DEVELOPING SUSTAINABLE BIOCHAR MARKETS: STRATEGIES, CHALLENGES, AND OPPORTUNITIES IN GHANA.

CSIR – FORIG.

KUMASI, GHANA.

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INTRODUCTION

- Biochar is like a charcoal residue, usually, a rich carbon product obtained when different biomass resources (agriculture residues, wood, dung, etc) are heated in a container with little or no available air (pyrolysis) (Lehmann and Joseph, 2015).
- A well produced biochar improves soil properties for crop production (soil retention capacity, water holding capacity), sustainably store carbon, reduces GHG emissions, and can be used as soil additive, and treat wastewater (Groot, *et al.,* 2017, IBI, 2022).
- Additionally, promoting the use of biochar globally has the potential to capture up to three billion metric tons of carbon dioxide annually, thus, 6% of global carbon emissions (total emissions of 803 coal-fired power plants in one year) (Carbon Herald, 2023).
- Biochar production requires a good technology, and such technologies could be challenging when producers have limited understanding and skills on their production and use variables (yield efficiency, environmental impact and economic impacts).

- Explored the potentials of three user-friendly kiln technologies for biochar production (requirements for usage, and benefits and challenges.

Courtesy by Asare, (2022)

Some feedstocks and benefits biochar

Courtesy by Dobson and Self, (n.d)

Courtesy by BackyardBiochar.net

Courtesy by BackyardBiochar.net

Purdue's Forestry and Natural Resources Extension and the Purdue's Community Service-Learning Projects partnered with the CSIR-FORIG, Kumasi, Ashanti, to create resources that encourage the production, use and opportunities of biochar production in Ghana.

This partnership has undergone four different Stages:

- Gathering information on biochar production technologies: Spring 2022
- Kiln selection, designing, prototyping and fabrication: Summer 2022
- Testing for the efficiencies of produced kilns using three Indiana agricultural feedstocks: Fall 2022
- Community engagement and stakeholder involvement in Ghana: Summer, 2023.

OBJECTIVES

Selection and Design of Biochar Kilns

- Established the baseline information of appropriate and globally used biochar kilns
- Choose kilns that could be manufactured in-house with little to no skills, and less costly

Manufacture Selected Kilns and Determine their Efficiencies

- Designed and manufacture three affordable and environmentally friendly biochar kilns using local materials
- Produced biochar from manufactured kilns using agro-industrial residues.

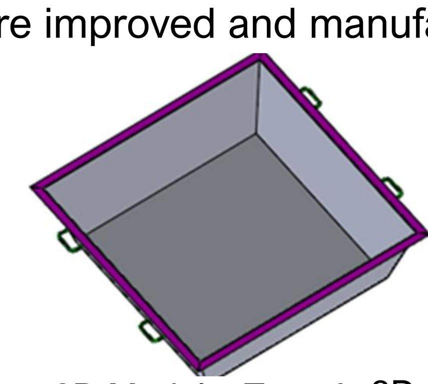
Engage Community and Involve Stakeholders Towards Implementation

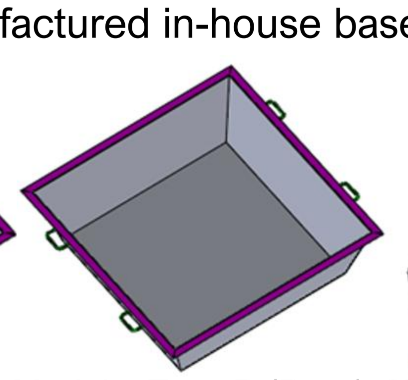
- Involve research scientists, educators, public and private organizations interested in biochar production
- Create a logic model/activity plan towards the implementation of sustainable biochar production and applications.

