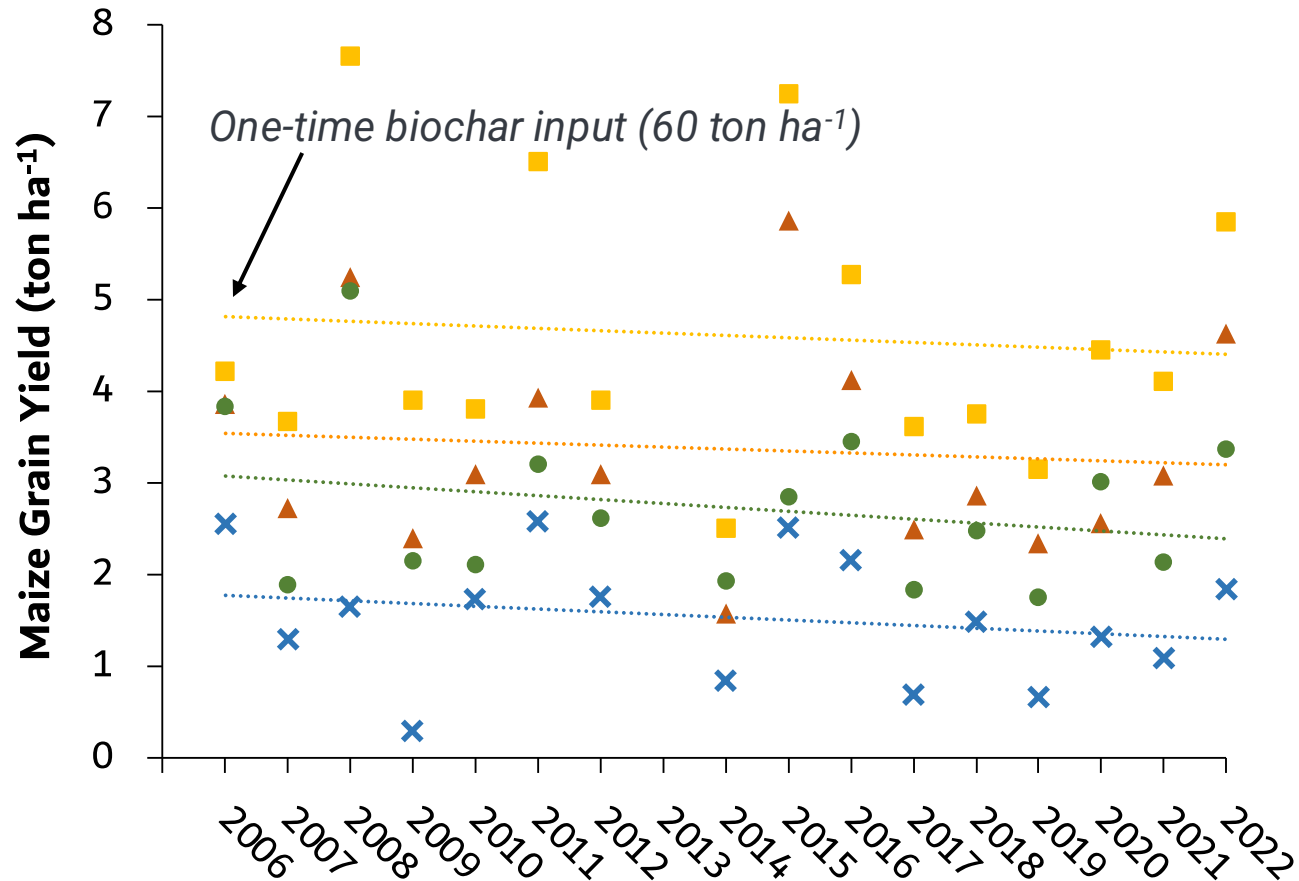


# BIOCHAR AGRONOMY AND DELIVERY MODELS FOR BROAD-BASED IMPACT

# **BIOCHAR AGRONOMY & CASCADDES**

# LONG-TERM EFFECTS



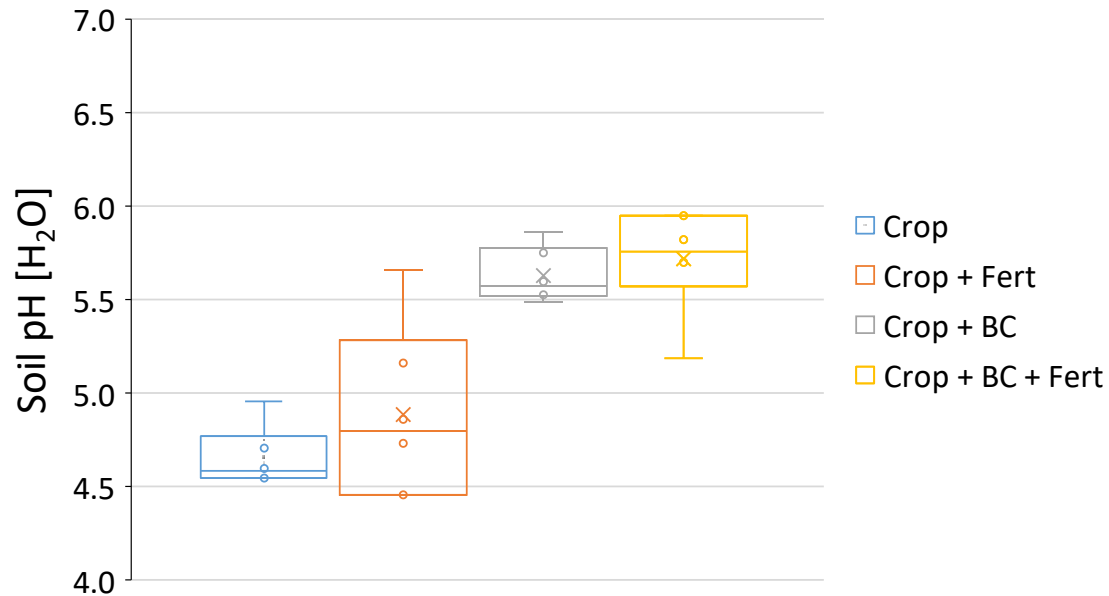
- Crop + BC + Fert  $\Rightarrow 4.60 \pm 1.44 \text{ ton ha}^{-1}$
- ▲ Crop + Fert  $\Rightarrow 3.37 \pm 1.12 \text{ ton ha}^{-1}$
- Crop + BC  $\Rightarrow 2.73 \pm 0.88 \text{ ton ha}^{-1}$
- × Crop  $\Rightarrow 1.53 \pm 0.68 \text{ ton ha}^{-1}$

- Maize yield for fertilizer + biochar is on average 1.2 ton ha<sup>-1</sup> greater than fertilizer only for 16+ years
- Relative seasonal variation in yield for fertilizer + BC 12% lower than fertilizer only (mixed model)



