial RS485 half-duplex protocol Modbus RTU, operating at 5-30 V. The output signal is RS485, with a resolution of 1 mg/kg and a measuring range of 0–1999 mg/kg [19]. Data is saved to an SD card every 5 minutes. The production of biofertilizer (Holmon

Egg) involves experimental equipment including a 700 liter tank and an asynchronous motor with a speed adjustment range of 90-1,400 RPM. The motor has four blades in two layers and is used to mix the biofertilizer. Additionally, there is a Soil NPK sensor with a measuring range of 0-1,999 mg/kg. The system operates with commands from a timer and manual operation via a switch, as shown in Figure 6.



**Figure 5:** Bio fertilizer (Holmon Egg) machine diagram



**Figure 6:** Experimental setup

Figure 7 depicts the field Soil Inspection Kit (LDD Test Kit) used after the completion of the production process with the biofertilizer (Holmon Egg) Machine equipped with NPK sensor technology. The biofertilizer (Holmon Egg) is mixed with water in the appropriate ratio and then poured into the soil, where it is left for 1 hour. Table 2 displays the experimental production of biofertilizer (Holmon Egg), which involves aerobic fermentation.

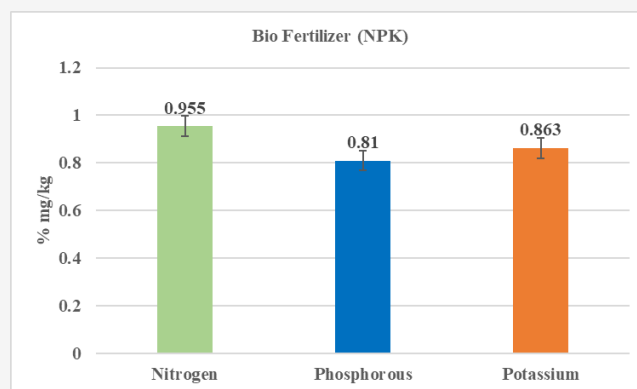
This process allows microorganisms to receive oxygen, aiding in the digestion of organic matter [20]. By rotating the motor, the blades mix the materials together, providing oxygen to the microorganisms, and allowing gas bubbles to escape. In experiment 1, the motor runs for 5 minutes at a speed of 40 RPM, while in experiment 2, the motor runs for 10 minutes at a speed of 60 RPM.



**Figure 7:** Field soil inspection kit (LDD test kit)

**Table 2:** Experimental setup

Sample No	Time (S)	Speed (rpm)
1	5	40
2	10	60



**Figure 8:** The motor runs 5 minutes at a motor speed of 40 rpm (Experiment 1)

### 3. Results

#### 3.1 Motor Running Time and Speed

The development of the Bio Fertilizer (Holmon Egg) Machine with NPK sensor technology in the production process of organic vegetables is undertaken by community enterprises at the end of the field. This aims to expedite the 20-day minimum production time of biofertilizers and reduce manual labor. Molasses and eggs are the primary materials readily available locally. By rotating the motor, the blades mix the ingredients, providing oxygen to the microorganisms and releasing gas bubbles.

In experiment 1, the motor runs for 5 minutes at a speed of 40 RPM. Figure 8 depicts the experiment with Bio Fertilizer (Holmon Egg), where the motor is required to run for 5 minutes per hour at a speed of 40 rpm. The blades mix the ingredients, providing oxygen to the microorganisms and releasing gas bubbles. Molasses is used, and data is saved to an SD card every 5 minutes. The results of the experiment show 0.955%, 0.81%, and 0.863% for Nitrogen, Phosphorus, and Potassium, respectively.

The color of the solution gradually decreases on day 8 of fermentation, and gas bubble formation increases from day 9 to 12, after which it diminishes. The trial lasted for 18 days. In experiment 2, the motor runs for 10 minutes at a speed of 60 rpm.

Figure 9 depicts the experiment with Bio Fertilizer (Holmon Egg), where the motor is required to run for 5 minutes per hour at a speed of 40 rpm. The blades mix the ingredients, providing oxygen to the microorganisms and releasing gas bubbles. Molasses is used, and data is saved to an SD card every 5 minutes. The results of the experiment show Nitrogen 1.091%, 0.9%, and 1.05% for Nitrogen, Phosphorus, and Potassium, respectively. The color of the solution gradually decreases on day 1 of fermentation, and gas bubble formation increases from day 7 to 11, after which it diminishes. The trial lasted for 15 days.

