Verified Carbon Removal by Smallholder Farmers

International Biochar Initiative

Biochar Webinar Series
March 4, 2022
Quick Notes

• You should be able to hear me talking now.
• Two Audio Options: Phone or Computer
  • Choose one and connect
  • Pro tip: Don’t call in on your phone if your audio is set to “Mic & Speakers”
• Ask questions using the Questions Panel on the right side of your screen ANYTIME.
• The recording of the webinar AND the slides will be available after the event.

Polls
This webinar will have polls. Polls will be “launched” by the organizers and will appear in the middle of your screen. Just answer them when they pop up to participate!
IBI Mission
To provide a platform for fostering stakeholder collaboration, good industry practices, and environmental and ethical standards to support biochar systems that are safe and economically viable.

Vision
One billion tons of biochar produced per year within 50 years.
Thank you

New & Returning Sustaining, Business & Organizational members

Business
• Belgium: Torrcoal
• Canada: GECO, Pure Life Carbon
• Spain: Circle Carbon
• Sweden: Ecotopic
• USA: Biomass Controls, International BioRefineries, North Suburban Tree Service, OFX Whitfield Biochar, Whittlesy Landscape Suppliers & Recycling

Organizational
• Germany: Lerchenmüller Consulting
• Israel: Biochar Israel
• UK: Rectella International Ltd. (Positive Carbon)
• USA: Appalachian State University,
Hans-Peter Schmidt has been a pioneer in the field of biochar since 2008. He has worked on all aspects of biochar including the creation of a wide variety of biochar production equipment, biochar production in high and low technology scenarios, application techniques, field trial design, biochar characterization, and biochar education (creator of the Ithaka Journal). In addition, Hans-Peter has designed and used biochar plaster as a building material and is working with researchers on its use in 3D printing. He has extensive experience working across Europe and has worked on developing world projects as well including Nepal, Bangladesh and Ghana.
Tropical C-sink certification
(on a small holder farmer base)
C-Sink vs. Certified Emission Reduction

**Verified Carbon Sink (VCR)**
- Is the result of an active removal of atmospheric CO$_2$.
- It is a material asset, traceable, and measurable (e.g., a unit of biochar - carbon).
- Underlies time dependent dynamic (decay or increase) and risks that need to be accounted for.

**Certified Emission Reduction (CER)**
- Prevents further increase of atmospheric CO$_2$ concentration but does not actively reduce it.
- Cannot be measured directly & needs a reference scenario: e.g., coal fired power plant vs. renewable energy.
CO$_2$ is **captured** by plants through photosynthesis, this biomass is **transformed** into stable carbon through the technical process of pyrolysis and **stored** by the use of biochar.
Assessment of PyCCS based Carbon-Sinks
Do not consider only the biochar as such but start the carbon accounting with the production of the biomass feedstock.

If harvesting the biomass interrupts and reduces the carbon uptake from the atmosphere, this has to be accounted for.
10.2 Biomass categories
Only biochars that have been produced either from residues or from C-neutral biomass are eligible for C-sink certification. This results in the specific requirements for the following six biomass categories, depending on the exact origin of the biomass:

10.2.1 Agricultural biomass
10.2.2 Organic residues from food processing
10.2.3 Wood from landscape management, short rotation plantations, agroforestry, forest gardens, field margins and urban areas
10.2.4 Biomass from forest management
10.2.5 Wood wastes
10.2.6 Other biogenic residues
Feedstock for tropical farmer C-sink

Only feedstock from the farmer’s farm is eligible:

- Farm residues (e.g., straw, husks, pods)
- Pruning wood
- Biomass from agro-forestry / carbon farming
PyCCS - parameters

Biomass production

transport chipping

Pyrolytic treatment

emissions, electricity

transport

Co-products (heat, oil)

Product transformation

emissions, energy

application to sink

spoilage

Sink storage

emissions, metabolism

leakage
Pyrolysis Emissions

Based on Amonette et al. (to be submitted)

Methane emissions can make biochar production a burden to the climate!
### Emission of Kon-Tiki and TLUDs

Table 3. Emission factors (g/kg charcoal) of CO₂, CO, CH₄, TSP, aerosols, particulate matter <10 μm (PM₁₀), non-methane volatile organic carbon (NMVOC), and the sum of nitrogen oxide and nitrogen dioxide (NOₓ), as well as the sum of all products of incomplete combustion, PIC (all gases except CO₂). Average values per flame curtain kiln type and per feedstock, and kiln literature values (traditional non-improved kilns, retort kilns with syngas circulation and combustion, TLUDs).

