



E-PROCEEDINGS

INTERNATIONAL TINKER INNOVATION & ENTREPRENEURSHIP CHALLENGE (i-TIEC 2025)

"Fostering a Culture of Innovation and Entrepreneurial Excellence"



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23 January 2025
PTDI, UiTM Cawangan Johor
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Electrical Engineering Studies, College of Engineering
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Kampus Pasir Gudang
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PREFACE

It is with great pleasure that we present the e-proceedings of International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), which compiles the extended abstracts submitted to the International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), held on 23 January 2025 at **PTDI, Universiti Teknologi MARA (UiTM) Cawangan Johor, Kampus Pasir Gudang**. This publication serves as a valuable resource, showcasing the intellectual contributions on the invention and innovation among students, academics, researchers, and professionals.

The International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), organized under the theme "Fostering a Culture of Innovation and Entrepreneurial Excellence," is designed to inspire participants at various academic levels, from secondary students to higher education students and professionals. The competition emphasizes both innovation and entrepreneurship, encouraging the development of product prototypes that address real-world problems and have clear commercialization potential. By focusing on technological and social innovations, i-TIEC 2025 highlights the importance of turning creative ideas into viable, market-ready solutions that can benefit users and society. The extended abstracts in this e-proceedings book showcase the diverse perspectives and depth of research presented during the event, reflecting the strong entrepreneurial element at its core.

We extend our sincere gratitude to the contributors for their dedication in sharing their innovation and the organizing committee for their hard work in ensuring the success of the event and this publication. We also appreciate the support of our collaborators; Mass Rapid Transit Corporation Sdn. Bhd. (MRT Corp), Universitas Labuhanbatu, Indonesia (ULB), Universitas Riau Kepulauan, Indonesia (UNRIKA) and IEEE Young Professionals Malaysia, whose contributions have been instrumental in making this event and publication possible.

We hope that this e-proceedings book will serve as a valuable reference for researchers, educators, and practitioners, inspiring further studies and collaborations in both innovation and entrepreneurship. May the knowledge shared here continue to spark new ideas and market-ready solutions, advancing our collective expertise and fostering the growth of entrepreneurial ventures.

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B-ST149: UTILIZATION OF OIL PALM FRONDS INTO BIOCHAR TO SUPPORT SUSTAINABLE SOIL IMPROVEMENT

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ABSTRACT

The utilization of oil palm frond waste as raw material for biochar production is a sustainable innovation in supporting environmentally friendly agriculture. Oil palm fronds are one of the abundant agricultural wastes in oil palm plantations that come from maintenance in the form of pruning oil palm fronds. Palm fronds contain lignin, cellulose and hemicellulose which can be used as raw materials for making activated carbon. Its utilization as biochar offers a sustainable solution to improve soil quality and reduce agricultural waste. Biochar contains carbon, oxygen, hydrogen, and organic ash. This research focuses on the conversion of oil palm fronds into biochar through pyrolysis process and evaluates its potential as a soil improver to improve fertility, structure, and water storage capacity. The results showed that palm frond biochar is effective in increasing soil organic carbon content, improving nutrient retention, and reducing dependence on synthetic fertilizers, as well as reducing global warming. In addition, its use also supports sustainable plantation management by minimizing waste and supporting a circular economy. This research emphasizes the importance of integrating biochar technology in agricultural practices to achieve long-term environmental and economic sustainability.

Keywords: Oil Palm Fronds, Biochar, Pyrolysis, Sustainable Agriculture.

1. Product Description

Biochar is an organic product produced from the pyrolysis process, which containing carbon, oxygen, hydrogen and inorganic ash. Biochar has antibacterial, and anti-fungal properties, making it safe to use for various types of plants without risk. Biochar is an organic product of incomplete combustion and uses anaerobic combustion or pyrolysis methods. In this study, the material for making biochar uses palm frond waste, because palm frond waste material is easily obtained from the maintenance of oil palm plants in the form of pruning oil palm fronds. Oil palm fronds also contain lignin, cellulose and hemicellulose which can be used as raw materials for making activated carbon. Biochar serves as an ingredient to improve soil physical properties, because with many pores biochar is able to store large amounts of water so that it can prevent soil erosion, and biochar serves as an ingredient to improve soil chemical properties, because biochar contains high carbon, so it can increase the content of soil organic matter, and biochar serves as an ingredient to improve soil biological properties, because the pore space of biochar is high.

