BIO LOOP

From Waste to Worth

To develop a data-driven mobile application that provides farmers in Thailand with the best solutions for efficient Black Soldier Fly (BSF) farming by leveraging real-time data to optimize colony tracking, food waste sourcing, and delivery logistics.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Team: Mamamamoodeng

Country: Thailand
Institution: Thammasat University
Member: Nunnaphat Makbun
Kunlanat Noinamkham

How much trash do you throw away each day?

Dumping and Landfills


Incineration

Every kilogram of waste represents money thrown away.

Direct Cost and Negative Externalities

Direct Cost

Hidden Cost

- GHG Emission
- PM2.5
- Human Toxicity
- Marine Toxicity
- Terrestrial acidification

Calculated Based on Environmental Prices 2015 EUR value by UNEP

The Total Quantifying Costs are...

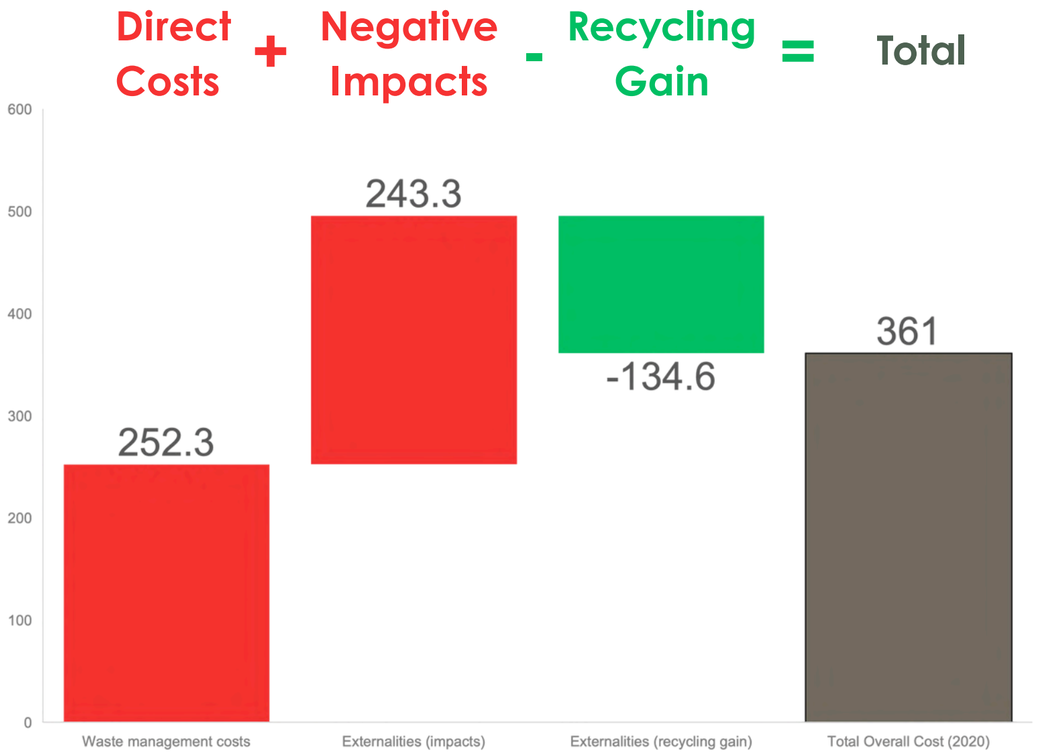
252.3
US$ Billion

243.3
US$ Billion

Source: UNEP (2024)

Partial Recovery of Loss from Poor Waste Management.

The 2020 Baseline of Total Cost of Waste Management



Estimated Costs (US$ billions)

Growing Population and GDP leads to higher future financial risk if no actions are taken