<table>
<thead>
<tr>
<th>Kiln Type</th>
<th>CO₂</th>
<th>CO</th>
<th>NMVOC</th>
<th>CH₄</th>
<th>TSP</th>
<th>PIC</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Per flame curtain kiln type</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>All-Steel deep octagonal</td>
<td>5600 ± 700</td>
<td>38 ± 20</td>
<td>6 ± 2</td>
<td>57 ± 52</td>
<td>22 ± 28</td>
<td>123 ± 82</td>
<td>0.3 ± 0.1</td>
</tr>
<tr>
<td>Steel-shield edifice</td>
<td>2300 ± 800</td>
<td>23 ± 28</td>
<td>5 ± 5</td>
<td>14 ± 20</td>
<td>9 ± 7</td>
<td>51 ± 31</td>
<td>0.3 ± 0.2</td>
</tr>
<tr>
<td>Soil pit</td>
<td>3800 ± 1300</td>
<td>36 ± 40</td>
<td>8 ± 1</td>
<td>32 ± 44</td>
<td>20 ± 24</td>
<td>97 ± 108</td>
<td>0.8 ± 0.7</td>
</tr>
<tr>
<td>Shallow steel pyramidal and octagonal</td>
<td>4700 ± 800</td>
<td>73 ± 31</td>
<td>5 ± 3</td>
<td>26 ± 75ᵇ</td>
<td>5 ± 4</td>
<td>108 ± 93</td>
<td>0.32 ± 0.12</td>
</tr>
<tr>
<td><strong>Per feedstock type</strong></td>
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<td></td>
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</tr>
<tr>
<td>100% Eupatorium</td>
<td>4600 ± 2100</td>
<td>74 ± 34</td>
<td>6 ± 3</td>
<td>60 ± 90ᵇ</td>
<td>11 ± 16</td>
<td>151 ± 109</td>
<td>0.4 ± 0.2</td>
</tr>
<tr>
<td>80% Eup, 20% wood</td>
<td>3400 ± 2300</td>
<td>23 ± 26</td>
<td>5 ± 3</td>
<td>28 ± 34</td>
<td>23 ± 27</td>
<td>79 ± 89</td>
<td>0.1 ± 0.2</td>
</tr>
<tr>
<td>50% Eup, 50% wood</td>
<td>3900 ± 2000</td>
<td>13 ± 4</td>
<td>9 ± 1</td>
<td>13 ± 21ᶜ</td>
<td>9 ± 7</td>
<td>43 ± 25</td>
<td>0.7 ± 0.6</td>
</tr>
<tr>
<td>50% Eup, 50% Rice husk</td>
<td>3810 ± 50</td>
<td>47 ± 16</td>
<td>3.0 ± 0.2</td>
<td>0</td>
<td>3 ± 2</td>
<td>52 ± 19</td>
<td>0.260 ± 0.003</td>
</tr>
<tr>
<td><strong>Kiln literature</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Traditional kiln</td>
<td>Ref. [10, 12]</td>
<td>n = 8⁸</td>
<td>2375</td>
<td>351</td>
<td>53</td>
<td>49</td>
<td>19</td>
</tr>
<tr>
<td>Retort kiln</td>
<td>Ref. [10, 12]</td>
<td>n = 5⁸</td>
<td>2602</td>
<td>148</td>
<td>7</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>TLUD</td>
<td>Ref. [20]</td>
<td>n = 5⁸</td>
<td>n.r.</td>
<td>94</td>
<td>274</td>
<td>40</td>
<td>7</td>
</tr>
<tr>
<td>High-tech large-scale reactor</td>
<td>Ref. [44]</td>
<td>n = 5⁸</td>
<td>3.10⁻⁷</td>
<td>0</td>
<td>0</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

ᵃ n is number of datasets (time series during one kiln run). Each dataset consists of 10–15 measurements. Thus, the total number of measurements is 20 to 150.

ᵇ large std since value is dominated by one large value of 238 g/kg char.

ᶜ large std since value is dominated by one large value of 37 g/kg char.

ᵈ average of two literature datasets where each data set was given equal weight.

