

CIRCULAR BIONUTRIENT ECONOMY NETWORK

ANNUAL NEWSLETTER

DEC 2024
ISSUE 1

The Kon-Tiki Tower Rig

HOW-TO: BIOCHAR
FERTILIZER

THE ARTISANAL
STUDY TOUR

VISION 2030 WITH
BIOCHAR



“Circular Bio-nutrient Economy [CBE] allows for transformation of organic wastes into products, including fertilizers, and linking directly to local agricultural enterprises that utilize these products.” - Prof Charles Midega

CBEN ANNUAL NEWSLETTER

Nairobi & Kisumu, Kenya

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TABLE OF Contents

4	2024 Thank You Message
7	Revolutionizing Sustainable Solution for Smallholder Farmers
8	Bridging Efficiency and Scalability in Biochar Production
10	Potential of Biochar with Crop Residues in Maize Systems of Kenya
11	Experiences and Challenges in Biochar Handling
13	Questions and Answers: Meet Ojok Okello
15	Introduction and Adoption of Biochar from <i>Prosopis juliflora</i> (Mathenge) in Salabani, Marigat, Baringo
16	Fostering Collaboration and Innovation: Insights from the Biochar Study Tour in Kenya
17	Vision 2030 with Biochar
18	CBEN/IBI 2025 Academy and Conference
19	Pictorials
21	Advertisements
23	Network Members
23	Authorship



MESSAGE FROM CBEN STEERING MEMBERS



Prof Johannes Lehmann,
Cornell University



Bella Culotta, CBEN
Programs Manager

It's been a wonderful two years of Circular Bionutrient Economy Network (CBEN) engagement. CBEN only exists because all of you create it with your activities, contributions, thoughts, and suggestions. Together we have come a long way from get-togethers in Kisumu and Gitega in January 2023 to an amazing workshop in January 2024 again in Kisumu, Kenya, with over 80 participants from 14 different countries to an Artisanal Biochar Study Tour with stakeholders in Baringo and Uasin Gichu Counties in October 2024. With monthly CBEN catch-ups open to anyone who wants to join, to sessions around specific topics including international biochar standards and CBEN formalization pathways to field trips and collaborative working days, CBEN has filled a need to advance sustainable fertilizer and feed production from poorly-utilized residues, including but not limited to human and animal excreta- and we have fun doing it!

This newsletter is another step towards bringing all of us together to build a community of purpose around CBE. Its immediate goal is information exchange within CBEN and may also emerge as a tool to showcase CBE, our members' 2024 achievements, and how to think about advancing sustainability to the outside world. In 2025, we are already planning a biochar academy connected to a CBEN annual community meeting that promises to be an outstanding event as well as network formalization to support our growth and guide policy engagement. The annual newsletter hopefully attracts more community members to this amazing network of practitioners, regulators, NGOs, academics, and anyone who wants to make the world a better place by recycling poorly utilized residues for agricultural production.

Thanks for a 2024 filled with collaboration, inspiration, and innovation.

MESSAGE FROM PLANTVILLAGE



**LAWRENCE OMBWAYO, ASSOCIATE DIRECTOR
PLANTVILLAGE**

Dear Distinguished Stakeholders,

PlantVillage, a global nonprofit, research and development organization that empowers smallholder farmers by providing modern technologies to adapt to climate change and combat crop challenges. Their initiatives include AI-driven tools and open-access resources to enhance agricultural productivity and sustainability.

This year, 2024, has been a remarkable period for PlantVillage and our partners. Together, we have made significant strides in promoting sustainable agricultural practices, integrating digital tools like the PlantVillage Biochar dMRV App, and enhancing smallholder farmers' livelihoods. Notable achievements include scaling biochar production, advancing carbon sequestration methods, and fostering regional partnerships across East Africa.

By sharing these outcomes, we aim to inspire further collaboration and innovation toward sustainable agriculture and climate resilience.

We wish to appreciate our stakeholders who stood with us to help us achieve these successes

A prosperous New Year 2025 to you all!

