CHAPTER I
INTRODUCTION

1.1 Background

Indonesia is a country endowed with abundant natural resources and fertile land. With these advantages, Indonesia should be able to meet its domestic food needs, particularly for soybeans, which are a staple food ingredient widely consumed in the country. Soybeans are a type of legume rich in plant-based fats and proteins and have long been a primary source of nutrition for the Indonesian population. The national demand for soybeans in Indonesia consistently exceeds 2 million tons annually, with 90 percent used for food purposes—approximately 88 percent for processed foods such as tofu and tempeh, 10 percent for other processed food industries such as flour and starch production, and the remaining 2 percent for seeds[1]. The government projected domestic soybean production to reach only 200,315 tons, while national soybean demand was estimated to reach 2,983,511 tons in 2022[2].

The majority of Indonesia's soybean demand is met by imports. In 2021, Indonesia imported approximately 2,489,690.5 tons of soybeans—a significant figure considering that Indonesia is an agrarian country, and food crops are among its leading agricultural commodities[3]. One of the contributing factors is that farmers tend to be reluctant to cultivate soybeans due to their uncompetitive price compared to imported soybeans from the United States, which cost only around Rp7,700 per kilogram. In contrast, the price of domestically produced soybeans exceeds Rp10,000 per kilogram, making imports a more attractive option[4]. One of the factors contributing to the high price is the low productivity, which still falls short of meeting market demand. This is despite the fact that, in terms of quality, locally produced soybeans are known to be of very high quality[5].

The low productivity of soybeans in Indonesia stands in contrast to the country's well-known fertile soil conditions. For conventional farmers, it is often difficult to distinguish between fertile and infertile land by only visual observation. As a result, farmers tend to use whatever land is available and manage it by applying fertilizers. Fertilization recommendations typically include the main macronutrients: Nitrogen, Phosphorus, and Potassium, commonly referred to as NPK[6]. The fertilization phase is the most cost-intensive stage in both plantation and agricultural processes. Therefore, fertilization must be carried out effectively. To support this, a tool is needed to monitor the soil's nutrient content, particularly the NPK elements, which play a crucial role in soil fertility.

Various tools have been developed to detect NPK content in soil, one of which is Jinawi, a product that is already available on the market. Jinawi is developed by MSMB Indonesia DIY and consists of a pH sensor (to measure soil acidity), a soil sensor (to measure NPK content), and an application that provides fertilizer recommendations. From a product standpoint, Jinawi is well-developed and suitable for a variety of conditions. However, it lacks a direct indicator of soil fertility specifically for soybean cultivation and is relatively expensive for the average Indonesian farmer[7]. Previous research related to NPK has also been conducted, resulting in the development of an IoT-based device for detecting soil fertility. However, the system only classifies soil into three levels—high, medium, and low—without providing additional supporting information that could enhance ease of use from the farmer's perspective[8]. There is a need for a device capable of detecting NPK content in soil that aligns with the specific requirements of soybean cultivation and is affordable for farmers in Indonesia.

Si Soil is a device designed to detect soil fertility, incorporating a pH sensor, a moisture sensor, and an NPK sensor. The uniqueness of the Si Soil product lies in its use of a custom NPK sensor that operates by measuring capacitance parameters combined with soil conductivity to determine the NPK content. Research has shown that the combination of conductivity and capacitance parameters can effectively indicate the levels of NPK present in the soil[9]. Another distinguishing feature of this device compared to similar tools is its ability to determine specific indicators of soil fertility. In field practice, soil with excessively high nutrient levels can hinder plant growth, just as soil with insufficient nutrients can. Therefore, it is essential to identify optimal soil condition parameters specifically suited for soybean cultivation. Si Soil can serve as a potential solution for improving soybean productivity in Indonesia. However, before proceeding to mass production, a feasibility study covering technical, economic, and regulatory aspects must be conducted.

1.2 Problem Statement

There is a need for a device capable of monitoring soil fertility, providing real-time fertilization recommendations for soybean crops, and offering an affordable price point suitable for the economic conditions of soybean farmers in Indonesia.

