RoCC Kilns and Biochar in Kenya

Green Carbon Webinar
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Presented by:

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Why this presentation?

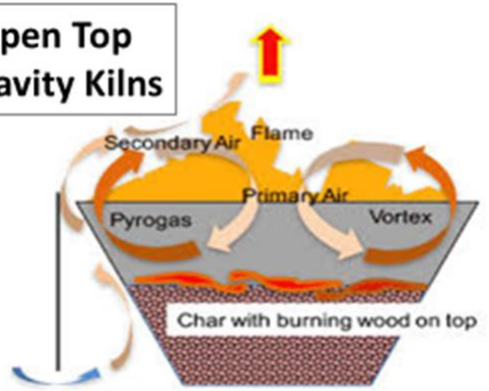
- We need biochar production with low(er) cost devices and operations.
  - RoCC kilns are being developed and deployed.
- The efforts in Kenya are the frontier, the firing line, the test cases.
- The Kenya experiences can be beneficial for starting RoCC kiln projects in other countries.
- **This is essentially an interim report on the first project that puts RoCC kilns into daily use.**

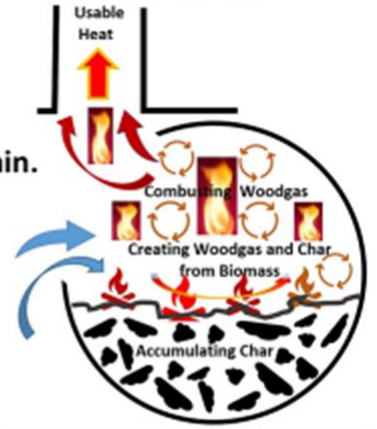
Background – 2014 to July 2019 – 4C Kiln

- 2014 to July 2019, Paul Anderson created and developed a **Clean Controlled Covered Cavity (4C) Kiln.** **It did not rotate.**
- It is Flame Cap technology.

The RoCC Kiln Technology

- **Flame Cap (aka Flame Curtain) pyrolysis technology is accomplished in cavities with closed bottoms and open tops.**
- **"4C kilns" were covered cavity kilns that were not rotatable.** [~ 8 made between 2014 and 2019.]
- **Rotatable Covered Cavity (RoCC) kilns from 2019.**





Shared Flame Cap Features

- Heat, flames and emissions rise away from the flame cap.
- Combustion of pyrolytic gases occurs with turbulence.
- Pyrolysis of biomass occurs because of the heat of the cap of flames.
- Char accumulates in the lower areas where oxygen cannot reach because of the cap of flames.

Advantages of RoCC:

- Flame is protected from wind & rain.
- Longer heat retention in the combusting gases.
- Created heat can be directed to uses via chimneys.
- Chimneys can assist with draft.
- Rotation mixes the char to assure that all the biomass is pyrolyzed.
- Rotation to easily empty the char.

Background – August to November 2019

- August to October 2019, **Anderson invents the Rotatable Covered Cavity (RoCC) kiln technology**, with assistance by Gary Gilmore. Earliest barrel size units are built in IL and PA.
- November 2019, Anderson attends the CCA cookstove conference in Nairobi, Kenya. He visits his friends at Wisdom Stoves in North Kinangop,, where Gilbert Mwangi is a manager.

- **The first RoCC kiln outside of the USA is built in 24 hours in Engineer, Kenya,** and it is tested successfully at the Wisdom Stove workshop. A report is at: https://woodgas.com/wp-content/uploads/2022/02/RoCC-barrel-Kenya-example-2020-03-28.pdf

Background – December 2019 to April 2021

- In December 2019 Paul guided the production of a **RoCC kiln at IMMT**, India with Dr. Manish Kumar.
- In February 2020, Paul arranged fabrication of the **4-ft diameter RoCC kiln in California** and later in South and Pennsylvania.
- COVID-19 arrives. There was no action for over a year in Kenya. Gilbert's employment ended and he became the custodian of the RoCC kiln.