ᵉ one dataset per kiln type.

doi:10.1371/journal.pone.0154617.t003
Methane compensation

At an average 30 kg CH4 / t biochar and a GWP20 of 86 t CO2, the production of 1 t biochar causes 2.6 t CO2eq.

The 30 kg CH4 (2.6 t CO2eq) will be decomposed after 20 years.

a not yet published approach
At an average 30 kg CH4 / t biochar and a GWP20 of 86 t CO2, the production of 1 t biochar causes 2.6 t CO2eq.

The 30 kg CH4 (2.6 t CO2eq) will be decomposed after 20 years.

To compensate the CH4-emissions of the biochar production:

**By planting trees:**

2.6 t CO2 needs to be extracted from the atmosphere for 20 years. This corresponds to:

- Planting 4 Michelia trees capturing 850 kg / CO2 over 20 years or
- Planting 15 Cinnamon trees capturing 200 kg / CO2 over 20 years or
Methane compensation

At an average 30 kg CH4 / t biochar and a GWP20 of 86 t CO2, the production of 1 t biochar causes 2.6 t CO2eq.

The 30 kg CH4 (2.6 t CO2eq) will be decomposed after 20 years.

To compensate the CH4-emissions of the biochar production:

By cessation of crop waste burning or uncontrolled decomposition

The cessation of open field burning of crop waste can be accounted for as CH4-compensation for 10 years (time horizon).

After 10 years, the new method of producing and using biochar will be considered the new standard and, therefore, no emission avoidance from crop waste burning can be accounted for anymore.
Rice straw and leaf pyrolysis in Bangladesh
Pod husks is the main biochar feedstock in cocoa farming.
Mixing biochar-based liquid fertilizers (Ghana)
Root zone application mixed with fertilizer

Furrow application
Root zone injection
Canopy circumference application
PyCCS - parameters

- Biomass production
- Transport chipping
- Pyrolytic treatment
  - Emissions, electricity
  - Transport
- Co-products (heat, oil)
- Product transformation
  - Emissions, energy
  - Spoilage
- Sink storage
  - Emissions, metabolism
  - Application to sink
  - Leakage
- Co-products (heat, oil)
Admissible biochar pathways to C-sink

a. Direct soil application
b. Compost
c. Liquid manure treatment
d. Bedding for cows, sheep, goats, pigs (no chicken, no horses if manure is not used as soil amendment)
e. Feeding cows, sheep, goats, pigs (no chicken, no horses if manure is not used as soil amendment)
f. Silage additive
g. Additive for anaerobic digestion (if digestate is not pyrolysed)
h. Organic biochar based fertilizer

i. Road construction
j. Building construction
Carbon Persistence of 74% over 100 years

At H/Corg < 0.4
BC+100 is above 70%
= annual decrease of carbon sink of 0.3%

Figure 9. The correlation between H/ C\textsubscript{org} and biochar C predicted to remain after 100 years as predicted by a two-component model (i.e. BC\textsubscript{+100}) was produced using data and calculations from Singh et al., 2012 (closed circles) and Zimmerman, 2010 as extended in Zimmerman and Gao, 2013 (open circles).

Budai et al. 2012 & Camps et al. 2015
Persistence of biochar

The MRT range of natural PyC could thus be calculated as \( \frac{550 \text{ Pg}}{0.383 \text{ Pg a}^{-1}} \) to \( \frac{1,650 \text{ Pg}}{0.114 \text{ Pg a}^{-1}} \) = \( 1,440 \text{ to 14,500 years} \). This time frame is confirmed by Bowring et al. (2021) who determined a minimum MRT of 2,760 years using the same data basis but without including sedimentary PyC.

© Santin et al. (2015)
Persistence of biochar

Conservative calculation of the mean residence time of biochar carbon applied to soil.