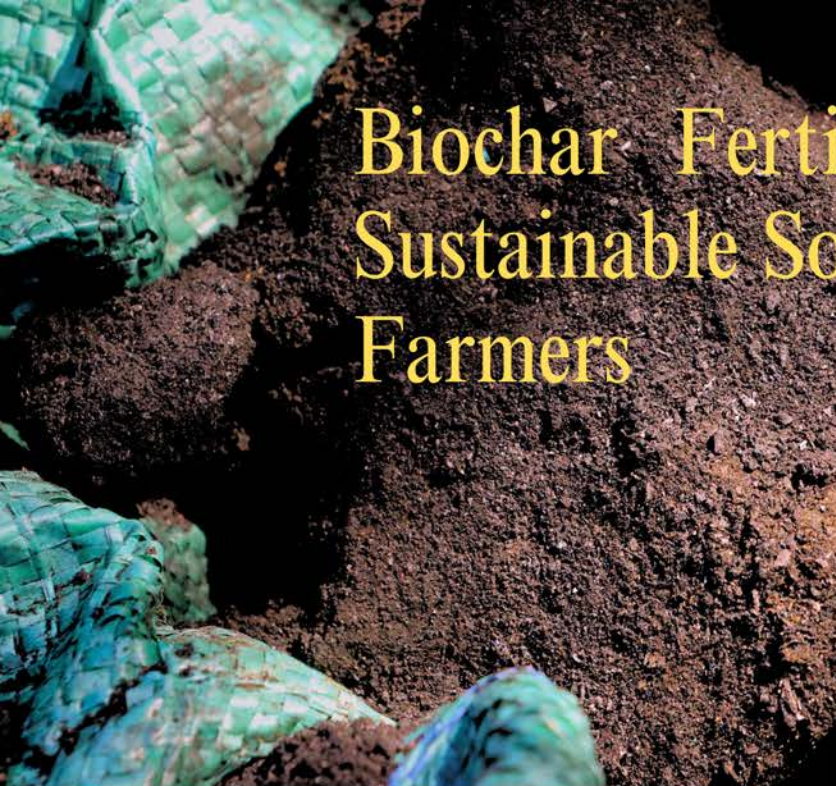
IN THIS ISSUE

Step into the creative buzz behind the CBEN Annual Newsletter! From dynamic photo shoots capturing impactful projects to thought-provoking interviews with biochar pioneers, each page comes alive through collaboration and passion. Peek behind the scenes to witness ideas transforming into stories, connecting our network's vision with the world.



Erick O. Abala
Editor In Chief & Head of
Communications-CBEN

Biochar Fertilizer: Revolutionizing Sustainable Solution for Smallholder Farmers



By Chelsea Akuleut and Tracy Amondi

Biochar is a carbon-rich product created through pyrolysis, a process that heats organic materials like agricultural residues, wood, or organic waste in a low-oxygen environment. The process begins with feedstock selection, ensuring it is sustainably sourced and has a moisture content below 25%. Techniques such as Kon-Tiki kilns or trenches are commonly used to produce biochar at a smaller-batch scale. After pyrolysis, biochar can be combined with compost, manures, pasteurized urine, or chemical fertilizers to create biochar-based fertilizers, bringing nutrients to crops with a high-carbon content material.

Biochar improves soil properties by increasing cation exchange capacity (CEC), enhancing nutrient availability, and fostering microbial activity. Its porous structure boosts water-holding capacity, regulates soil hydrology, and adsorbs soluble nutrients, reducing losses through runoff or leaching. Additionally, biochar buffers soil acidity and provides long-term stabilization of organic carbon, contributing to climate mitigation by sequestering carbon.

When mixed with nutrients, biochar enhances nutrient efficiency and supports sustainable farming practices, particularly for smallholder farmers. It reduces reliance on costly chemical fertilizers, addresses degraded soils, and helps farmers manage erratic rainfall. Biochar also transforms agricultural residues into valuable fertilizer, reducing waste and associated disposal costs.