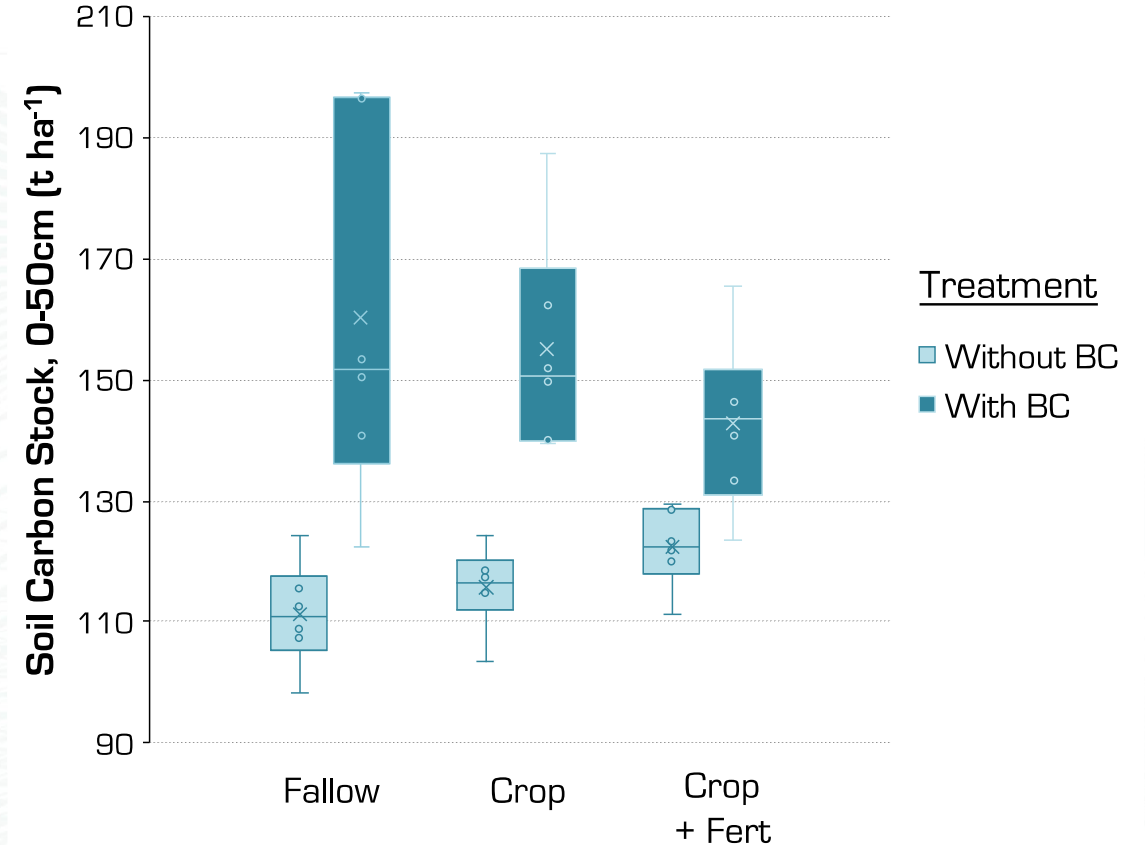
# LONG-TERM EFFECTS

## Fate of Soil Acidity



pH level increased by 0.8 to 1.2 point over a period of 16 years after biochar application

## Fate of Soil Carbon



- Biochar amendment persistently increases soil C stock under intensive cropping; 50-60% recovery after 16 years
- Fertilizer addition enhances plant C input but reduces soil C sequestration from biochar