It is necessary to design, test, and implement Si Soil as a tool for detecting soil fertility, followed by an evaluation of its impact on soybean productivity and its effectiveness in supporting soybean farming activities.

A business analysis must also be conducted for Si Soil as an innovative product, to assess its feasibility for mass production and its potential to positively impact soybean farmers in Indonesia.

1.3 Research Objectives

The objective of this project and thesis is to design and evaluate the effectiveness of Si Soil as a new breakthrough in agriculture, particularly for soybean cultivation, to assess its impact on soybean crop productivity, and to analyze the feasibility of mass-producing Si Soil as an innovative agricultural tool.

1.4 Research Benefits

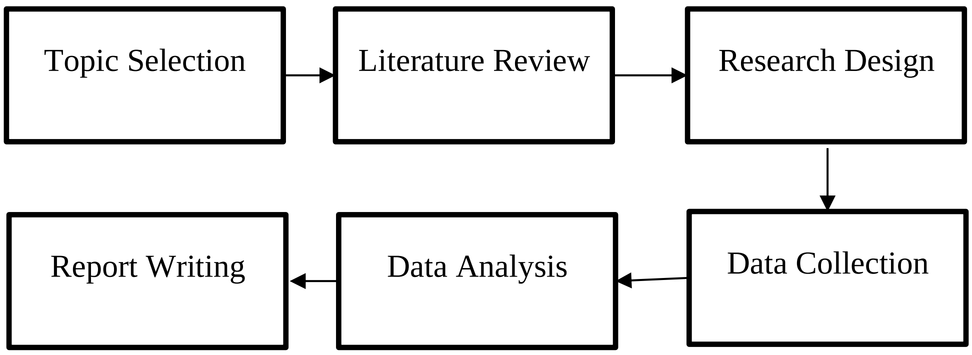
The expected benefit of this thesis is to analyze the effectiveness of Si Soil as a new breakthrough in agriculture, particularly in soybean cultivation. It is also expected to provide analytical insights into the economic feasibility of mass-producing Si Soil for soybean farmers, both at the macro and micro levels, as well as its impact on soybean productivity.

1.5 Research Limitations

Given the broad scope of issues in this feasibility study, the limitations of this research are defined as follows:

1. Field experiments are conducted in soybean farming areas as samples to evaluate the impact of Si Soil on the effectiveness and productivity of soybean crops.
2. Technical analysis includes testing the device's performance in terms of accuracy, detection area coverage, and the performance of the LoRa system.
3. The technical testing of sensor accuracy focuses solely on the accuracy of the NPK sensor.
4. The measurement of the area detection is limited to estimation purposes, in order to approximate the number of sensors required for a large-scale area.
5. The performance testing of the LoRa system used in Si Soil is conducted through simulation using OMNeT++.
6. The economic analysis is based on production costs and assumptions related to demand and selling price.

1.6 Research Methodology



The research methods used in this thesis are in accordance with the principles of academic writing and are as follows:

1. Literature Review

An understanding of the concepts and theories related to key considerations in the feasibility study of a new innovative product is essential. The references used must also be up-to-date and relevant to the technical development of the product. References related to the feasibility study of innovative products are also crucial to identify the key aspects that need to be addressed in Si Soil as an integrated product.

2. Research Design

Conducting the planning and simulation of Si Soil device usage in soybean plantation areas. The planning includes selecting suitable locations for conducting the research in soybean farming and determining the testing mechanisms, as this study involves direct technical testing using the device. For the economic projection, planning is also required to ensure that the product is feasible and viable for market commercialization.

3. Data Collecting

Collecting data from the application of Si Soil on soybean crops, which is then processed and analyzed as required. Various types of data are needed for this research, including technical data from device testing, as well as data related to efficiency and productivity, which are obtained through field testing to evaluate the impact on soybean farming.

4. Data Analysis

The collected data is then analyzed to obtain the necessary information. The data analysis used in the feasibility study of Si Soil includes technical analysis to measure the device's accuracy and efficiency, as well as economic analysis using capital budgeting methods.

5. Report Writing

The analysis will produce results that can be formulated into a structured report, covering all components from the background of the problem to the conclusion.