On the policy and commercialization front, biochar is a sustainable solution for regenerating agricultural systems. Growing demand for sustainable inputs opens new markets for biochar-based fertilizers, which can be locally produced using affordable and abundant feedstock. Collaboration with government agencies, NGOs, and private-sector partners can scale production and distribution to benefit smallholder farmers. Ultimately, biochar aligns with broader goals of waste valorization, carbon sequestration, and resource-efficient agricultural systems, offering both economic and environmental benefits.

The Kon-Tiki Tower

Bridging Efficiency and Scalability in Biochar Production

*"The KonTiki Tower,
developed by PlantVillage,
bridges the gap between
artisanal and continuous-flow
systems with innovative
features, repurposing heat for
biomass drying, minimizing
emissions, and ensuring
scalability at competitive
pricing."*

By Dr. Dries Roobroeck





Uniting for Innovation: Participants of the October Artisanal Study Tour proudly pose in front of the Kon-Tiki Tower, celebrating hands-on learning, collaboration, and advancing sustainable biochar practices

Biochar project developers grapple with balancing operational efficiency, financial feasibility, and the stringent demands of carbon credit markets. These markets emphasize high output capacity, cost efficiency, compatibility with diverse biomass types, and minimal production-linked emissions. While artisanal KonTiki kilns are inexpensive, they fall short in delivering the large biochar volumes needed for scaled applications. Conversely, larger continuous-flow systems, though efficient, are over-engineered for many use cases, and tend to come with high costs and operational sensitivities.

The KonTiki Tower, developed by PlantVillage, addresses this gap with a combination of innovative yet nimble features. It repurposes heat generated during operation for biomass drying, maintaining a consistent flame bed to keep methane emissions below levels that would require compensatory tree planting.

Its internal design supports a broad range of biomass, from small materials like rice husks to larger pieces such as 10–20 cm coconut shells, minimizing pre-processing requirements.

Automation further enhances its appeal. Feeding mechanisms reduce labor costs, while its design allows for efficient, single-motion emptying of hot biochar. Local manufacturing capabilities reduce lead times for commissioning and make maintenance straightforward. The system's modular construction and integration of smart monitoring devices enable incremental investment and scalability to match growing demands.

With its ability to cater to diverse stakeholders and its scalability across various applications, the KonTiki Tower is well-positioned to meet growing demand at competitive pricing and tightly controlled process-linked emissions.



Potential of Biochar with Crop Residues in Maize Systems of Kenya

By Dr. Dries Roobroek



A recurring question is the practical scale and impact that biochar could achieve. To foster evidence-based conversations, the International Institute of Tropical Agriculture (IITA), funded by the GIZ ProSoil program and enriched with insights from industry informants, conducted an upscaled assessment of maize systems in Kenya. This study employed a robust modeling framework that incorporated official County-level data, allometric conversions of grain to stover and shank, livestock density considerations, provisions for enhanced soil mulch cover, and realistic crop response functions.

It was found that 17% of all maize residue in Kenya is addressable and mainly located in six counties. This available biomass could produce 358,970 tons of biochar, and when applied to the same area of farmlands, it would increase maize production by 160,976 tons in the first season, compensating 36% of the production shortfall caused by the fertilizer price surge that occurred in 2020-2022. Looping the simulation into a second season with legacy effects and dilution, the produced amount of biochar would increase by 26% and grain yield by 52%, offsetting 54% of the output loss caused by the fertilizer crisis.

Economic analysis, factoring in production costs and carbon credits demonstrated that the required investment in biochar during the first season is higher than that of synthetic fertilizers to reach the same yield increase. Thereafter biochar becomes more cost-efficient. In a four-year period, biochar inputs from available maize residue would have a cumulative net return of KES 553 million (US \$ 4.25 million) greater than intensification with synthetic fertilizer.

In that time, with the modeled 17% of available Kenyan maize residue, the cumulative climate mitigation effects from biochar use would amount to 2.23 million MT CO₂, accounting for 5% of Kenya's 2030 Climate Reduction Goals.

This study illustrates that biochar is a compelling pathway for Kenya to shore up maize production and cushion the impacts of fertilizer price surges. Deploying biochar in the vast maize-growing regions presents operational challenges, unlike cash crop systems and mills with aggregated residues. So, how can public sector engagement be leveraged to catalyze broader adoption and maximize impact?