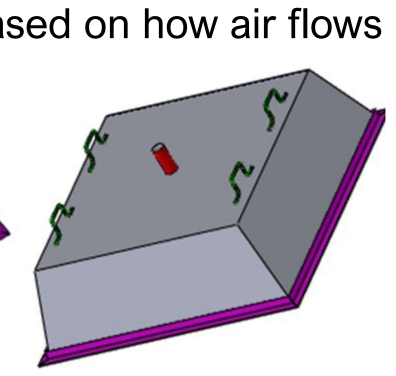
METHOD 1: KILN SELECTION, DESIGNING AND PROTOTYPING

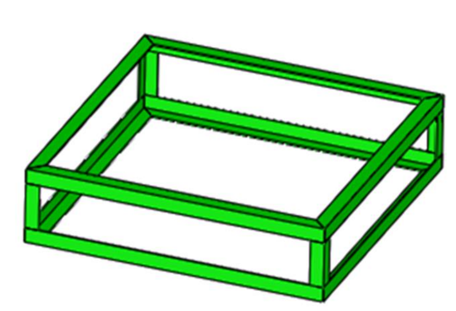
- Desk study, interviews, questionnaires and panel discussion were used to gather information on 15 potential biochar kilns worldwide.
- Three of these kiln were selected due to their flexibility in production, ease of usage, environmental friendliness and cost effectiveness.
- Selected kilns were improved and manufactured in-house based on how air flows into the burning chamber during pyrolysis.

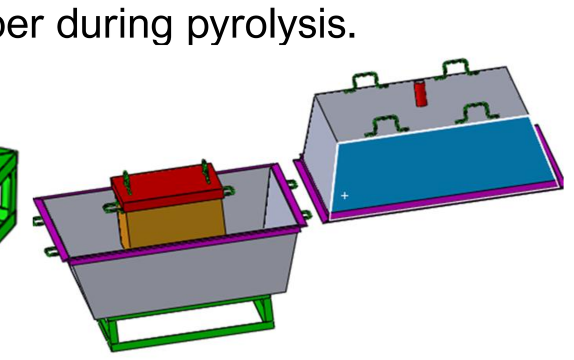
- Modified kilns were named Type A (Open Chamber with No Lid), Type B (Type A with a Lid) and Type C (Places an Inner Chamber in Type B).


3D Model – Type A


3D Model – Type B (Base)


3D Model – Type B (Lid)


3D Model – Type C (Stand)


3D Model – Type C

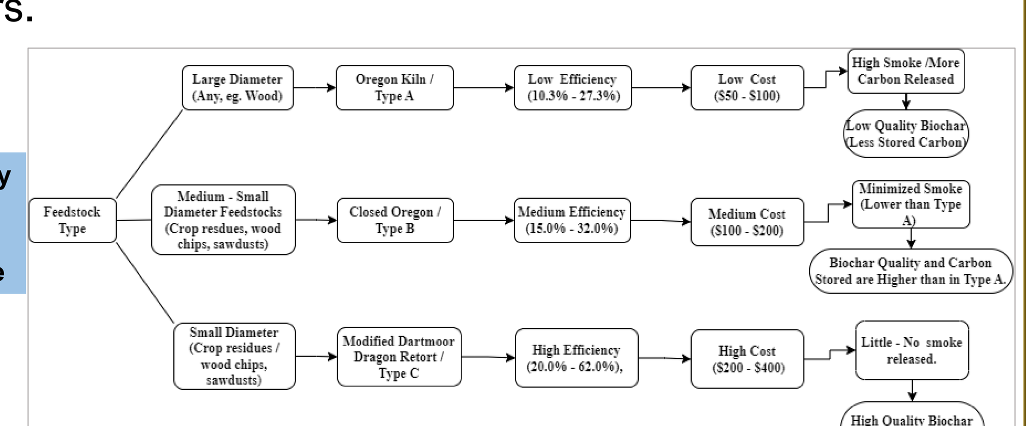
METHOD 2: KILN MANUFACTURING AND BIOCHAR PRODUCTION

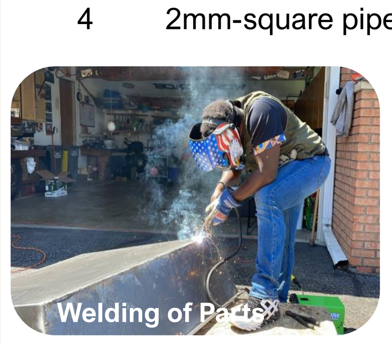
- Cutting list was prepared based on the type of kiln/retort, availability of materials, tools and equipment ,and preference of producers.
- Fabrication consisted of cutting, bending and assembling of parts (welding)
- Dimensions and shape/size of kilns depend on the choice and need of producers.