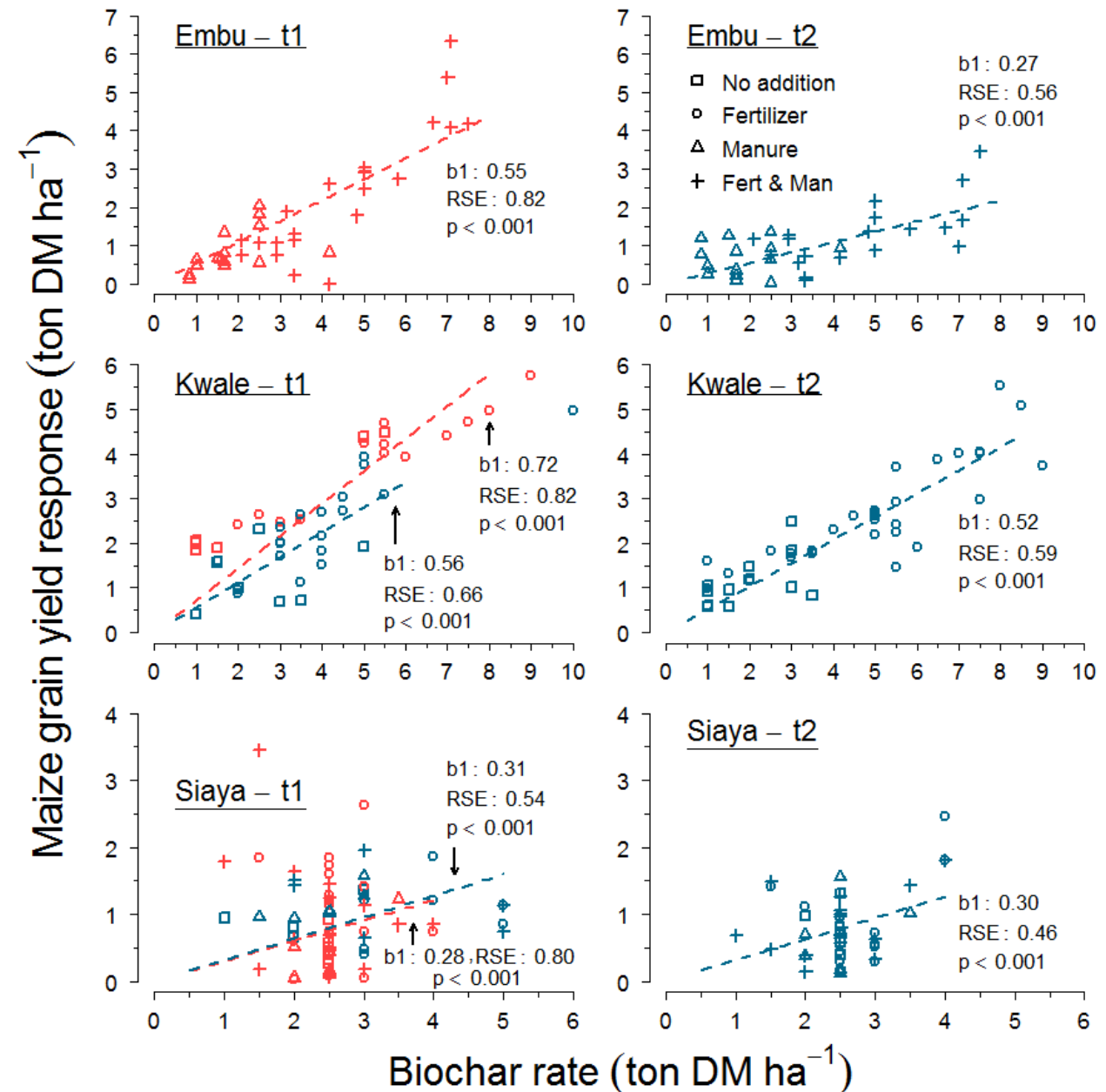
# DOSE-RESPONSE



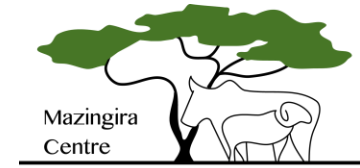
*Farmer-managed trials = variable real-world conditions*

*Different biomass feedstocks in gasifier cookstove*

- Linear dose-response; additive effect on accompanying inputs.
- Yield increase of 0.3 to 0.7 ton ha<sup>-1</sup> per ton biochar ha<sup>-1</sup>, CV of 34 to 65%.
- Effectiveness of new and old biochar input varies by 0.02 ton per ton.
- Influence of seasonal conditions on effectiveness is up to 0.16 ton per ton.



# CASCADING BENEFITS



Ammonium volatilization reduced  
by 30 to 85%

=

Conservation of nutrients for  
plant nutrition

+

Improved animal health



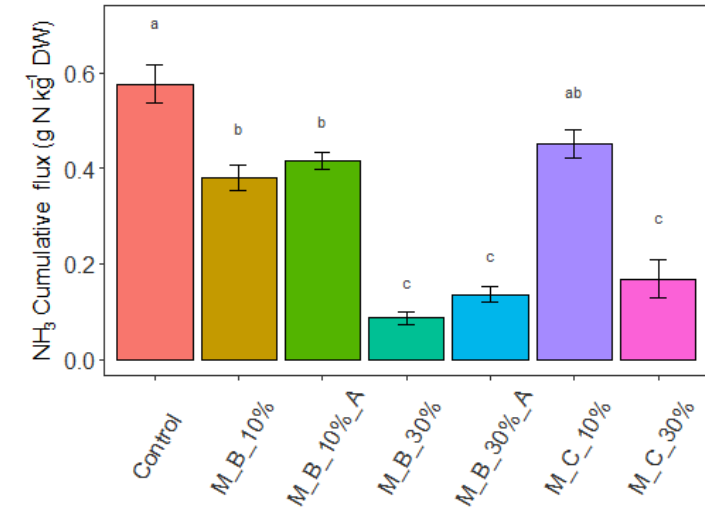
Methane and nitrous oxide emission  
reduced by 15% to 35%