- On average 0.3% C-loss per year
- After 100 years, at least 740 kg of carbon remain from an initial application of 1 t biochar carbon
EBC-quality of Kon-Tiki biochar

Bridge Technology

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Lab.</th>
<th>Akkr.</th>
<th>Methode</th>
<th>EBC-Feed Klasse I</th>
<th>EBC-AgroBio Klasse II</th>
<th>EBC-Agro Klasse III</th>
<th>EBC-Material Klasse IV</th>
<th>(\text{BG in Einheit} )</th>
<th>(\text{Einheit} )</th>
<th>(\text{wl} )</th>
<th>(\text{af} )</th>
<th>(\text{wl} )</th>
<th>(\text{af} )</th>
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<tbody>
<tr>
<td>Schüttdichte &lt; 3 mm</td>
<td>FR</td>
<td>RE000 FY</td>
<td>in Anlehnung an VDLUFA-Methode A 13.2.1</td>
<td>-</td>
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<tr>
<td>spezifische Oberfläche (BET)</td>
<td>SN001</td>
<td>DIN ISO 9277: 2010</td>
<td>-</td>
<td>kg/m²</td>
<td>157</td>
<td>-</td>
<td>160</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>Wassergehaltskapazität (WHC)</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN EN/ISO 14238, A: 2014-01</td>
<td>%</td>
<td>-</td>
<td>254.1</td>
<td>248.5</td>
<td>-</td>
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<tr>
<td>Gesamtwaschgehalt</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN 5118: 2002-06</td>
<td>%</td>
<td>25.5</td>
<td>-</td>
<td>28.2</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Aschegehalt (550°C)</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN 5119: 1987-07</td>
<td>%</td>
<td>16.4</td>
<td>22.1</td>
<td>21.6</td>
<td>-</td>
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<tr>
<td>Kohlenstoff</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN 5132: 2014-07</td>
<td>%</td>
<td>51.4</td>
<td>63.9</td>
<td>70.7</td>
<td>-</td>
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<tr>
<td>Kohlenstoff, organisch</td>
<td>FR</td>
<td>RE000 FY</td>
<td>berechnet</td>
<td>%</td>
<td>50.3</td>
<td>67.4</td>
<td>69.0</td>
<td>-</td>
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<tr>
<td>Wassersstoff</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN 5132: 2014-07</td>
<td>%</td>
<td>1.1</td>
<td>1.6</td>
<td>1.2</td>
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<tr>
<td>Stickstoff, gesamt</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN 5132: 2014-07</td>
<td>%</td>
<td>7.1</td>
<td>9.6</td>
<td>11.7</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Schwefel, gesamt</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN 51334-3: 2012-07</td>
<td>%</td>
<td>16.0</td>
<td>22.2</td>
<td>21.9</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Sauerstoff</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN 5133: 2016-04</td>
<td>%</td>
<td>7.6</td>
<td>9.2</td>
<td>6.5</td>
<td>9.1</td>
<td>-</td>
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<tr>
<td>TiC</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN 5133: 2004-06</td>
<td>%</td>
<td>1.1</td>
<td>1.5</td>
<td>1.2</td>
<td>1.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Carbonate-CO₂</td>
<td>FR</td>
<td>RE000 FY</td>
<td>DIN 5128: 2004-06</td>
<td>%</td>
<td>4.2</td>
<td>5.6</td>
<td>4.6</td>
<td>6.4</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>C/H Verhältnis (molar)</td>
<td>FR</td>
<td>RE000 FY</td>
<td>berechnet</td>
<td>%</td>
<td>0.26</td>
<td>0.26</td>
<td>0.20</td>
<td>0.20</td>
<td>-</td>
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</tr>
<tr>
<td>O/C Verhältnis (molar)</td>
<td>FR</td>
<td>RE000 FY</td>
<td>berechnet</td>
<td>%</td>
<td>0.11</td>
<td>0.11</td>
<td>0.096</td>
<td>0.097</td>
<td>-</td>
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</tbody>
</table>
This biochar could be certified as a carbon sink if:

1. The biomass was procured sustainably.
2. Was dried or aerated to avoid emissions during storage.
3. The pyrolysis was done with care to prevent non-CO$_2$-greenhouse gas emissions.
4. The biochar was applied to the soil and not burnt or sold as charcoal.
Main principles: tropical C-sink certification

1. Registering of each farmer, and their cultivated land (GPS data), including crop rotation and harvest

2. Accounting and verification of the farm biomass to be transformed into biochar.

3. Documentation of the technology used (Kon-Tiki type or TLUD) to average the emission factors

4. Documentation of the biochar making (registering with georeferencing and date photo).

5. Workshops to teach, control and develop the craft of biochar making and application

6. Accounting of the biochar produced (measured by the farmer him/herself, plausibility check with the available farm biomass).