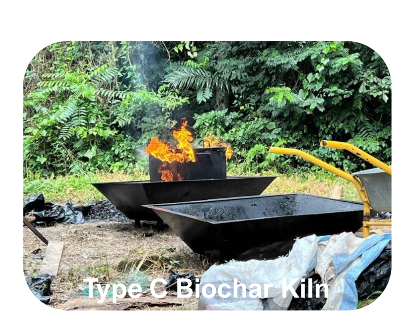
Cutting List used for the Kiln Production

Pieces	Type of Material	Dimension	Purpose of Material
2	3mm-gauge mild steel	40''x 40''	Kiln Base (Types-A and B)
4	3mm-gauge mild steel	48''x 40''	Kiln sides (Types-A and B)
4	3mm-gauge mild steel	40''x 40''	Lid/Cover (Types-B)
1	3mm-gauge mild steel	20''x 20''	Kiln base (Type-C)
3	3mm-gauge mild steel	14'' x 20''	Kiln sides (Type-C)
1	3mm-gauge mild steel	21'' x 21'' x 2'' height	Lid/Cover (Type-C)
1	Iron pipe	2'' dia. x 5''height	Chimney
2	Iron rod bar	¼''dia. x 14''	Handles
4	2mm-square pipe	15''	Stand

Choosing a technology based on feedstock, yield requirement and producers' preference







METHOD 3: COMMUNITY ENGAGEMENT AND STAKEHOLDER INVOLVEMENT

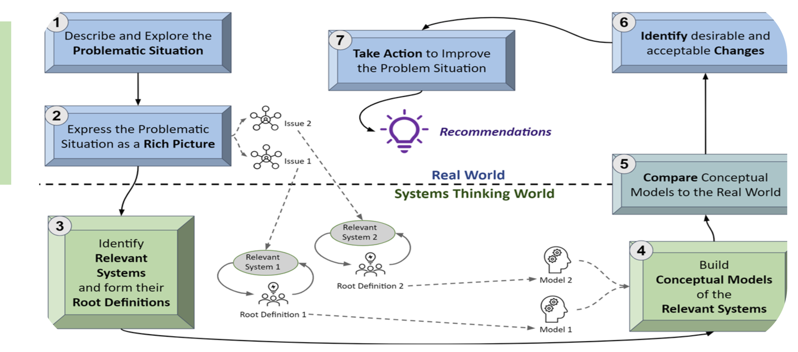
- We directly involved small-scale farmers, researchers, students, partnering industries (manufacturers), and stakeholders in four regions (Ashanti, Bono, Ahafo and the Greater Accra) of Ghana.
- We used in person interviews, focus group discussions and semi-structured questionnaires.
- We organized four seminars' presentations, two training workshops on kiln manufacturing and biochar production were organized
- We demonstrated of the step-by-step approach of kiln manufacturing and biochar production to participants.
- We involved stakeholders (those with special interest and commitment) to develop a conceptual model to produce and market biochar.

KEY ITEMS TO CONSIDER WHEN PLANNING COMMUNITY ENGAGEMENT ACTIVITIES

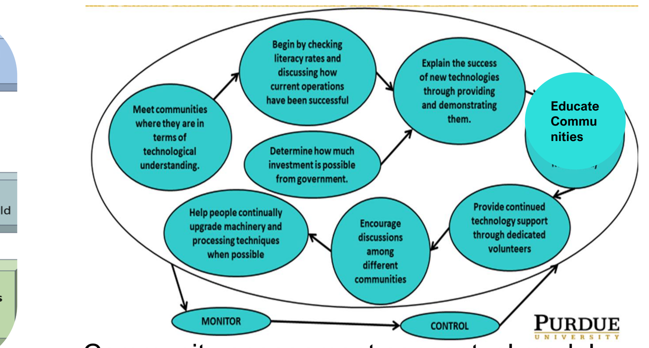
- We created strategies and outlined the opportunities in the biochar industry with participants using logic models (See below)

Steps:

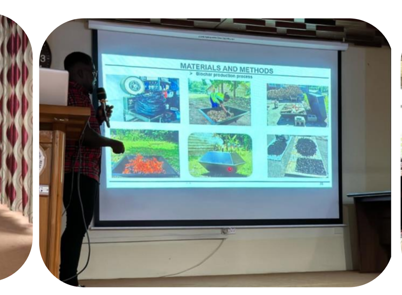
1. Use the SSM and CSH Approaches
2. Explore the CATWOE model
3. Introduce Conceptual Models
4. Develop your Logic Model /Action Plan