Background – April to July 2021

- ~March 2021, long-time friend Dr. James Onchieku at Kisii University in western Kenya desires to make biochar.
- April 2021, Gilbert travels with the first Kenyan RoCC kiln to Kisii where two more RoCC kilns are made and put into use. Successful biochar production from rice husks was accomplished.
- Gilbert travels with one RoCC kiln to Bungoma (town and district) where biochar activities by others with TLUD stoves and barrels had been tried but had stopped years ago.
- **Gilbert begins as managing director of Biochar Pamoja Kenya.** Four more RoCC kilns are fabricated, including two with the new H-Frame design.
- Biochar production begins in late July, including record keeping for eventual recording in the CERCS CharTrac system for claiming carbon credits.

Objectives of the Biochar Pamoja Kenya Project

We need to have and we are a test case for

- RoCC kilns — Kiln fabrication
- Biomass types — Fuel characteristics and supply
- Biochar production — Producing biochar on a regular basis.
- Biochar usage — How to sequester the biochar in soils
- CharTrac — How to claim carbon credits
- Costs — Understand the practical issues of expenses
- Sustainability — Check of sustainability

RoCC kilns with H-Frames as built in Kenya

These are H-Frame kilns, the preferred design for fabrication. The "H" is seen at both ends of the kiln.

Two RoCC kilns with X-Frames

A biochar discharge shelf to be under the kiln barrels.

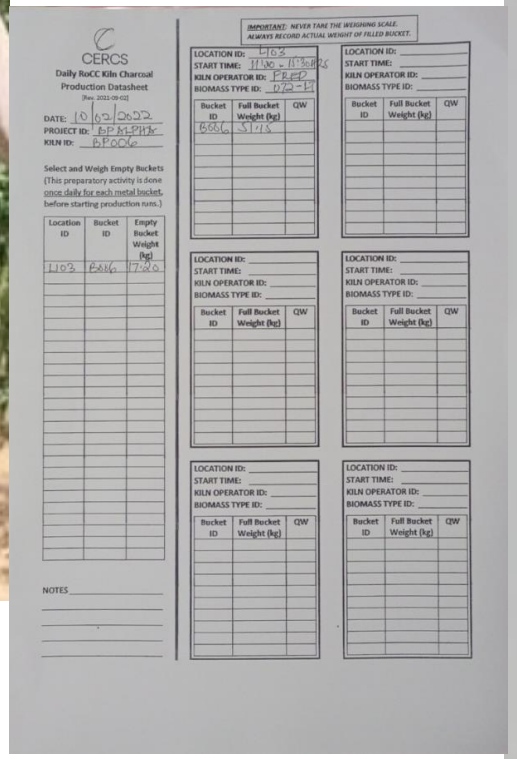
Biochar production methods

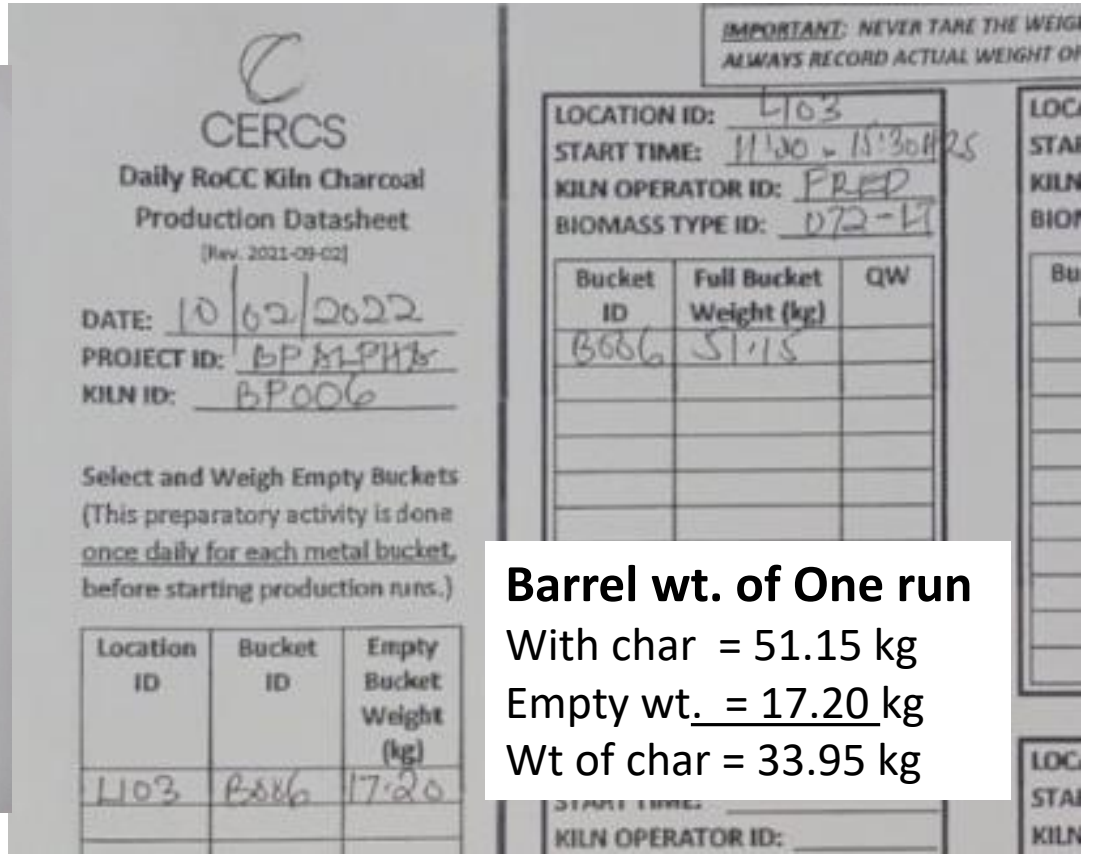
The produced biochar is **weighed while totally dry** (and still hot). Initially we used 20-liter buckets. Now we weigh in 200-liter barrels.