Experiences and Challenges in Biochar Handling

By Milkiyas Ahmed & Sophia Bothe

Biochar users highlight its transformative potential in agriculture but are initially skeptical about the new practice. In regions dominated by invasive species like *Prosopis juliflora*, producing biochar from this material offers a dual benefit: controlling invasive growth and enhancing soil for agriculture. In arid and semi-arid regions with nutrient-depleted soils, biochar is applied after mixing, or nutrient ‘charging’ with other materials such as manures and composts. In regions where maize is a primary crop, residues that would otherwise be burned in open fires—a practice harmful to the environment—are converted into biochar.



Mixing manure with biochar reduces ammonia emissions from the slurry and after two weeks of charging, is highly effective for soil improvement. As biochar raises soil pH, manure-mixed char improves nutrient availability and addresses acidity in soils. Biochar production in these cases follows Artisan Pro Certification, ensuring that 80% of the biochar is returned to farmers, while the remaining 20% is sold locally. Both farmers and local governments value the initiative and actively support it.

A key challenge is maintaining quality standards in production. Although carbon content and pH are tested under the Artisan C-Sink Certification, testing for toxic compounds like polycyclic aromatic hydrocarbons (PAHs) is costly and limited by laboratory capabilities. Despite these obstacles, the exchange of knowledge and best practices within the network continues to enhance the effectiveness, safety, and accessibility of biochar use.



*"Producing biochar from invasive species like *Prosopis juliflora* offers a dual benefit: controlling invasive growth while enhancing soil for agriculture."*



Mixing manure with biochar reduces ammonia emissions from the slurry and, after two weeks of charging, produces a highly effective soil amendment that enhances nutrient availability and soil health



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QUESTIONS & ANSWERS



Meet Ojok Okello, the CEO of Okere City in Uganda. During the October study tour, Ojok first encountered biochar, sparking a passion for its potential.

1 *What was your first impression of biochar, and how do you perceive its role in sustainable agriculture and environmental conservation?*

My first encounter with biochar during an artisanal study tour left a lasting impression. Witnessing agricultural waste transform into a valuable resource highlighted its simplicity and immense potential. Biochar is a game-changer, addressing challenges like soil fertility, water retention, and food security. Its benefits include improving soil health, enhancing agricultural productivity, and acting as a powerful tool for carbon sequestration. Embracing biochar embodies circular economy principles, turning waste into a resource that supports sustainable agriculture, mitigates climate change, and fosters environmental stewardship. Its integration into local farming practices could revolutionize rural communities by boosting economic growth while promoting ecological balance, creating opportunities for both people and the planet.



2 *What motivated you to join CBEN, and how do you see biochar aligning with your personal or professional goals?*

My motivation to join CBEN began during my time as a Hubert H. Humphrey Fellow at Cornell University, where I met renowned biochar scientist Prof. Johannes Lehmann. Events at the Soil Factory in Ithaca, NY, transformed my perspective on soil's role in addressing global challenges. Bella, CBEN's coordinator, deepened my engagement, culminating in a biochar study trip. This experience inspired me to integrate biochar into the Okere Shea Butter Cooperative, aligning with my vision for sustainable development. Biochar enhances soil health, boosts productivity, and supports conservation while creating economic opportunities and combating climate change. I'm excited to explore its transformative potential for Okere City.





3 *What aspects of biochar production or application are you most curious or excited to learn more about?*

I am most curious and excited to delve deeper into the practical and technical aspects of biochar production, especially its scalability using local agricultural waste like shea nut shells and shea butter cake.

I'm also eager to learn more about integrating biochar into bio-fertilizers and how this can provide a cost-effective, sustainable solution for smallholder farmers. Understanding the science behind biochar's interaction with soil—how it improves nutrient availability, enhances water retention, and supports pest and disease resistance—excites me because of the direct impact it can have on agricultural productivity and food security.