2. Flow Charts

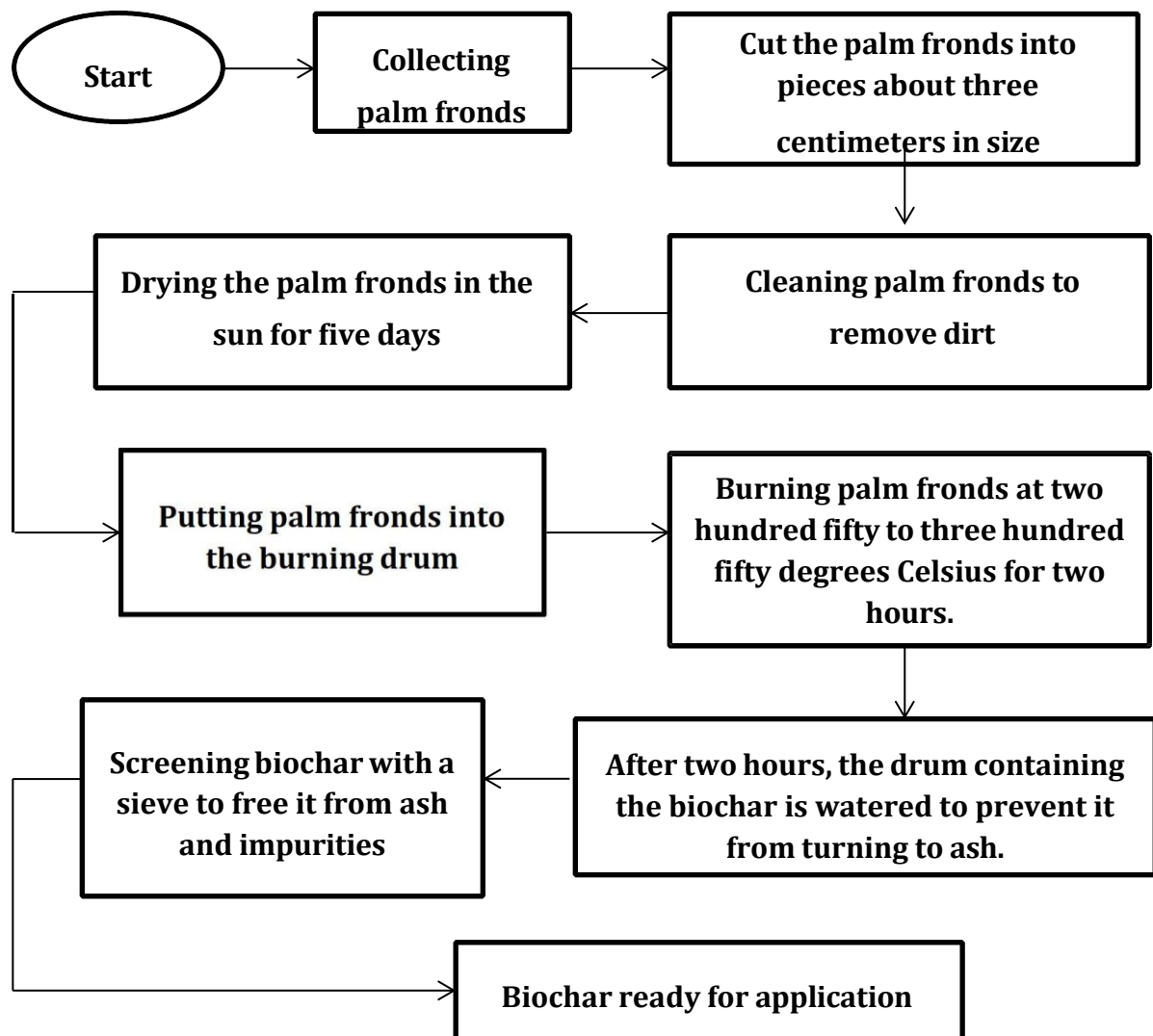


Figure 1. Schematic drawing of biochar making.

This flowchart illustrates the steps that need to be taken to make biochar from palm leaves. Biochar itself is a biochar that has many benefits, such as improving soil quality and reducing greenhouse gas emissions.

Table 1. The ability of Palm Kernel Biochar to provide soil water when compared with no Biochar

<i>Parameters</i>	<i>Without Palm Frond Biochar</i>	<i>Palm Frond Biochar (%)</i>
<i>Wind Dry Moisture Content</i>	14,54%	1.87
<i>Field Capacity Moisture Content</i>	32,97%	6.54
<i>Soil Water Requirement</i>	1,47%	2.56

Based on **Table 1**, it can be seen that palm frond biochar can increase soil moisture content in wind dry and field capacity. The increase in wind-dry moisture content after biochar application is because biochar is a soil improver that can store water in the soil. Biochar is a biological charcoal that can store carbon in the long term because biochar is an ameliorant that is recalcitrant. Increased carbon in the soil can increase the activity of micro and macroorganisms in the soil as a source of nutrients in the soil. The results of microorganism activity can produce an increase in pores in the soil so as to increase the porosity of the soil matrix. Biochar in the manufacturing process through combustion, so that it can increase water holding capacity.