Weights are recorded four times:

1. Photograph with time stamp
2. Written data sheet
3. Spreadsheet (not shown) by Gilbert
4. Entry into the CERCS CharTrac mobile app for transmission to its blockchain-enabled component (soon to be released)

Clear data are <u>essential</u> for verification and certification.





Barrel wt. of One run

With char = 51.15 kg

Empty wt. = 17.20 kg

Wt of char = 33.95 kg

Types of biomass

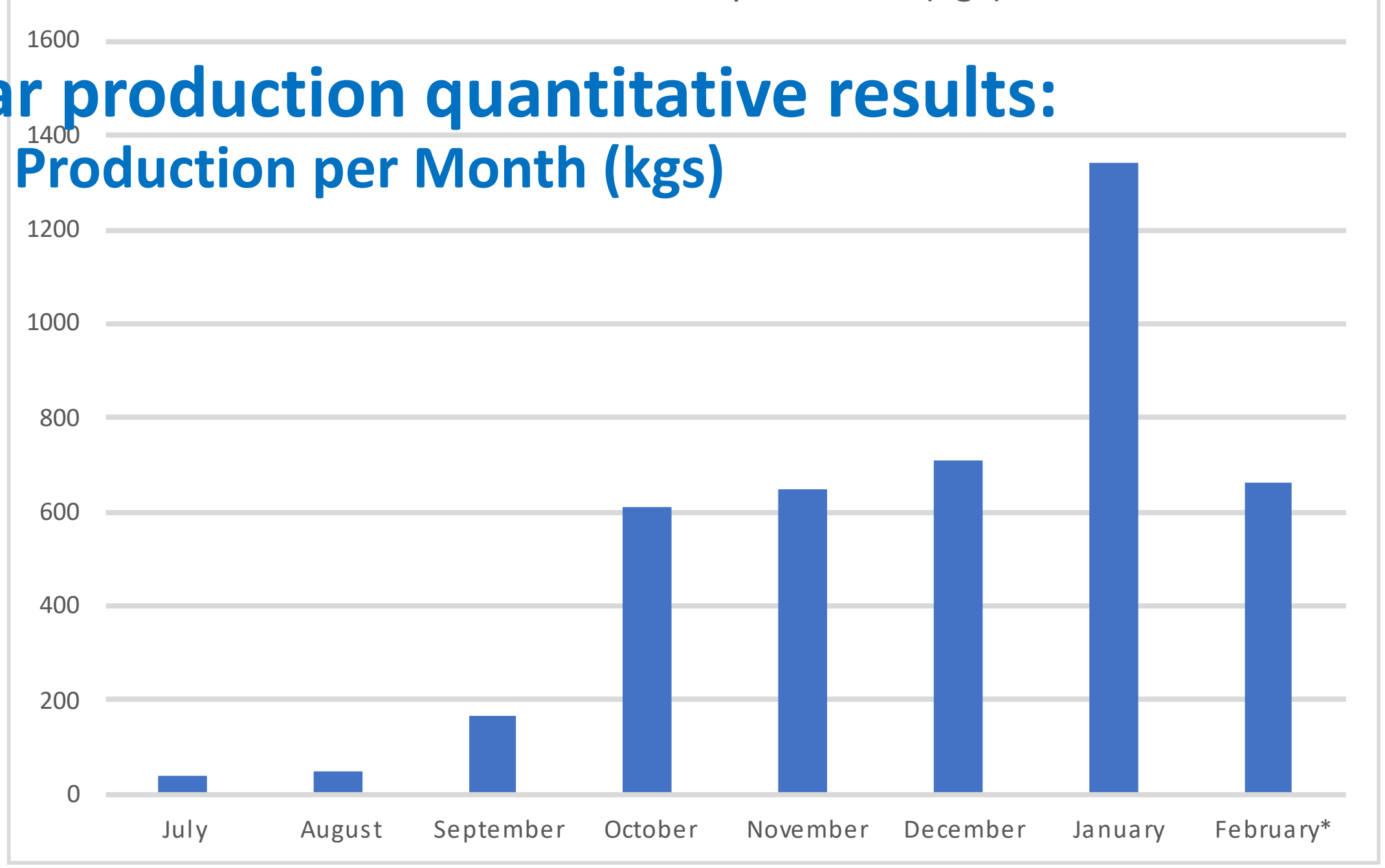
Mexican Sunflower is a weed

Biochar production quantitative results

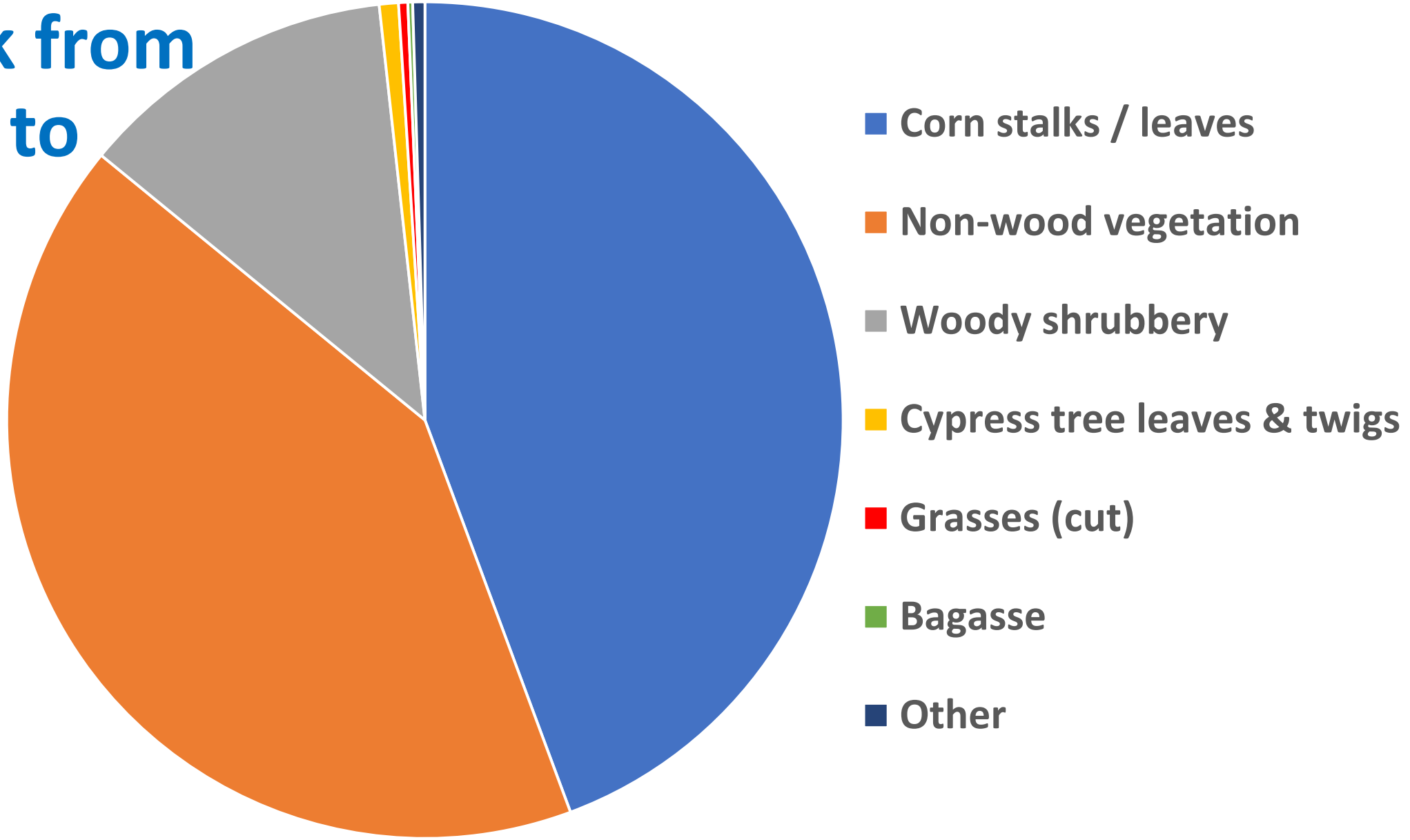
- 1 worker 1 run 1 kiln 1 day for average of 29 kg.
- 1 wk => 100 kg. 10 wks = 1 tonne