On the application side, I'm particularly interested in exploring how biochar can help Okere City enter carbon credit markets. The potential to not only improve soil health and crop yields but also contribute to climate change mitigation through carbon sequestration is fascinating. Learning how to measure, monitor, and monetize these benefits is something I'm deeply invested in as I work toward building a sustainable and economically resilient model in Okere village in particular and northern Uganda in general.

4 *What opportunities do you see for biochar to create positive impacts in your community or region?*

Biochar offers a transformative solution to address the challenges faced by Okere and the broader region, including low agricultural productivity, water scarcity, and climate change. In regions like Otuke district, which experiences irregular rainfall, biochar's ability to retain water and nutrients in the soil is particularly beneficial. Biochar's environmental benefits extend beyond agriculture, promoting long-term ecosystem health and alignment with carbon mitigation goals.

Looking ahead, I aim to actively contribute to the advancement of biochar use through the CBEN network, using Okere as a model for other rural communities in northern Uganda. I have already connected with Verst Carbon, a Nairobi-based organization, to bring technical and capacity-building support to establish a biochar project in Okere. My ultimate goal is to create a self-sustaining biochar initiative that enhances soil health, boosts food security, and opens new revenue opportunities.



Introduction and Adoption of Biochar from *Prosopis juliflora* (Mathenge) in Salabani, Marigat, Baringo

By John Mayieka

Prosopis juliflora, an invasive tree species also known as mathenge, was introduced to Kenya in the 1970s to curb desertification, provide fuelwood, and restore degraded lands. In Baringo, it quickly spread due to its resilience in arid and semi-arid lands (ASALs). The unintended invasiveness has been severe, displacing native species, reducing grazing lands for the pastoralists thereby limiting their source of income, and disrupting the ecosystem including shifts in river channels among other land changes.

These impacts have brought about challenges in Baringo County and ASALs. The process of eradication is quite laborious and costly making it difficult for these communities to effectively manage the invasive trees. PlantVillage's biochar project in Baringo has repurposed mathenge into an opportunity: 'turning trash into treasure.' The project began with community engagement to understand the impacts of this tree and alternative uses for it. The project involves converting mathenge into high-quality biochar which is put into the soil and grass seeds are sown. This addresses ecological impacts and financially incentivizes the community. Farmers can actively produce fodder and grass seeds for their livestock and surplus for sale. Biochar improves soil fertility, enhances soil's water retention, and sequesters carbon aligning with sustainable and agricultural goals.

The circular 'trash to treasure' process is community-driven, engaging the community members from the felling of the tree until biochar application and sowing of grass seeds. To standardize the process, community members are trained in accordance with the Artisanal Global C-Sink biochar standards where they prepare the biomass, produce biochar in well-crafted Kon-tiki Kilns, and record their work in PlantVillage's dMRV system which has been endorsed by Carbon Standards International. This PlantVillage dMRV system tracks the process from production to usage providing a highly transparent system for artisan biochar producers.

Key challenges remain to create awareness and build local capacity. However, initiatives such as study tours and community engagement showcase the feasibility and benefits of biochar for agricultural application, fostering adoption and broader acceptance.

Fostering Collaboration and Innovation: Insights from the Biochar Study Tour in Kenya

By Annet Pollex & Sophia Bothe

From October 24-29, an inspiring five-day study tour place providing insight to biochar production and application as implemented in Uasin Gishu and Baringo counties, Kenya. The tour brought together diverse participants from CBEN Kenya, Ethiopia's Ministry of Agriculture, Bureau of Agriculture Oromia, Jimma University and Agricultural Research Institute Oromia (IQOO), Plant Village Kenya, as well as representatives from Okere City in Uganda and DBFZ, Germany.

The focus was on sharing experiences on Artisan C-Sink certification and learning from smallholder farmers using biochar. A standout highlight was visiting villages where biochar production is well established. In Baringo County, an invasive species (*Prosopis juliflora*) that is dominating the landscape provides large amounts of woody material for biochar production.