=

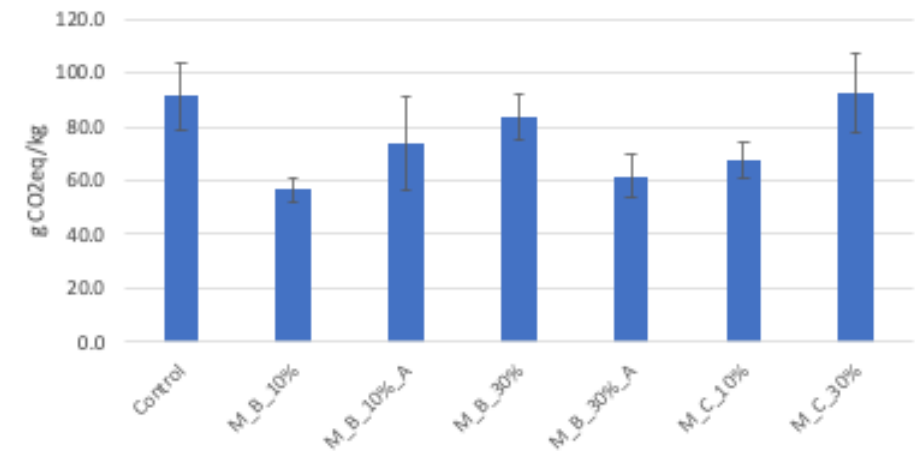
Drawdown of climate footprint from  
animal manure

+

Compensation of backpack  
emissions from pyrolysis



Combined GWP (CH<sub>4</sub> + N<sub>2</sub>O)



# **TECHNOLOGIES & DELIVERY MODELS**



# IN-FIELD OPERATION



## 1. SOURCING



## 2. CONVERSION



## 3. MIXING



## 4. SINKING





# CHAIN-OF-CUSTODY



- Plant Village
- Home
- Observatory
- Users & Profiles
- Broadcast
- Analytics
- Content
- Settings

## Biochar Production Surveys General

Map to bottom

Search...

Aug 26, 2024 - Aug 28, 20

Filters

User	Organisation	Farm name	Location	Date	Quality type
Antony Bruno Otieno	Biochar Life	Christine Anyango Ac...	Kenya, Siaya	Aug 28, 2024 at 16:35	pending
Sarah atieno	Biochar Life	Jacob ochieng	Kenya, Siaya	Aug 28, 2024 at 16:29	pending
Antony Bruno Otieno	Biochar Life	Christine Anyango Ac...	Kenya, Siaya	Aug 28, 2024 at 16:25	pending
Antony Bruno Otieno	Biochar Life	Christine Anyango Ac...	Kenya, Siaya	Aug 28, 2024 at 16:10	pending
Millicent Akoth	Biochar Life	Neddy Ouma	Kenya, Homa Bay Cou...	Aug 28, 2024 at 15:52	pending
Stacy Awino	Biochar Life	Joseph Ogwenso	Kenya, Homa Bay	Aug 28, 2024 at 15:43	pending
Sarah atieno	Biochar Life	Joseph Otieno	Kenya, Siaya	Aug 28, 2024 at 15:41	pending
alice	Biochar Life	Lawrence Aluko	Kenya, Homa Bay	Aug 28, 2024 at 15:38	pending
Clinton Omondi O...	Biochar Life	Eunice Achieng	Kenya, Siaya	Aug 28, 2024 at 15:26	pending
Caroline Atieno	Biochar Life	Pamela Akinyi	Kenya, Siaya	Aug 28, 2024 at 15:26	pending
Brian	Biochar Life	Jack Odhiambo Ogindo	Kenya, Homa Bay	Aug 28, 2024 at 15:24	pending
Millicent Akoth	Biochar Life	Neddy Ouma	Kenya, Homa Bay	Aug 28, 2024 at 15:20	pending
Emmanuel Osewe	Biochar Life	Elly Akoko Abuso	Kenya, Homa Bay	Aug 28, 2024 at 15:19	pending