Biochar production quantitative results:

Biochar Production per Month (kgs)



Production by Feedstock from July 2021 to Feb 2022



Production by Feedstock by Month (kgs)

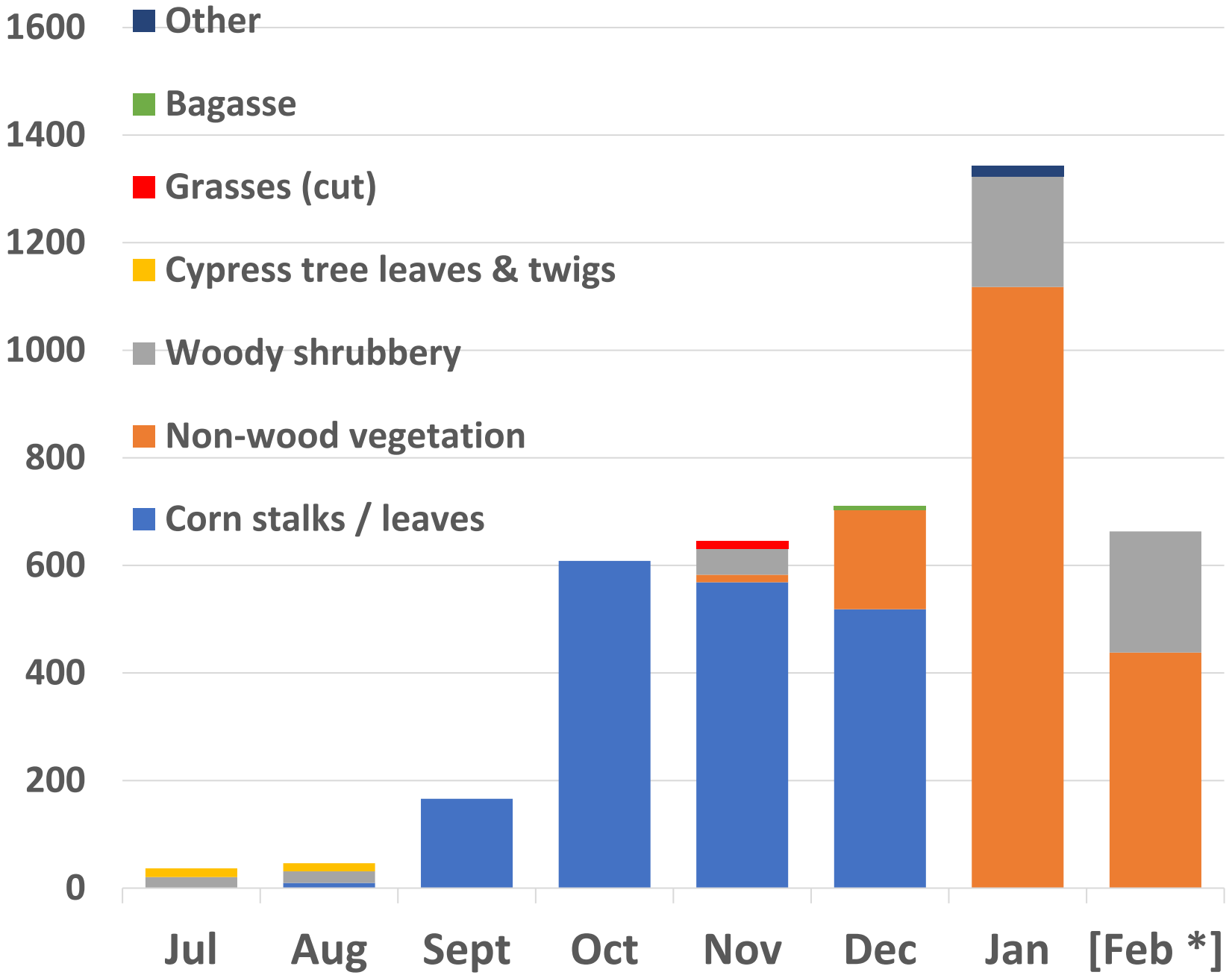
From our spreadsheet of data. See Graph (next)