7. Proof and measuring of biochar application to soil, compost, manure, etc.

8. Controlling by dedicated farmer organization, triad peer group, or independent certifier, coupled to signing a declaration of honor that the above was completed correctly

9. Controlling and guaranteeing the methane compensation (signed declaration, accounting of trees, etc.)

10. Direct payment to participating farmers
Carbon Sink & Climate Balance per tropical hectare

- An average 4 t (dry matter) of residual biomass per ha can be harvested
- Methane emission from uncontrolled decomposition avoided
- Production of at least 1 t biochar (DM) per ha
- C-sink potential of 70% of biochar weight = 700 kg C
- Minimum expected C-sink per farm: 2 t CO2eq
- Farmer income at 75 Eur / t CO2eq = 150 Eur per farm as C-sink benefit
Tropical C-sink certification

• Should be done by organizations with strong roots and understanding of farmer life and policy in the respective region or country
• The organization should build its own Carbon Sink Certification procedure following the general EBC C-sink standard adapted to the culture and policy in the region or country
  - The Ithaka Institute consults and reviews the procedure
  - The organization assures the farmer training and sets up the controlling
  - The EBC / Carbon Standards International accredits the method and procedure
European Biochar Certificate (EBC)
Developed by the Ithaka Institute
Ensured by Carbon Standard International

Biochar certification, analysis & consulting: www.european-biochar.org
Michael is the co-founder and director of Warm Heart Worldwide, a grassroots community development organization serving one of the poorest districts in northern Thailand as well as several rural communities throughout Africa. He spent 30 years teaching the international political economy of development and has done consulting for USAID, the US State Department, the EU and others on issues of higher education reform (the Baltic States, Poland, Moldova, and Lebanon) and with direct or partnered grant support from East-East, Prudential, USIP and others on issues of community rebuilding (ex-Yugoslavia, Ethiopia, and South Africa). Since 2008, Warm Heart has grown dramatically and has transformed the lives of many people in small, rural areas. His specialties include small-scale biochar production and use by small holder farmers.
Jason is a successful serial entrepreneur and is a Board Trustee of Warm Heart Worldwide and acting CEO of Biochar Life, PBC, an impact venture by Warm Heart Worldwide which supports biochar-backed carbon removal via the support and collaboration with smallholder farmers. Jason is a Board Director of the Mercu Learning Point Pte Ltd, a private education center that offers a comprehensive range of early childhood educational services and opportunities for children. He has been the CEO of Highbarger Enterprises since 2003 which continues to support a wide range of companies and charities.
Biochar Life
An Impact Venture by Warm Heart Worldwide, Inc.

Cool the planet, clean the environment, improve public health and reduce rural poverty.
Warm Heart

We’re a grassroots, community development organization serving the rural poor of Thailand and the developing world for over 13 years. We partner with communities to find environmentally, economically and socially sustainable solutions to community-identified needs.

Countries of operation: Thailand, Malawi, Ghana, Kenya. Charities established in Thailand, Ghana and USA.

Warm Heart is non denominational, non-discriminatory, nonpartisan, and follows the principles of the Universal Declaration of Human Rights in pursuit of the Sustainable Development Goals.

Children’s empowerment. 40 children supported at children’s home, 30 with partner hill-tribe school, 20 at vocational high school / college.

Sustainable livelihoods. Multiple social enterprises launched leveraging community resources, improvement of gender and income equality.

Elder care. 100 elders of the community provided with care and 2,500 meals, over 1,000 home visits.

Environment. Trained over 10,000 farmers on making biochar which improves crop yields and reduces/removes emissions.
We take a local approach with global impact.

- Rural client centered development
- Cross-cutting programs
- Socially and economically sustainable communities
Warm Heart - Biochar
It’s been a journey...

**Equipment prototypes**
Trialed multiple prototypes of low tech/low cost pyrolizers in SE Asia and Africa.

**2016**

**Farmer trials and refinement**
Proven adoption by mass communication and neighborhood examples.

**2017**

Refined business/financial sustainability approach.

**2018**

**Farmer engagement and feedback**
Confirmed effectiveness, cost, and attractiveness for smallholder farmers using TLUD.

**2019**

**Biochar training scale up**
Established new footprints in Malawi, Ghana and Kenya for training and production of biochar.

**2020**

**Mobile app & platform MVP**
Jointly designed a mobile solution and blockchain-enabled platform with Task.io & EBC to facilitate in-field validation and verification process.