To manage the population of *Prosopis juliflora*, the PlantVillage team pyrolyzed *Prosopis* stumps and branches using Kon-tiki kilns and applied the resulting biochar to cleared pastoral land to improve the water-holding capacity of the soil. Consequently, soil improvement was combined with reviving of pastoral land. In Uasin Gishu County, maize residues form the primary biochar feedstock. Here, workers showcased an advanced semi-automatic practice employing an automated Kon-Tiki tower. Maize straw which was cut into smaller pieces is used as feedstock and the residual heat of the pyrolysis process is used to dry the next batch of maize residues, enhancing efficiency and sustainability.

The study tour provided valuable networking opportunities. Participants benefited from discussions with experts from Plant Village, whose guidance provided clarity on the Artisan C-Sink certification process and insight into the responsibilities of the C-sink manager. They showcased their and the steps of the digital monitoring, reporting, and verification (dMRV) tool. Interactions with Edward Sawe, a county executive committee member from Uasin Gishu, offered insights into the challenges faced by smallholder farmers and the impactful solutions Plant Village brings to these communities.

Beyond structured sessions, the personal exchanges and connections made during the tour enriched the experience. Every interaction contributed to a deeper understanding of biochar's potential in sustainable agriculture and strengthened collaborations among researchers, practitioners, and policymakers. This study tour not only highlighted technological advancements but also underscored the importance of collaboration in building resilience for smallholder farmers.

"In Baringo County, an invasive species, Prosopis juliflora, provided large amounts of woody material for biochar production. Pyrolysis of its stumps and branches using Kon-Tiki kilns resulted in biochar application to cleared pastoral land, improving water-holding capacity and reviving degraded soils."





Vision 2030 With Biochar

By Sam Thuo



The journey toward Vision 2030 presents a unique opportunity to embrace innovative solutions like biochar that address pressing agricultural, environmental, and economic challenges. As Kenya accelerates its development goals, biochar emerges as a transformative tool across multiple levels—from producers and farmers to the national agenda.

From the Producer's Perspective; Biochar production is a cornerstone of Kenya's green economy aspirations. By utilizing organic waste, producers not only minimize environmental pollution but also create a versatile product that addresses soil degradation and carbon sequestration. The production process itself generates employment, particularly in rural areas, empowering youth and women. Investments in hybrid technologies, such as solar-powered kilns, further demonstrate Kenya's commitment to sustainable innovation.

From the Farmer's Perspective; Biochar is more than a soil amendment; it is a lifeline. By enhancing soil fertility, retaining water, and reducing the need for chemical fertilizers, biochar enables smallholders to increase crop yields while cutting costs. Farmers using biochar also benefit from resilience against climate change impacts, such as droughts and declining soil productivity. This aligns with Vision 2030's emphasis on agricultural transformation and food security.

From the National Perspective; At the national level, biochar supports Kenya's commitments to climate action and sustainable development. Its ability to sequester carbon positions Kenya as a leader in the fight against climate change, while its agricultural benefits directly contribute to economic growth and poverty reduction. By scaling biochar production and adoption, Kenya can enhance its global standing while delivering on Vision 2030's triple-bottom-line goals: economic prosperity, social equity, and environmental sustainability.

As highlighted during the 2024 Artisanal Study Tour, biochar's potential is boundless. With collaborative efforts from producers, farmers, and national stakeholders, biochar can drive Kenya toward a greener, more resilient future.

Upcoming Event



Biochar Education Event Opportunity

The International Biochar Initiative (IBI) and the Circular Bionutrient Economy Network (CBEN) are partnering to offer a biochar education and capacity-building program in Kenya in June 2025.

EVENT HIGHLIGHTS

The multi-day event features a new IBI Biochar Academy focused on business development (5 days), with the integration of a nutrient and carbon recovery-focused CBEN conference (2 days). Participants can either attend the entire 5-day event (Biochar Academy and CBEN) or they may just attend one of the events: Biochar Academy, 5 days or CBEN, 2 days

The event will culminate with a final showcase open to international stakeholders to meet the local attendees, learn about their biochar and nutrient recovery work, and gain insights. **We are seeking support for this incredible effort.**