	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22			
	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb [1-22]			
Production by Feedstock	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**[Feb *]**		**TOTALS**	
Corn stalks / leaves	0	10	166	608	569	518	0	0		1871	44%
Non-wood vegetation	0	0	0	0	14	184	1118	438		1754	42%
Woody shrubbery	21	21	0	0	48	0	206	225		521	12%
Cypress tree leaves & twigs	16	15	0	0	0	0	0	0		31	1%
Grasses (cut)	0	0	0	0	15	0	0	0		15	0%
Bagasse	0	0	0	0	0	8	0	0		8	0%
Other	0	0	0	0	0	0	20	0		20	0%
Totals	**37**	**46**	**166**	**608**	**646**	**710**	**1343**	**663**		**4219**	

Four tonnes of biochar

Production by Feedstock by Month (kgs)

Total = 4219 kg



Biochar storage is in sacks or at fields

Variables include weather, security, time of year and volume

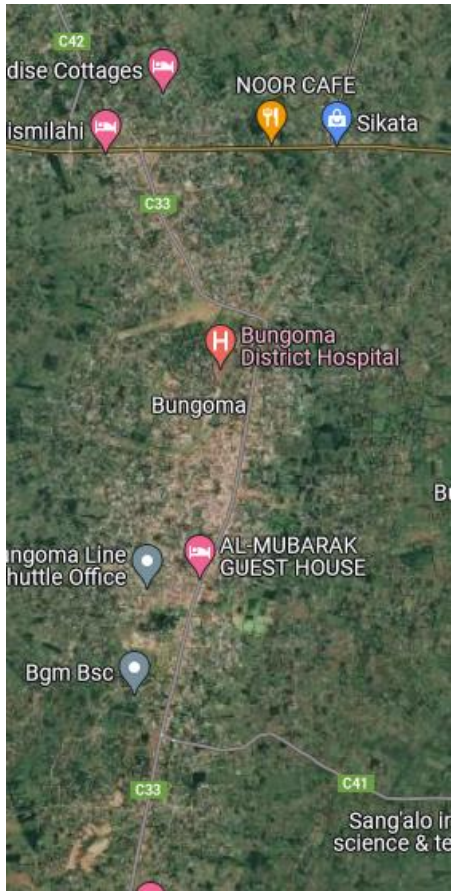
Piles of RoCC kiln biochar in a project field