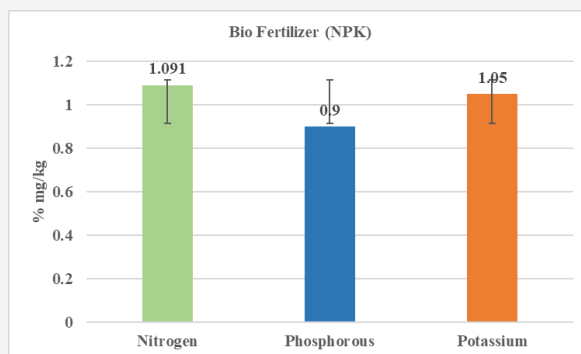
### 3.2 NPK Test Results with Field Soil Inspection Kit (LDD Test Kit)

#### 3.2.1 Analyze bio fertilizer (Holmon Egg) using the experiment 1

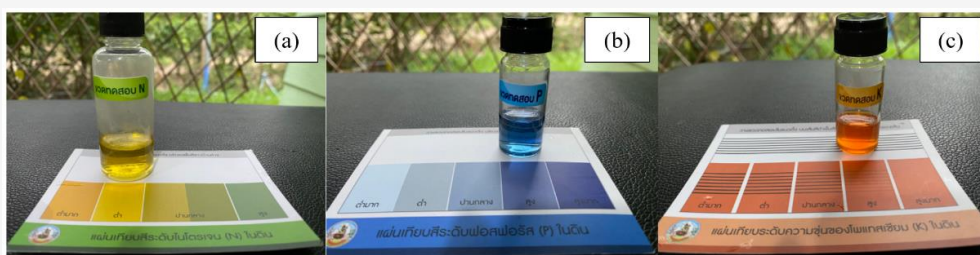
Figure 10 displays the results of the biofertilizer (Holmon Egg) from experiment 1 using the field Soil Inspection Kit (LDD Test Kit). It was discovered during the testing of a sample of unkempt soil that the levels of Nitrogen were in the range of 0.05-0.09%, Phosphorus ranged from 26-45 mg/kg, and Potassium ranged from 91-120 mg/kg.

#### 3.2.2 Analyze bio fertilizer (Holmon Egg) using the experiment 2

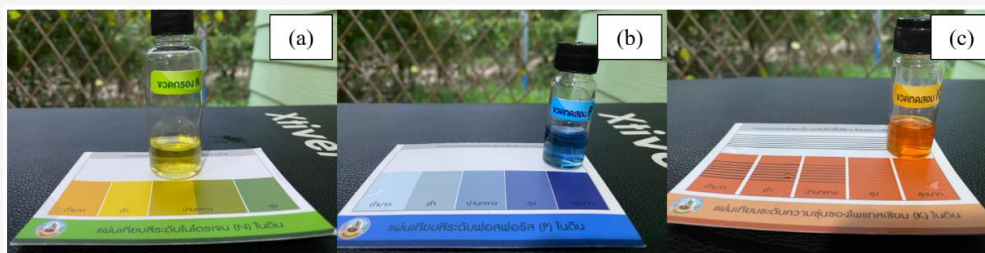
Figure 11 presents the results of the biofertilizer (Holmon Egg) from experiment 1 using the field Soil Inspection Kit (LDD Test Kit). It was discovered during the testing of a sample of unkempt soil that the levels of Nitrogen were in the range of 0.10-0.14%, Phosphorus was at 45 mg/kg, and Potassium was at 120 mg/kg.



**Figure 9:** The motor runs 10 minutes at a motor speed of 60 rpm (experiment 2)



**Figure 10:** Experiment 1 field Soil inspection kit (a) Nitrogen (b) Phosphorus (c) Potassium



**Figure 11:** Experiment 2 field Soil inspection kit (a) Nitrogen (b) Phosphorus (c) Potassium

#### 4. Conclusion

The development of the Bio Fertilizer (Holmon Egg) Machine with NPK sensor technology in the production process of organic vegetables is handled by community enterprises at the field's end, aiming to eliminate the need for physical work and expedite biofertilizer production. The NPK sensor analyzes the nutrient levels in Holmon Egg, including Nitrogen (N), Phosphorus (P), and Potassium (K), and saves data to an SD card every 5 minutes. By allowing the motor to rotate, the blades mix the ingredients, providing oxygen to the microorganisms and releasing gas bubbles. Experiment 1 involves the motor running for 5 minutes at a speed of 40 rpm, yielding quantitative results of 0.955%, 0.81%, and 0.863% for Nitrogen, Phosphorus, and Potassium, respectively. The color of the solution gradually decreases on day 8 of fermentation, with gas bubble formation increasing from day 9 to 12, after which it diminishes. The trial lasts for 18 days. In experiment 2, the motor runs for 10 minutes at a speed of 60 rpm, resulting in quantitative results of 1.091%, 0.9%, and 1.05% for Nitrogen, Phosphorus, and Potassium, respectively. The color of the solution decreases gradually on day 1 of fermentation, with gas bubble formation increasing from day 7 to 11, after which it diminishes. This trial lasts for 15 days. The change in molasses color is influenced by the motor's spinning time and speed, causing gradual deterioration in Glyn, followed by a growth and subsequent diminishment of gas bubbles. Moreover, this research supports the development of non-chemical pollen products to restore degraded land regions, which are crucial in many places. This technology enables the production of precision biofertilizers.

#### Acknowledgements

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