Day 1:
IBI Academy

Day 2:
IBI Academy

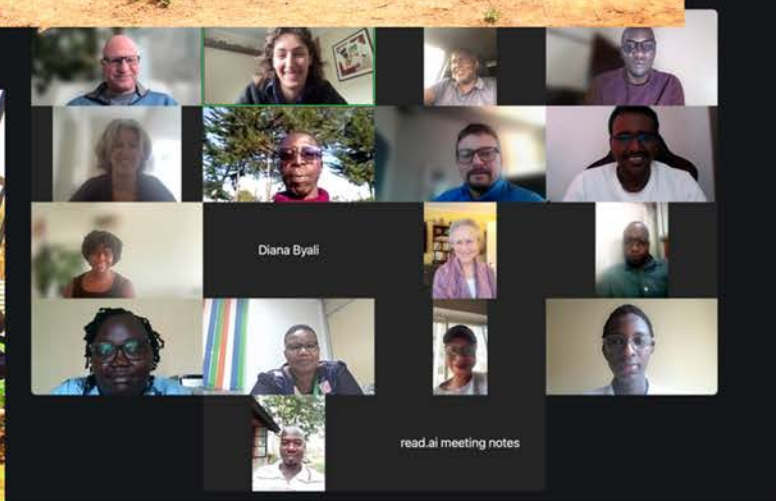
Day 3: IBI Academy

Day 4:
CBEN & IBI Academy
parallel sessions

Day 5:
CBEN & IBI Academy
joint session



Pictorials



Pictorials



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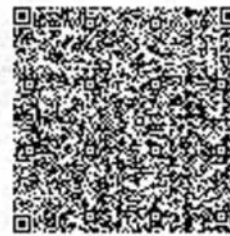
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Importance of Biochar

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- Soil fertility improvement: Enhances nutrient retention and promotes microbial activity.
- Increased water retention: Biochar helps soils retain moisture.
- pH balancing: Acts as a buffer, stabilizing soil pH.

PlantVillage

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AUTHORSHIP



Annett Pollex is a research scientist at Deutsches Biomasseforschungszentrum gemeinnützige GmbH (DBFZ) and chair of DIN Standardization Committee for biochar and pyrogenic carbonaceous materials/biochar quality assurance and analysis.



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Dries Roobroeck is a Associate Scientist and Researcher in Applied Biosciences at International Institute of Tropical Agriculture (IITA).



Erick O. Abala is the Head of Communications at CBEN. Erick has a background in Corporate Communication with over 6 years experience in the sanitation space



Isabella Culotta is the East Africa Programs Manager at CBEN and Head of R&D at BIOSORA. Her research background is biochar and soil chemistry at Cornell University



Johannes Lehmann is a Professor in the Soil and Crop Sciences Department at Cornell University and on the steering committee of the International Biochar Initiative and CBEN.



John Mayieka oversees Biochar Production and leads Operations Lead at PlantVillage+ Kenya.



Lawrence Ombwayo is the Associate Director at PlantVillage+ Kenya with a background in Agronomy, Plant Breeding and Biotechnology



Mercy Achieng is a Communication Associate and Social Media Manager at PlantVillage+ Kenya



Milkiyas Ahmed is a Lecturer and a Soil Science Researcher at Jimma University. He has over 13 years experience working with biochar.



Ojok Okello is the founder and CEO of Okere City, in Uganda. He is a visionary rural futurist, community organizer, and artist.



Samuel Thuo Mungai is the founder of Ziada Solutions Kenya and is a sustainability expert, agronomist and entrepreneur championing green innovations & sustainable agriculture.



Sophia Bothe is a Research Associate at Deutsches Biomasseforschungszentrum gemeinnützige GmbH (DBFZ)



Tracy Amondi the the Lead Technical and Client Support Officer at PlantVillage + Kenya. She specializes in biochar account management and has a forestry background.

OUR NETWORK



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Poverty and Health
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LaserArts



A Living Wind Blows



UNIVERSITY OF NAIROBI



ON THE GROUND



Transforming African Agriculture



Cornell University



Oromia Agricultural Research Institute



ORGANIC FERTILIZER & INPUT
MANUFACTURERS ASSOCIATION OF KENYA



An Impact Venture by Warm Heart Worldwide



World
Agroforestry



STUDI ANALISI E RICERCHE
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