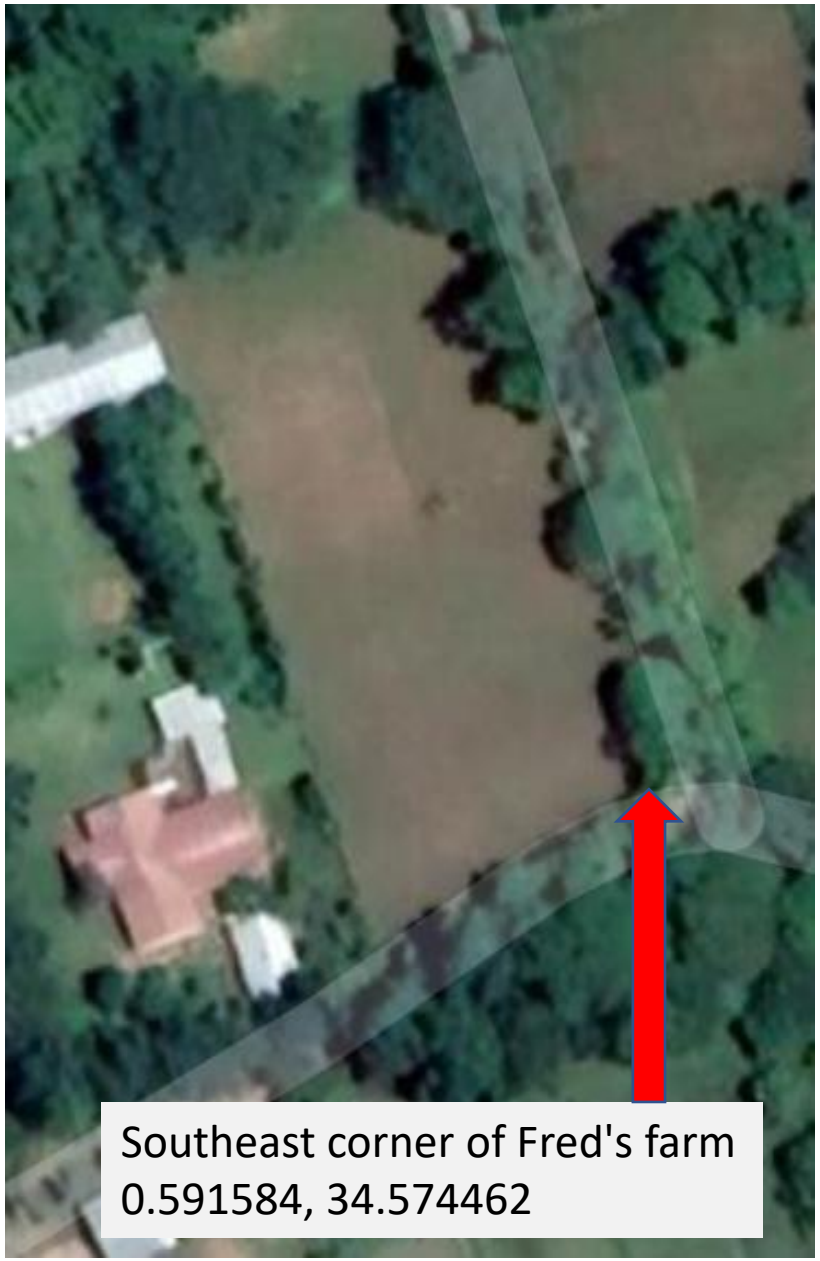
Biochar into the soil = verifiable sequestration

- **Placement of the biochar is starting in preparation for the planting season in March.**
- **We have already marked out seven plots of 10 by 5 meters for our project at Fred's place.**
- **The plots shall contain corn planted on the same day. We have chosen corn because it shall demonstrate better any variations and easy to capture on camera.**
- **The additives of the seven corn plots shall be as follows;**
- **1. Nothing added (Control plot).**
- **2. Biochar alone.**
- **3. Synthetic fertilizer.**
- **4. Biochar charged with animal manure.**
- **5. Biochar charged with urine.**
- **6. Biochar charged synthetic fertilizer.**
- **7. Manure alone.**

We are hoping to finish working on all requirements and preparations of the plots by the end of February.

The Demonstration Plots are Measured from the SE Corner of Fred's Farm





Preparation of biochar

- We shall be using biochar we charged on 25/01/2022. We had used 102.14Kgs of manure to charge 205.46Kgs of char. We have been maintaining **a ratio 1:2 during our animal manure charging**. Dispersal is by a designate cup where seeds are planted.