**2021**

**Field testing, accreditation, purchases**
Field tested app in Thailand, Kenya and Malawi and checked its effectiveness with a sample network for scaling in Malawi. Established new program in Democratic Republic of Congo.

EBC tropical farmer c-sink accreditation process and audit by Ithaka Institute.

Initial customer purchases of C-sink and social impact certs.
Plan 1

Farmers Making Biochar

Villagers Working at Factory

Main Village

Off-taker

Market

Farmers from Satellite Village
Plan 1 – failed in every dimension

Farmers Making Biochar

Villagers Working at Factory

Main Village

Market

Farmers from Satellite Village

Off-taker
Plan B

What to do?
- Back to basic questions
- How to:
  - Remove CO₂
  - Stop crop waste burning
  - Stop the smoke
  - Help the poorest farmers
    - Create jobs
    - Provide new income
    - Improve health
  - Self-replication because profitably sustainable
Empower Smallholders!

- Existing verification and certification methodologies too complex and costly
- Excluded billions of smallholders
- Excluded possible sequestration of billions of tonnes of CO₂
- Promise of money for making biochar → less burning and ↓ GHG emissions

But how?
Biochar Life Overview
Mission

Biochar Life’s mission is to support the environmental and wellness needs of the general public via the removal of carbon dioxide from the atmosphere and reduction of emissions. Our proceeds and future investments will be deployed to improve the lives of rural communities and uplift the underrepresented, which will be accomplished by removing still more carbon dioxide and reducing emissions further. We are committed to gender and income equality by employing fair and equal hiring practices for the once excluded.

Established a Public Benefit Corporation to facilitate scaling and financing the venture.

Owned and controlled by Warm Heart Worldwide (non-profit) which ensures social and environmental mission.

Scale via the engagement of SMH farmer networks throughout the world and buyers of carbon offset credits.

Goal of engaging 1 million farmers within 5 years!
The world is on fire!

Millions of SMH farms supporting 2.4 billion people in the developing world emitting billions of tonnes of GHG and PM2.5 through crop burning now have the potential of getting paid for removing CO2 from the atmosphere by producing biochar while yielding significant agricultural benefits.

Open field burning by smallholder farmers has significant impact on the **environment**, **public health** and **economy**.

- **500** Million farms in the developing world generating billions of tonnes of GHG and PM2.5.
- **4.1** Million outdoor deaths attributed to PM2.5 in developing world.
- **18** Over $18 billion in negative economic impact in SE Asia alone.
Total addressable market for carbon offsets projected to reach between $50 to $200 billion by 2050.

Increasing demand from corporations and consumers for carbon negative / removal credits to meet CSR / ESG goals. Walmart, Amazon, Microsoft, Nestle, Shopify, IKEA and more have already committed $7.6 billion for carbon removal.

Increasing investment from VC and corporations for carbon removal ventures. Climate tech VC investment increased from $418 million per annum in 2013 to $16.3 billion in 2019. Microsoft has established a $1 billion carbon removal fund.
Significant and measurable impact

<table>
<thead>
<tr>
<th></th>
<th>10,000</th>
<th>100,000</th>
<th>1,000,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td>10,000</td>
<td>100,000</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Biochar (tonnes)</td>
<td>6,800</td>
<td>68,000</td>
<td>680,000</td>
</tr>
<tr>
<td>CO2eq removed (tonnes)</td>
<td>13,600</td>
<td>136,000</td>
<td>1,360,000</td>
</tr>
<tr>
<td>Local team size</td>
<td>46</td>
<td>421</td>
<td>4,171</td>
</tr>
<tr>
<td>Farmer site visits</td>
<td>20,000</td>
<td>200,000</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Training sessions</td>
<td>300</td>
<td>3,000</td>
<td>30,000</td>
</tr>
</tbody>
</table>

Hypothetical production and operational projections based on pilot projects and experience.

Farmer contribution weighting of Malawi (40%), Kenya (40%), Thailand (20%).
Solution: low tech, low cost CO2 removal with biochar

Farmer training

Homemade equipment

Engage + Train Farmers

Produce and verify biochar

Sink and Mint

Improved soil health and delicious food!