## Pending

Confirm

Verify

Reject

No notes Click to add...

## Survey information

Observer	Antony Bruno Otieno
Started date	Aug 28, 2024 at 16:35 your device time Aug 28, 2024 at 16:35 survey local time
Submitted date	Aug 28, 2024 at 16:49 your device time Aug 28, 2024 at 16:49 survey local time
Uploaded	Aug 28, 2024 at 16:49
Location	Kenya, Siaya
Farm name	Christine Anyango Achoki
Farm location	0.1025, 34.28904
Fire temperature	—
Organisation	Biochar Life
Farm size	1 ha

## Feedstock

Add item...

Corn stalk Edit

Moisture: %



Biochar feedstock item photo

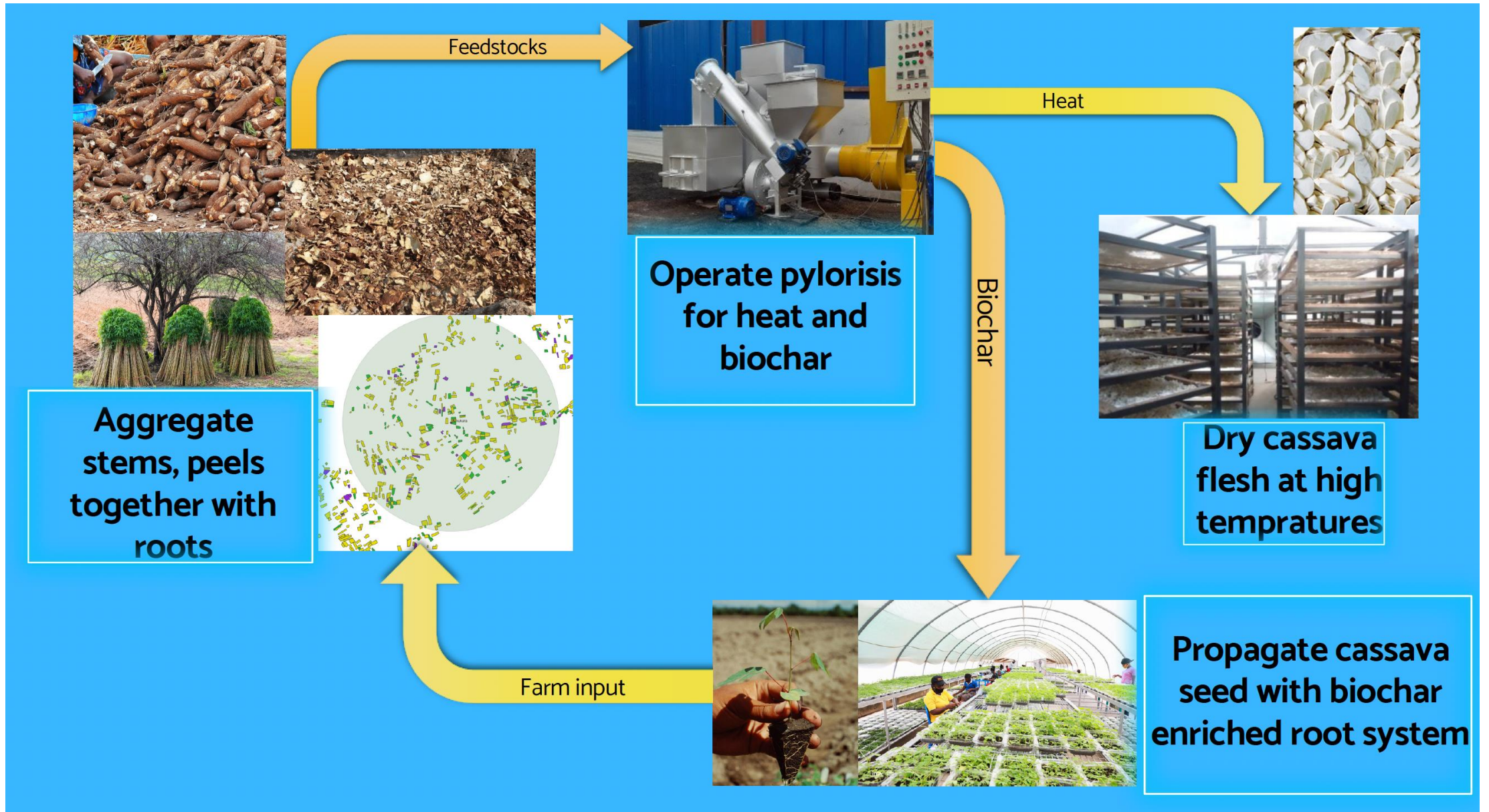
Distance: 2.76 m.  
Aug 28, 2024 at 16:35 your device time  
Aug 28, 2024 at 16:35 survey local time