Claiming carbon credits

- We are focused on CO2 REMOVAL with tonnes of tangible biochar as the verifiable unit of measurement. CO2 REMOVAL.
- Emission reductions are more difficult to quantify, less valued in the carbon markets, and expensive to establish, in part because of needed base line measurements. But they can be claimed if documented.
- Approximate conservative calculations for the CO_2 REMOVAL:
  4 tonnes of biochar with ~60% fixed carbon = 2.4 t carbon (C) removal.
  Use ration 1 : 3.5 to get 8.4 t CO_2 removal that has a market value (when certified) of ~$150 / t CO_2 which = **$1260.**
- **This does not include the value of the physical biochar that can be marketed as a soil amendment.**
- For carbon credits, we are using CERCS CharTrac. See https://cercs.io

Bitmaxim Laboratories
bitmaxim.com | bitmaxim.io

CERCS

A Comprehensive App Ecosystem for
Carbon Emissions-Reducing and Carbon-Sequestering
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- **CERCS NFT** (Public Blockchain/Digital Wallet) cercs.io

CERCS™ CharTrac™

CERCS CharTrac [Project Mode]
cercs.io | chartrac.com

CERCS CharTrac [Client Mode]
cercs.io | cercs.org

CERCS CharTrac [Operations Mode]
chartrac.cercs.io | chartrac.app

- **Public Blockchain (ETH)**
- **CERCS GIS**
  cercs.io

Data Collection
- IoT
- GPS
- Phone/Tablet (Signed Batch)

Data Quality (NIST Calibration of Sensors and Measuring Equipment)
Biochar Sampling / Lab Testing

Client Services
- Fuel Supply
- **CERCS PAYGO**
  cercs.io

The capabilities of CERCS CharTrac

Using an immutable ledger (blockchain) to capture digitally-signed, timestamped operations data—as soon as they are available—has been a key, early feature in the evolution of CharTrac.

Every carbon offset generated by the project is calculated from and linked to a unique subset of field operations data secured by cryptographic hashes (“digital fingerprints”) on the blockchain. Thus, every carbon offset can be traced to specific data (digitally-signed, timestamped measurements from field operations) for purposes of verification and validation.

The **CERCS Registry**, which is one of the newer apps, delivers important new features that support carbon reduction and removal projects of all types (not just woodgas projects). One of those features enables aggregating fractional unit claims so that small or limited contributors (*e.g.*, small producers who periodically make and sequester biochar in small gardens, *etc.*) may have the opportunity be recognized and rewarded with micro-incentives while contributing data for potential use by the future **CERCS GIS** application.

CERCS GIS is a planned app that enables data to be selected, processed, and utilized for mapping and loading to third-party GIS services such as ArcGIS (Esri).

Some lessons learned

- Field work is at the mercy of the local weather each day:
  - Too wet; Too hot; Too windy; Too dry (fire risk);

- One run per day for 2 to 3 hours is typical, but if biomass quantities were more abundant and ready, production could double or triple per RoCC kiln.

- Field labor in Bungoma, Kenya costs $5 per day.

- The commercial value of biochar as perceived by local farmers needs to be established, and that requires having biochar and time (growing season(s) to demonstrate verifiable impacts. This means delays in having needed cash flow.

Financial and operational realities

- Projects do not run themselves. **Our full-time project manager**, Gilbert Mwangi, has a university degree in management, years of experience in related activities, supports a wife and four children, and solves all the on-location issues. His salary of US$40 per day ($1000 per month) is currently an administrative expense that is not covered by the value of the biochar nor the (eventual) carbon credit sales.
- Laborers are paid $5 per day, often for about 6 hours. Almost breaks even.
- The **cost of the kilns is almost negligible** compared to the operational costs. If <$200, that is less than 50 cents per day per year for equipment cost.
- The **biomass has been provided free** by the landowners with no expectation of receiving the biochar. Some provide labor for gathering the biomass.

This project is open for additional sponsors / donors. Contact Paul Anderson

Future steps / Conclusion

- We are only completing **seven months of activities** in the Bungoma area, so we have not yet experienced a full year of agricultural cycle.
- **The commercial value of the biochar is not yet evident.**

- **Replications with variations in other countries are encouraged.** Initial steps are underway in Venezuela, Bolivia and El Salvador. Contact Paul Anderson for assistance.

Discussion and Q&A

- Visit **https://woodgas.com** where the documents are at /resources and (soon) by each country. Example: https://woodgas.com/ven (Venezuela)
- **If you would like to sponsor a RoCC kiln biochar project in your country/community, contact Paul Anderson.**

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