Mobile app and blockchain enabled ledger for tracking
Where we are today

**Locations:** Kenya, Malawi, Thailand

**Current expansion plans:** Democratic Republic of the Congo, Uganda, Laos, Myanmar, Zambia

**Pyrolysis technology:** Trough, trench, TLUD

**Biomass:** Corn husk, cob and stalk, millet stalk, orchard tree trimmings

**Biochar applications:** soil amendment, fertiliser, animal feed

**C-sink standard:** European Biochar Certification (“EBC”) for tropical farmers

**Operations:** Experienced Country Managers handle day to day operations supported by 20 trainers.

- **Kenya:** Ms. Mercy Awuoro Ogembo
- **Malawi:** Mr. Sylvester G. Chiweza
- **Thailand:** Ms. Aom Kwanpirom Suksri
- **Ghana:** Mr. Abedi Sam Bawa

**Farmers trained:** 10,000 and counting
Built with world-class partners

Ithaka Institute

Biochar and carbon science strategy, research, methodology and standards.

Task.io

Fintech solutions for social enterprises and NGOs, Stellar Blockchain partner, remote teams and payment solutions.
Demo slides
Project (campaign)

Setup parameters and task profiles (equipment, location, crop type, etc)

Onboarding and training of data gatherers and trainers

Train farmers (if not done already)
Biochar production and usage

Arrange with farmers to meet demand requirements and payment*

Data gatherers visit farmer site to gather production and usage data via mobile app

Data includes farmer, date, location, crop type, equipment, quantity, pictures, farmer declaration, distance traveled (if any) and other relevant data

*Important to have adequate buyer commitments and/or financing.
Verification and sampling

Data is verified by managers at Biochar Life or Warm Heart

Once verified, data is committed to the blockchain

Payment made to farmer within a few days (local fiat)

Random chemical analysis conducted with local universities
Dashboards and reporting

Impact by activity type

Impact by location

Custom reports and dashboards
C-sink and social impact certificate

Production and usage data aggregated to produce certificate

Aggregated by region, crop type, equipment type, usage, CH4 compensation method

Emissions accounted for entire lifecycle, includes security margin of 10%

C-sink accommodates degradation after 100 years, $C_{sink}^{100}$
C-sink and social impact certificate NFT marketplace

C-sink and social impact certificate secured in NFT

Available for purchase via thebluemarble.io marketplace provided by Task.io

STS token that tracks cumulative total of C-sink and referenced in NFT

QR code and link to C-sink and social impact PDF report

Openly available on Stellar blockchain, immutable and traceable

Scan to visit NFT marketplace
## Around the corner...

In the next 12-24 months we have several exciting improvements planned.

<table>
<thead>
<tr>
<th>Procedures &amp; Methodology</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Openly available stats database used for calculations for others to view</td>
<td>● Simplify mobile app for easier data input and onboarding,</td>
</tr>
<tr>
<td>● Updates to procedures to meet future accreditation requirements and improvements</td>
<td>machine learning for verification of data</td>
</tr>
<tr>
<td>● Refinement and updates to the C-sink calculations based on more sampling and data</td>
<td>● Integration with local financial services to streamline farmer and local</td>
</tr>
<tr>
<td>● Update procedures and</td>
<td>team member payments</td>
</tr>
<tr>
<td></td>
<td>● Enhance current wallet capabilities using smart contract</td>
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</table>
We’re looking for partners!

**Customer partners**

Multi-year purchase agreements

**Financing partners**

Investment and donations welcomed to scale our team and footprint

**Network partners**

Established (or soon to be) organisations working with smallholder farmers

Cool the planet, clean the environment, improve public health and reduce rural poverty.
Thank you!

HTTPS://BIOCHAR.LIFE
QUESTIONS?
Upcoming Events

IBI WEBINARS
• April - Biochar Use in Capping Abandoned Oil Wells – Mark Mersman
• May – Biochar as a component of soil-less growing media - Nadav Zev, Omar Frenkel

NEW IBI PODCAST SERIES
• Episode 1 – VOW/ETIA;
• Upcoming Episodes: Carbofex, Syncraft, ARTi, Biomass Controls

IN PERSON EVENTS
Aug 9 – 11 USBI Biochar Conference, Morgantown, W Virginia
Become an IBI member!

If you paid for today’s webinar and would like to convert your registration to become an IBI professional member and have access to all previous webinars and listen to any new webinars for the next 12 months, you can do so for only $40. A discount for upgrading to business and organizational members is also available.

This offer is only good through the end of March, 2022
Please contact Brian Schorr at:  BSchorr@ttcorp.com