Biochar feedstock moisture photo

Distance: 1.66 m.  
Aug 28, 2024 at 16:36 your device time  
Aug 28, 2024 at 16:36 survey local time

# COTTAGE STYLE




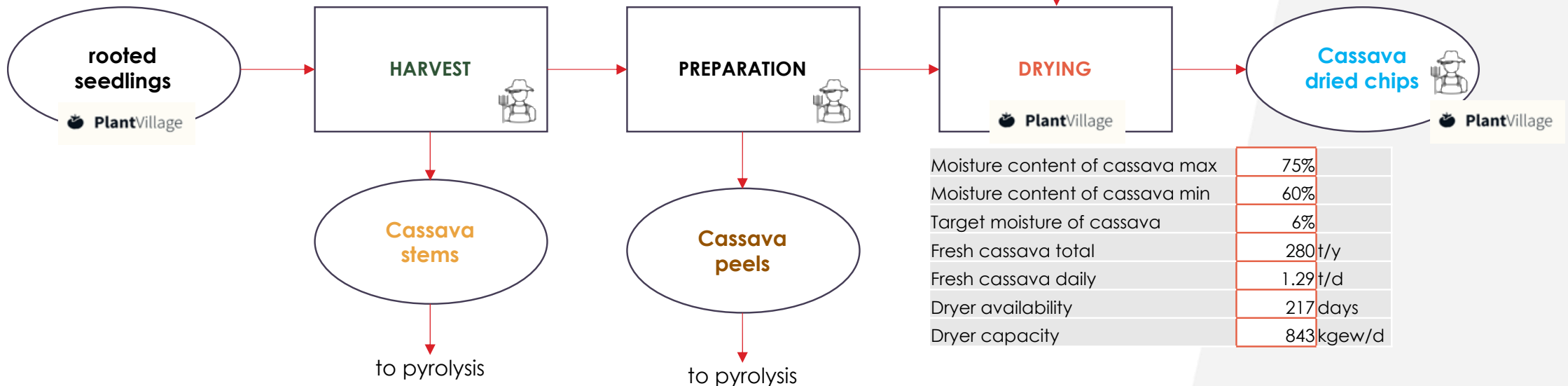


# COTTAGE STYLE

Area	100 acres
Area	40.5 ha
Intake	60%
Productivity low	6 t/acre/y
Productivity high	8 t/acre/y

Total power	147 kW
Total biomass needed	471 kgDS/day
Biochar produced	147 kg/day

<b>PYROLYSIS</b>	Target moisture of cassava	6%
 <b>PlantVillage</b>	Dry cassava yearly production	96.8 t/y
	Dry cassava daily production	446 kg/d



