# CHAPTER I
# INTRODUCTION

## 1.1 Introduction

A liquid by-product of the production of crude palm oil (CPO), palm oil is made from the Elaeis guineensis tree. Originating in West Africa's tropical rainforests, the oil palm tree was brought to South America in the sixteenth century and then to Asia in the nineteenth. Asia was the world's leading oil palm-growing region by the 1970s. Oil palm trees are currently grown in a number of nations that are between 10° north and 10° south of the equator (Imam et al., 2024).

The oil palm can grow upwards of a height of almost 20 m and is characterized by its brown trunk. The productive period of the tree is normally two to two-and-a-half decades; however, the tree can reach a life span of 200 years (Khin et al., 2022). This species of palm is essentially grown in monoculture, as oil palm trees are usually grown in large plantations, and naturally favor warm humid climates with consistent rainfall. The mesocarp of the fruit is the main factor in extracting palm oil, and the seeds of the fruit have a reddish color due to the high content of beta-carotene in the seeds. On an average plantation hectare, oil palm may produce anywhere between 10 to 35 tons of fresh fruit bunches (Thakur et al., 2024). Globally, the production of palm oil is usually felt in a few key areas, which include Malaysia, Indonesia, Thailand, Nigeria, Colombia, and Guatemala as the main producers (Soo et al., 2022).

Over the years, palm oil consumption has increased significantly due to its versatility and cost-effectiveness compared to other oils. According to 2020 data, palm oil is the most widely consumed edible vegetable oil, making up 31.4% (74.02 million tons) of global oil production (Limaho et al., 2022). However, the production of palm oil requires a substantial amount of water. Approximately 5.0–7.5 tons of water are needed to produce one ton of crude palm oil (CPO), with over 50% of this water turning into waste. Additionally, that processing each ton of palm oil generates around 2.5 $m^3$ of palm oil mill effluent (POME) (Zulfahmi et al., 2021).

Palm oil mills manage waste using a ponding system, consisting of several treatment ponds that progressively reduce pollutants. The Cooling Pond lowers the wastewater temperature before further treatment. In the Acidification Pond, the initial breakdown of organic matter begins. The Anaerobic Pond facilitates microbial degradation of organic compounds, producing methane and significantly reducing biochemical oxygen demand (BOD) and chemical oxygen demand (COD). The Facultative Pond facilitates a balance between anaerobic and aerobic conditions, promoting the sedimentation of suspended particles. Subsequently, the Dumping Pond finalizes the treatment process by eliminating remaining nutrients and pathogenic organisms (Zahrim et al., 2014).

Palm oil mill effluent (POME) is an important biomass by-product produced as liquid waste in various stages of palm oil production i.e. sterilization, oil extraction, clarification, etc. (Low et al, 2021). This effluent is a heterogeneous community of organic and inorganic compounds of which some are biodegradable while others are more resistant to degradation by microbial processes. Microbial processes (e.g. bacteria, fungi, viruses, etc.) have the ability to digest organic-rich waste materials, and thus it is possible to treat and manage the waste using biological methods (Widyastuti et al, 2019). POME ages and separates and what was POME now is called Palm Oil Mill Effluent Digested (POMED).

The process of anaerobic digestion of POME gives rise to a secondary product, POMED, which has considerable value. In particular, anaerobic digestion not only generates biogas, but also lower nutrient-rich sludge from the organic content of the effluent. A particularly prominent feature in POMED is the prevalence of Actinobacteria, a group of microorganisms that are known to produce multiple bioactive compounds (Akhbari et al., 2024). POMED represents a unique and attractive habitat for Actinobacteria because of the richness of organic content from the effluent, the balanced pH of the effluent, and the presence of polymers (cellulose and lignin) that other microorganisms would struggle to assimilate in an anaerobic environment that Actinobacteria can consume. The suitability of POMED as a biofertilizer production raw material, a substance that can enhance productivity and soil enhancement for crops, can also support a transition towards more sustainable and environmentally sensible agricultural practices while utilizing the microbial potential of POMED.

Organic wastes are generally biodegradable because microbial activity can effectively degrade their components so they can be treated biologically for regulatory purposes. Actinobacteria are one of the most notable decomposers. Their ecological importance is evident from their wide array of habitats: soils, compost, and aquatic systems. Actinobacteria significantly contribute to waste management and farming prosperity because they break down complex organic matter into simpler forms, allowing the conversion into nutrient-rich forms (Fitri et al., 2023).