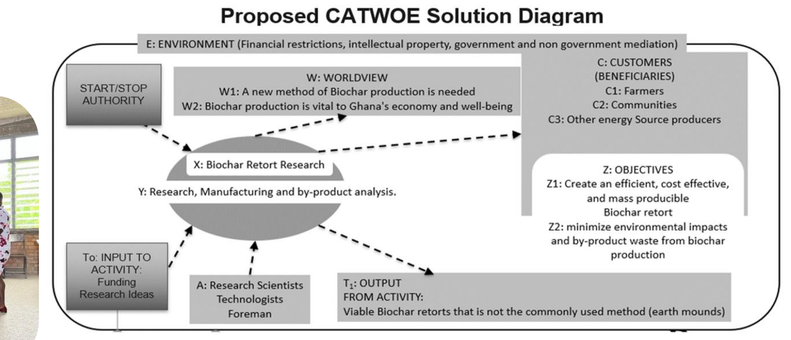


Soft Systems Methodology and CSH Approach

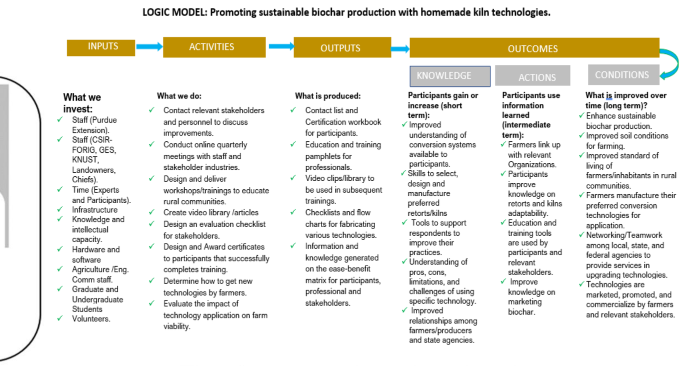


Community engagement conceptual model





Decision making process using CATWOE model


Tips for extension plan development

IMPACTS

- The education and training sessions directly involved 323 people (**128 farmers, 96 students, 9 university lecturers and/or instructors, 31 volunteers, 59 stakeholders)** from different sectors.
- Seminars and training sessions equipped participants to acquire the **skill set (welding) needed for kiln production** which could **minimize labor and fabrication costs** from other producers/manufacturers.
- Participants obtained the **knowledge and skills to produce biochar** using the three manufactured kilns, and from both agricultural (corn cob, coconut shells, and coconut husk) and wooden debris (Cedrela and Teak).
- Students **networked** with stakeholders and farmers to create biochar conceptual models for future engagements.
- Stakeholders obtained knowledge in tailoring and developing their own **logic models and activity plan** for the implementation of biochar production activities.
- Participants were able to **decide on the type of kilns needed based on their need, financial investment and benefits**
- This project was **sensitized using different social media platforms** and it is believed to reach quite a few numbers of people than what is recorded in this work.

REFLECTIONS AND CONCLUSIONS

- The project lays the groundwork for innovative, cost-effective solutions to agricultural and environmental challenges.
- The seminars and training sessions appear to have successfully imparted essential skills and fosters self-sufficiency among the participants towards developing eco-friendly practices.
- The opportunity for networking among participants would catalyze further innovation and collaboration in the field of biochar technology.
- The yield and quality of biochar significantly increases as air entry to the kiln is more controlled, thus, the Type C kiln had the highest yield with less environmental pollution, followed by Type B and Type A.
- Farmers hardly patronize expensive technologies without the financial support from stakeholders, and this happens when they have alternatively cheaper and easily accessible replacements/means for such technologies.
- There is less availability of biochar markets in Ghana, and this could be a great business opportunity for young entrepreneurs.
- We encountered challenges in scaling the project to reach a broader audience, ensuring the sustainability of the project through continuous funding and engagement, and addressing the technical and practical challenges faced by participants

Future Plans:

- Enhance communication and outreach strategies to maximize project impact.
- Foster partnerships with several educational institutions and stakeholders for knowledge exchange and resource mobilization.
- Monitor and evaluate the project's outcomes to inform improvements and adaptations in different communities

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