



# BIOCHAR CASE STUDY

Circular Economy Cocoa: From Bean to Bar



## From Residues to Climate Solutions

Agriculture is Vietnam's economic backbone, sustaining the livelihoods of tens of millions of farming households. Yet the same sector generates a paradox: tens of millions of tonnes of agricultural residues every year, most of which are treated as waste — openly burned or improperly discarded, polluting air, soil, and water. What makes this doubly costly is the missed opportunity. These residues are not waste. In the right hands, they are a resource.

To turn this challenge into opportunity, the EU-funded Circular Economy Cocoa: From Bean to Bar project, implemented by Helvetas Vietnam, has demonstrated a suite of circular economy solutions for agricultural residue management — with three biochar-based innovations at the centre



## 3 BIOCHAR INNOVATIONS

### 1 Gasification Technology



Converts agricultural residue into clean heat for crop drying, reducing fuel use and drying costs.

2 systems

### 2 Pyrolysis Kilns



Converts cocoa husks and other residues into biochar for soil application and circular farming.

19 kilns

### 3 Soil Improvement Trials



Tests biochar-based formulas to improve soil structure, moisture retention and crop performance.

2 trial sites

## Where it works best



**Gasification:**  
cooperatives and SMEs with continuous drying demand



**Pyrolysis:**  
farmers and small cooperatives with abundant biomass residues



**Soil trials:**  
cocoa areas facing soil degradation, acidity or cadmium concerns



**All solutions:**  
contribute to cleaner air, lower emissions and better soils

## Key impacts



**938**

mil. VND/year

Highest estimated net benefit from one model



**75%**

reduction in fuel consumption



**231**

tCO<sub>2</sub>e/year

estimated reduction in greenhouse gas emissions



**19–29%**

increase in crop yield after 6 months

## Project Footprint

23 deployments across 9 provinces

- Gasification
- Pyrolysis
- Soil improvement

Dak Lak

(Q) 1 (P) 6

Dong Nai

(G) 1

Binh Duong

(P) 1

Kien Giang

(P) 1

Gia Lai

(P) 5

Binh Dinh

(P) 1

Khanh Hoa

(P) 2

Lam Dong

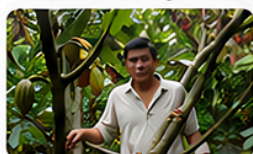
(P) 3

Vinh Long

(S) 2

G = Gasification P = Pyrolysis S = Soil improvement

## Beneficiary Story



“At first, I was hesitant. But after the first harvest, I could clearly see the difference — better soil, was softer, held moisture better, and the plants looked healthier.”

— Cocoa farmer, Vinh Long

Field observations in Vinh Long showed better soil friability, moisture retention and healthier plant growth after applying biochar-based soil amendments.

## Broader Significance



Climate

**231** t CO<sub>2</sub>e/year avoided

≈ 10,600 trees absorbing CO<sub>2</sub> for one year



Healthier Living

**21** biochar-based systems delivered

21 sites with less open burning, smoke, and cleaner workplaces



Scaling potential

**9** provinces with tested models



66

*“Neighbors came over and asked in surprise: ‘Where is the smoke?’”*

— Representative of Nhat Tam Cooperative



### Near-zero fuel cost

when agricultural residues are available on-site

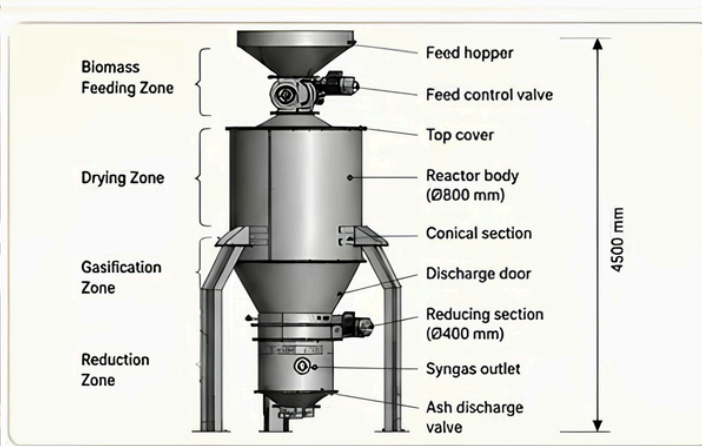


### Virtually smoke- & odour-free



### High-capacity drying

with just one operator



## A. Product Description

The Kanai-800 system is designed to convert dry biomass residues such as macadamia shells, cocoa husks, rice husks, cashew shells, coffee husks, and biomass pellets into syngas and hot air for rotary drying systems. It provides clean thermal energy for drying while co-producing biochar as a valuable by-product. The system supports agricultural residue valorization, reduces energy costs, and contributes to a circular-economy production model for cooperatives and agro-processing enterprises.

