COMPARATIVE REPORT ON CORN STALKS BIOCHAR PRODUCTION METHODS.

1. Introduction.

This comparative experiment was conducted on 6th and 7th February 2025 in Sikata, Bungoma County, Kenya on this GPS coordinates 0.589, 34.575 by Gilbert Mwangi and Biochar Pamoja staff. The quantity measurements were volumetric. All three volumes were determined by filling feedstock (corn stalks) into a panel kiln until full to the brim.

The panel kiln bottom sheet, two side panels and both end panels were used to make a flat surface for the Top Down burn. This was to reduce an earth scar and to ensure collection of clean dry biochar for weight measurements after the burn.

A panel kiln was used for the TLUD experiment by providing a space of 50cm along both bottoms of end panels to provide air flow. Lighting of the feedstock was done from the top.

This report presents a comparative analysis of three biochar production methods;

- Top Down burn
- Top Lit Updraft (TLUD)
- Panel kiln

The methods are evaluated based on the following;

- Advantages and disadvantages
- Application and efficiency
- Environmental impact.

1. Biochar Yield Summary

- Top-Down Burn: 3.6 kg
- Top-Lit Updraft (TLUD)**:** 4.85 kg
- Panel Kiln (Frame Cap)**:** 8**.**3 kg

2. Advantages and disadvantages.

Method	Advantages	Disadvantages
Top-Down burn	a) Simple setup: Requires minimal equipment, making it accessible for small-scale operations b) Low cost: Initial investment is low due to the simplicity of the setup c) Quick fast burn Requires a few minutes to produce biochar from a corn stalk pile. d) Low Initial Cost: Requires minimal equipment, often just a pile of feedstock making it very cost-effective.	a) Inconsistent quality The quality of biochar can vary significantly due to uneven heating. b) Low yield: Typically results in lower yields compared to more controlled methods. c) Limited control Wind can blow away the burning feedstock and create a fire disaster d) Lots of heat It is not possible to immediately pick dry biochar for weight measurements.
Top Lit Updraft (TLUD)	a) Efficient Combustion: Provides a more controlled burn environment, improving biochar quality and consistency. b) Moderate Production: Biochar production is better than Top burn but lower than the panel kiln. c) Enhanced carbon retention The controlled environment contributes to carbon enhancement due to better feedstock combustion. d) Consistent Quality: Provides more consistent biochar properties due to controlled airflow and temperature management.	a) Higher Initial Cost: Requires metal kilns and may require a chipper for some feedstock preparation, increasing upfront costs. b) Complexity in Operation: Requires experience to maintain a steady burn line and manage airflow effectively. c) Variable Yield Rates: Biochar recovery rates can vary based on feedstock type and operational conditions. d) Limited scalability Requires careful design and control of feedstock

Panel kiln	a) High Yield Potential: Often results in higher yields compared to other methods, as seen with 8.3kg production. b) Controlled Environment: Offers better control over temperature and pyrolysis conditions, leading to consistent biochar quality. c) Scalability Advantage: Offers potential for large-scale production with modular designs	a) Moderate to high Initial cost: While panel kilns can be designed to reduce costs compared to some other systems, they still require more investment than simple top-down burns. b) Skilled manpower: Requires specialized equipment for construction and kiln operators. c) Energy Consumption: May consume more energy than simpler methods like top-down burning

3. Application and efficiency.

a) Top-Down Burn

Best for small-scale or tradition setting but inefficient in biochar production due to high ash formations. Highest ash content due to incomplete pyrolysis and oxidation leading to lower fixed carbon.

b) **TLUD**.

Suitable for moderate biochar production with a controlled environment for combustion, which can enhance carbon retention in the biochar. Moderate ash content, as it allows better control of combustion, producing a high fixed carbon.

c) Panel kiln.
Most efficient for large scale biochar production, offering the highest yield and more controlled pyrolysis. Lowest ash content with the highest carbon yield due to efficient carbonization and greatest potential for large-scale production.

4. Environmental impact:

Method	Environmental benefits	Environmental concerns
Top-Down burn	a) Less expensive Uses minimal equipment and resources b) Minimum experience No specialized tools and least training needed. c) Quick and fast Huge volumes of feedstock can be converted into biochar in the least time.	a) Higher ash content: Typically results in higher ash content due to incomplete combustion and less control over pyrolysis conditions b) Air pollution Releases particulate matter, volatile organic compounds (VOCs), and other pollutants into the air, contributing to poor air quality.

		c) Soil and water contamination: Ash can contaminate soil and water bodies, affecting ecosystems. d) Variable quality: The lack of precise temperature control leads to inconsistent biochar quality. e) Earth scars The method leaves a burn scar on the surface of the land.
Top Lit Updraft (TLUD)	a) Lower ash content: Offers better control over combustion conditions, potentially reducing ash content compared to open burns like top-down methods. b) Consistent quality: Provides more consistent biochar properties due to controlled airflow and temperature management c) Reduced emissions: Offers more controlled combustion compared to open burns, reducing emissions of harmful pollutants like VOCs and particulates.	Requires careful monitoring to optimize emissions.
Panel kiln	a) Optimum conditions Offers precise temperature control during pyrolysis, allowing for optimal conditions that maximize carbon content in the resulting biochar. b) Controlled environment: Provides a well-controlled burn environment that minimizes unburned carbon emissions and reduces air pollution compared to open burning methods. c) Efficient use of resources: Can optimize biochar yield while minimizing waste.	Requires an initial heating to burn down paints and other elements that are on the surface of the new fabricated panels increasing the carbon footprint.

5. Conclusion

Among the three methods, the panel kiln is the most efficient and environmentally friendly, producing the highest biochar yield with the lowest ash content. The TLUD offers a balance between efficiency and environmental benefits, while the Top-Down Burn is the least efficient but remains an accessible method for small scale use. For large scale biochar production with maximum environmental benefits, the panel kiln is recommended.

The ash content in biochar can vary greatly depending on the production method and can significantly affect its usability as a soil amendment. Ash can contain nutrients like potassium, calcium, and magnesium, which are beneficial for plant growth. However, high ash content may also introduce unwanted elements. Overall, moderate levels of ash in biochar can be beneficial as a nutrient source but should be balanced to avoid adverse effects on soil health and plant productivity.