The special characteristics of Actinobacteria allow them to enhance the properties of compost, mainly by converting organic waste into agricultural materials that are rich in active nutrients (Sathya et al. 2017). By including Actinobacteria in POMED compost we used a new and innovative approach to better address the environmental issues surrounding palm oil processing and promote more sustainable ways to farm the agricultural system. The enriched POMED compost reveals great potential to be a natural biofertilizer as it improves soil fertility, promotes plant growth and reduces reliance on synthetic fertilizers.

However, particularly with high-yield crops, organic fertilizers may not be sufficient to provide that all of the required nutrients needed for plants. This restriction indicates a need for research on the interactions and responses of Actinobacteria to different levels of potassium (K), phosphorus (P), and nitrogen (N) contained in biochemical fertilizers derived from POMED. To enhance nutrient composition and, ultimately improve crop growth and productivity while reducing dependence on conventional fertilizers, research on enhancing Actinobacteria in these formulations is necessary.

### 1.2 Aim and Objetives

The primary aim of this study is:

1. To study the adaptability of Actinobacteria and evaluate their Colony Forming Unit (CFU) responses at different nitrogen (N), phosphorus (P) and potassium (K) concentrations in biochemical fertilizers produced from POMED.
2. To develop incorporation and enrichment of Actinobacteria into biochemical fertilizer formulations.

The objectives of the study are:

1. To assess the resilience and response of Actinobacteria, including changes in CFU counts, when exposed to different N, P, and K levels in POMED-based biochemical fertilizers.
2. To optimize strategies for enriching Actinobacteria populations in the formulation of these fertilizers, ensuring their maximal functional contribution.

### 1.3 Benefits of The Research

This research offers several key benefits:

1. Understanding how Actinobacteria adapt to different concentrations of nitrogen, phosphorus, and potassium (NPK) can inform the development of more efficient biochemical fertilizer formulations, improving nutrient availability for crops.
2. Enhancing the presence of Actinobacteria in fertilizers provides a sustainable alternative to synthetic chemical inputs, reducing environmental pollution and mitigating soil degradation.
3. Incorporating adaptable Actinobacteria can decrease reliance on expensive chemical fertilizers, offering farmers a cost-effective and eco-friendly approach to nutrient management.

4. Given the role of Actinobacteria in nutrient cycling and soil structure enhancement, their enrichment promotes soil fertility, supports beneficial microbial interactions, and contributes to long-term soil health.

**1.4 Problem Limitations**

The limitations of this study are as follows:

1. The research is focused solely on Actinobacteria and their adaptability in biochemical fertilizer formulations, excluding other microbial communities or additional chemical compounds.
2. The study examines only variations in nitrogen (N), phosphorus (P), and potassium (K) levels within POMED-based fertilizers, specifically testing the ratios 0-0-0, 12-12-17, 15-15-15, 12-6-22, and 5-5-5; effects of other nutrients or organic amendments are beyond this research's scope.
3. Actinobacteria adaptability is evaluated exclusively through CFU measurements; other growth indicators, such as enzymatic activity or genetic-level analyses, are not considered.
4. The research is limited to biochemical fertilizers formulated specifically from Palm Oil Mill Effluent Digested (POMED);
5. The methods and equipment used to measure Actinobacteria adaptability are limited to available laboratory technologies and techniques, which may influence the accuracy and depth of the findings.

**1.6 Systematization of Writing**

**CHAPTER I** **INTRODUCTION**

The chapter contains the background, aims, objectives, benefits, laminations of the research problems and signification of the study.

**CHAPTER II** **BACKGROUND RESEARCH**

This chapter contains theoretical literature of Actinobacteria Phylum, Role of Actinobacteria in Plant Growth Promotion, Compost Palm Oil Mill

Effluent Digested (POMED), the benefits of Nitrogen, Phosphorus and Potassium in increasing plant growth productivity and other supporting theories.

**CHAPTER III** **RESEARCH METHODOLOGY**

The research stages conducted, analysis method in the laboratory as well the location and time of the research.

**CHAPTER IV** **RESULT AND DISCUSSION**

The research discussion is accompanied by a discussion.

**CHAPTER V** **CONCLUSION AND RECOMMENDATIONS**

This chapter contains conclusions and suggestions based on the discussion that has been described.