Moisture content of cassava max	75%
Moisture content of cassava min	60%
Target moisture of cassava	6%
Fresh cassava total	280 t/y
Fresh cassava daily	1.29 t/d
Dryer availability	217 days
Dryer capacity	843 kgew/d

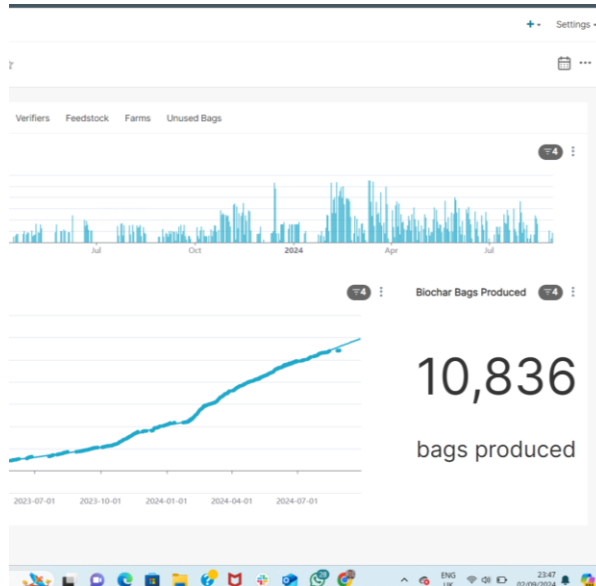
Ratio of stems versus total cassava	0.50
Moisture content of stems	40%
Stems available daily	0.644 t/d
Stems available daily	387 kgDS/d

Ratio of peels versus total cassava	0.33
Moisture content of cassava peels	50%
Peels available daily	0.644 t/d
Peels available daily	322 kgDS/d



# **BROAD-BASED IMPACT**

County	num_bags	revenue_expected	revenue_received	balance
<b>Machakos</b>				
William Nzau	11.0	Ksh19,800.00	Ksh18,000.00	Ksh1,800.00
PV staffs and Interns	13.0	Ksh23,400.00	Ksh20,350.00	Ksh3,050.00
Mercy Mbatha Mutunga	3.0	Ksh5,400.00	Ksh3,700.00	Ksh1,700.00
Fransisca Muli	12.0	Ksh21,600.00	Ksh21,600.00	Ksh0.00
Florentina Mbithe	11.0	Ksh19,800.00	Ksh15,450.00	Ksh4,350.00
Diana Kimani	11.0	Ksh19,800.00	Ksh18,900.00	Ksh900.00
<b>Narok</b>				
PV staffs and Interns	34.0	Ksh61,200.00	Ksh61,200.00	Ksh0.00
<b>Meru</b>				
Borniface Munene	12.0	Ksh21,600.00	Ksh21,600.00	Ksh0.00
<b>Uasin_Gishu</b>				
PV staffs and Interns	6.0	Ksh11,100.00	Ksh11,100.00	Ksh0.00
Dennis Too	1.0	Ksh1,800.00	Ksh1,800.00	Ksh0.00
<b>Grand Total</b>	<b>114.0</b>	<b>Ksh205,500.00</b>	<b>Ksh193,700.00</b>	<b>Ksh11,800.00</b>







# CONTACTS

- Roobroeck, Dries (IITA) \_  
[D.Roobroeck@cgiar.org](mailto:D.Roobroeck@cgiar.org) FOR Science and Innovation
- Hughes, David \_ [dph14@psu.edu](mailto:dph14@psu.edu) FOR Partnerships & Broader based PlantVillage Initiatives
- Chelsea Akuleut\_  
[chelseaakuleut@plantvillage.ke](mailto:chelseaakuleut@plantvillage.ke) FOR Biochar Commercialization & Operations management.



# **BIOCHAR AGRONOMY AND DELIVERY MODELS FOR BROAD-BASED IMPACT**



**PlantVillage**



*Transforming African Agriculture*



**CGIAR**