## B. Technical Specification

| Parameter               | Value                    |
|-------------------------|--------------------------|
| Flame temperature       | 800–1100°C               |
| Fuel consumption        | About 70 kg/hour         |
| Continuous burning time | About 2.5 hours/batch    |
| Airflow                 | About 30,000 m³/hour     |
| Adjustable drying temp. | About 60–300°C           |
| Main outputs            | Syngas, hot air, biochar |

**Practical meaning:** Suitable for drying cacao, coffee, pepper, rice and other crops, while using locally available biomass residues as fuel.

## C. Key Highlights

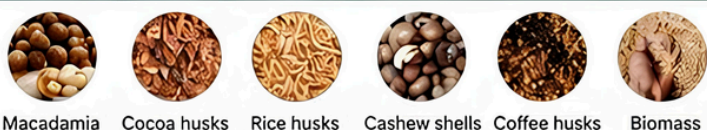
- Suitable for commercial-scale drying needs of cooperatives and enterprises
- Compatible with multiple dry biomass feedstocks
- Produces syngas and hot air for drying while recovering biochar
- Stable performance under different weather conditions
- Helps reduce open burning of agricultural residues and improves the working environment

## D. Indicative Impact

|                            |                                        |
|----------------------------|----------------------------------------|
| Fuel use reduction         | 40–75% less than wood, gas, etc.       |
| Drying time reduction      | 10–15%                                 |
| Est. emission reduction    | 231 tCO <sub>2</sub> e/year (1 system) |
| Highest annual net benefit | VND 938 million/year                   |
| <b>Simple payback</b>      | <b>~4 months</b>                       |
| Biochar co-production      | 26.4 tonnes/year                       |

**5-year IRR: ~299%**

## E. Suitable Feedstocks



## F. Application Context

|                    |                                                 |
|--------------------|-------------------------------------------------|
| Demonstration site | Nhat Tam Cooperative, Dak Lak, Vietnam          |
| Core function      | Clean heat for drying and biochar co-production |



## Interested in applying this model?

Suitable for cooperatives and agro-processors with continuous drying needs and locally available biomass residues.

**Basic conditions:** available dry biomass, regular drying demand, installation space, and one operator.

Contact: Helvetas Vietnam | Circular Economy Cocoa project





ONLY ~ VND 20 MILLION  
INITIAL INVESTMENT



PAYBACK IN  
**3-5**  
MONTHS

Practical and affordable for farmer groups and cooperatives.

## ABOUT THE PYROLYSIS KILN

This compact pyrolysis kiln converts agricultural residues into biochar and wood vinegar under oxygen-limited conditions.

It turns waste into valuable products that improve soil, help control pests, and reduce emissions.

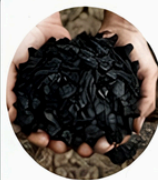
A practical solution for smallholder farmers and cooperatives.



### SUITABLE FOR:

Smallholder farmers, farmer groups and cooperatives with available dry agri-residues and interest in soil improvement, pest management and creating additional income.

## WHAT IT PRODUCES



### BIOCHAR

- ✓ Improves soil fertility
- ✓ Increases water retention
- ✓ Enhances crop productivity
- ✓ Creates additional income

~40 kg biochar per batch  
~4.0 t biochar per year



### WOOD VINEGAR

- ✓ Natural pesticide & disease control
- ✓ Improves plant health
- ✓ Reduces input costs

Estimated value:  
~VND 25 million/year



### CARBON REMOVAL

Removes and stores carbon in soil  
Contributes to climate change mitigation

~8.8 tCO<sub>2</sub>e/year  
carbon removal potential

## SIMPLE OPERATION – LOW LABOUR DEMAND



LOAD  
~2.5 hours



PYROLYSIS  
(24–48 hours/batch)  
You can do other work  
while the kiln operates



COLLECT BIOCHAR  
~1 hour

- ✓ Low smoke, safe handling, better sealing, and easy to operate.

## KEY PERFORMANCE



Operating cycle  
(per batch)

24–48 hours  
(loading ~2.5h, collection ~1h)



Biochar output

~40 kg/batch



Biochar recovery

41.4 – 67.8%



Estimated biochar production

~4.0 t/year

## IMPACT HIGHLIGHTS (TO DATE)



**3-5**  
MONTHS  
payback period



**VND 50.9–74.1**  
MILLION/YEAR  
net cash flow



**~8.8**  
tCO<sub>2</sub>e/year  
carbon removal



**19**  
pyrolysis kilns  
transferred



**6**  
localities  
reached



**5**  
training rounds  
57 participants



“Since I started spraying wood vinegar, I've noticed a significant drop in pests and diseases.”

— Mr. Nguyen Dinh Thien  
(Dong Tien Cooperative)



“I can earn money from biochar which generated from agri-residuals.”

— Mr. Le Quang Truong

## IMMEDIATE FARM BENEFITS



Improve soil  
fertility



Reduce pests  
and diseases



Add income from  
biochar & wood  
vinegar



Manage residues  
sustainably

## LONG-TERM CLIMATE VALUE



Carbon removal  
potential



Contribute to  
NDC targets



Future readiness  
for carbon market



This model supports Vietnam's NDC implementation and future domestic carbon market development under Decision 232/QĐ-TTg on establishing and developing the domestic carbon market.