Table 2. Differences in nutrient content of naturally decomposed oil palm fronds and oil palm frond biochar

<i>Parameters</i>	<i>Palm Fronds in Natural Decomposition (%)</i>	<i>Oil Palm Frond Biochar (%)</i>
<i>Ph</i>	7,15%	8,05%
<i>C-Organic (%)</i>	12,95%	28,89%
<i>N-total (%)</i>	1,28%	1,61%
<i>P-total (%)</i>	0,53%	0,25%
<i>K-total (%)</i>	2,02%	1,02%

Based on **Table 2**, it can be seen that the pH of palm frond biochar is higher when compared to naturally decomposed palm fronds. This is because biochar has undergone a pyrolysis process. This biochar has a pH value that is close to neutral so that it can be used as a source of ameliorants in the soil. The pyrolysis process can cause decomposition of cellulose and hemicellulose which produces volatile substances. This decomposition can form carboxyl groups on the surface of biochar. After the process of making biochar with the addition of water, it can break down carboxyl groups and carbonic acid so that it donates OH to biochar with the following reaction.

3. Novelty and uniqueness

These fronds, if left to waste, could become a breeding ground for pathogenic fungi, potentially harming the land, especially for rhizophora plants. However, they can be a valuable resource for soil amendment, particularly for oil palm plantations. The novelty and uniqueness of biochar products because biochar is made from palm frond waste from biomass natural resources whose materials are biological and come from pruning oil palm frond leaves, and the material can be renewed faster than naturally decomposed. Because palm frond waste material is often neglected by humans so, to eliminate palm frond waste into organic product materials, namely biochar products that function as an improvement

in soil physical properties, soil chemical properties, and soil biological properties for the creation of sustainable and waste-free oil palm plantations.

4. Benefit to mankind

The benefits for humans are that Biochar can be used as a soil conditioner to increase soil fertility, improve soil quality, and increase food crop production. Biochar can help absorb water and nutrients, reduce soil acidity, create a good living space for microorganisms, suppress nutrient losses that can become pollutants in water bodies. Biochar is also beneficial to the environment because biochar reduces the rate of CO₂ emissions and accumulates carbon in large enough quantities so as to reduce the rate of greenhouse gas emissions, because biochar comes from plants, plants absorb CO₂ from the atmosphere through photosynthesis. So, biochar is storing and removing CO₂ atoms, so biochar as a CO₂ remover. Global warming will increase the temperature on the earth's surface, trigger droughts, and trigger forest fires. This will cause haze which is very dangerous for health, even death.

5. Innovation and Entrepreneurial Impact

Biochar is an innovation that provides new solutions in agriculture and the environment. The innovation lies in its production process based on organic waste through pyrolysis, thus not only reducing environmental pollution but also creating added value from previously unutilized materials. As a multifunctional product, biochar not only improves soil fertility and crop yields, but also serves to reduce the rate of CO₂ emissions and accumulate carbon in large enough quantities to reduce the rate of greenhouse gas emissions. In terms of entrepreneurship, biochar opens up new business opportunities, especially among farmers and small businesses. With cheap and abundant raw materials, simple production processes, and a wide market in the agricultural sector, this product can be a source of additional income while supporting local economic growth. With this innovation, biochar makes a real contribution to the development of a more modern and environmentally friendly agribusiness sector.

6. Potential commercialization

Biochar has very promising commercialization potential due to its multifunctional, environmentally friendly, and abundant organic raw material-based properties. With increasing global awareness of sustainable agriculture and the need for organic products, biochar is a relevant solution to replace chemical fertilizers and is beneficial to the environment with its active carbon content that can reduce the rate of greenhouse gas emissions. The potential market includes smallholder farmers, large agribusiness players, and consumers in the plantation and horticulture sectors. Its efficient and low-cost production process allows businesses to offer products at competitive prices. With the development of marketing strategies such as educational campaigns, partnerships with farmers, and distribution through digital platforms, biochar can become a superior product that is not only financially profitable but also has a positive impact on the environment and the sustainability of the agricultural sector.

7. Authors' Biography



Feri Sandria was born in Rantauprapat City, Labuhanbatu Regency, North Sumatra Province, in the country of Indonesia on September 7, 2003. He is the 4th child of 4 siblings. His father's name is Rahmat and his mother's name is Paenah. He lives in a simple and happy family. Feri Sandria is a student of Agrotechnology Study Program, Faculty of Science and Technology, Universitas Labuhanbatu, Indonesia. He can be contacted via email: ferisandriaaja@gmail.com.



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