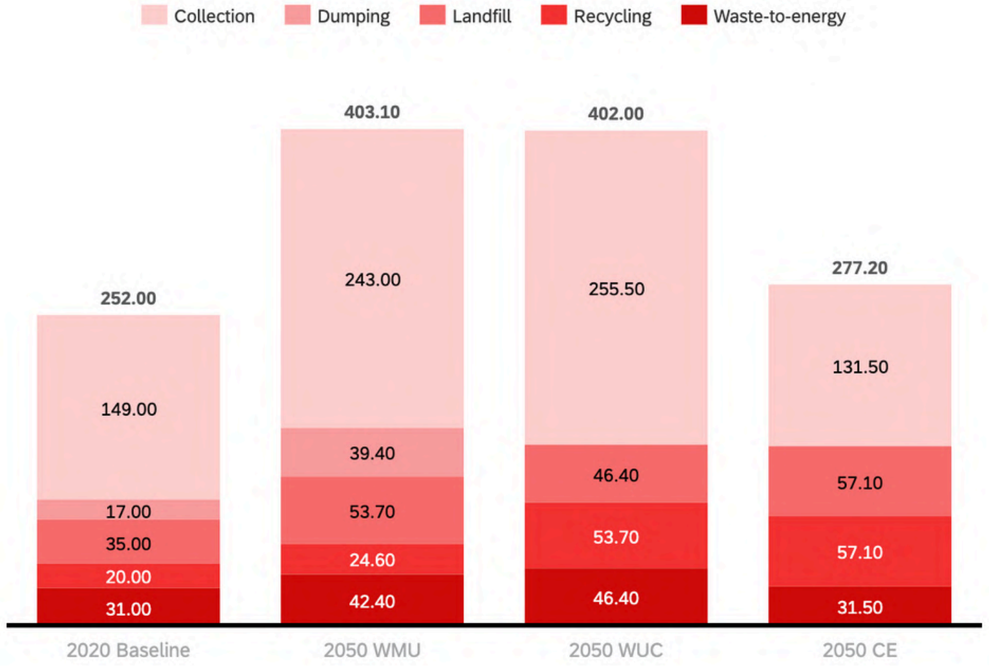
Three scenarios for global municipal solid waste generation

Source: UNEP (2024)

Circular Economy as the Pathway to Climate and Economic Resilience.

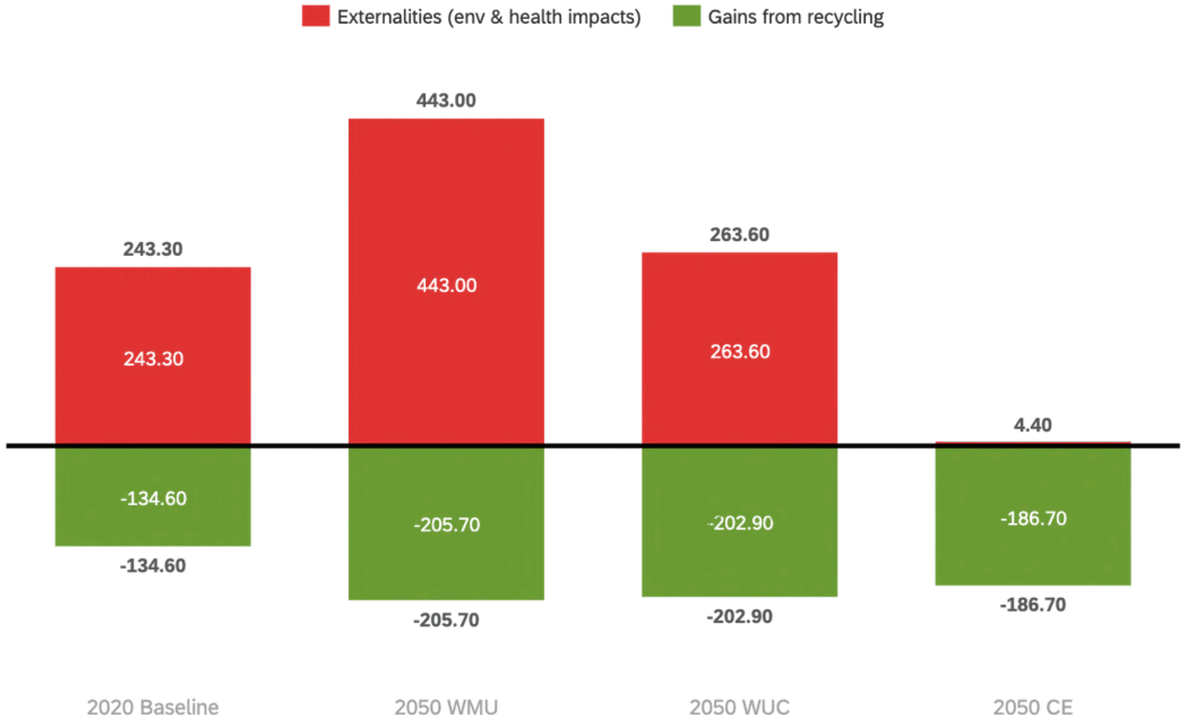
Waste Reduction can stabilize future direct costs of waste management

Global direct costs of municipal solid waste management in 2050 under the three scenarios (US$ 2020).



Full waste management could lead to a full net gain of

USD 108.5 BILLION PER YEAR



Source: UNEP (2024)

Monetizing Emission Reductions through Carbon Markets.

Methane Emissions from Waste

Organic Waste from
Landfills, Opendumps, Wastewater

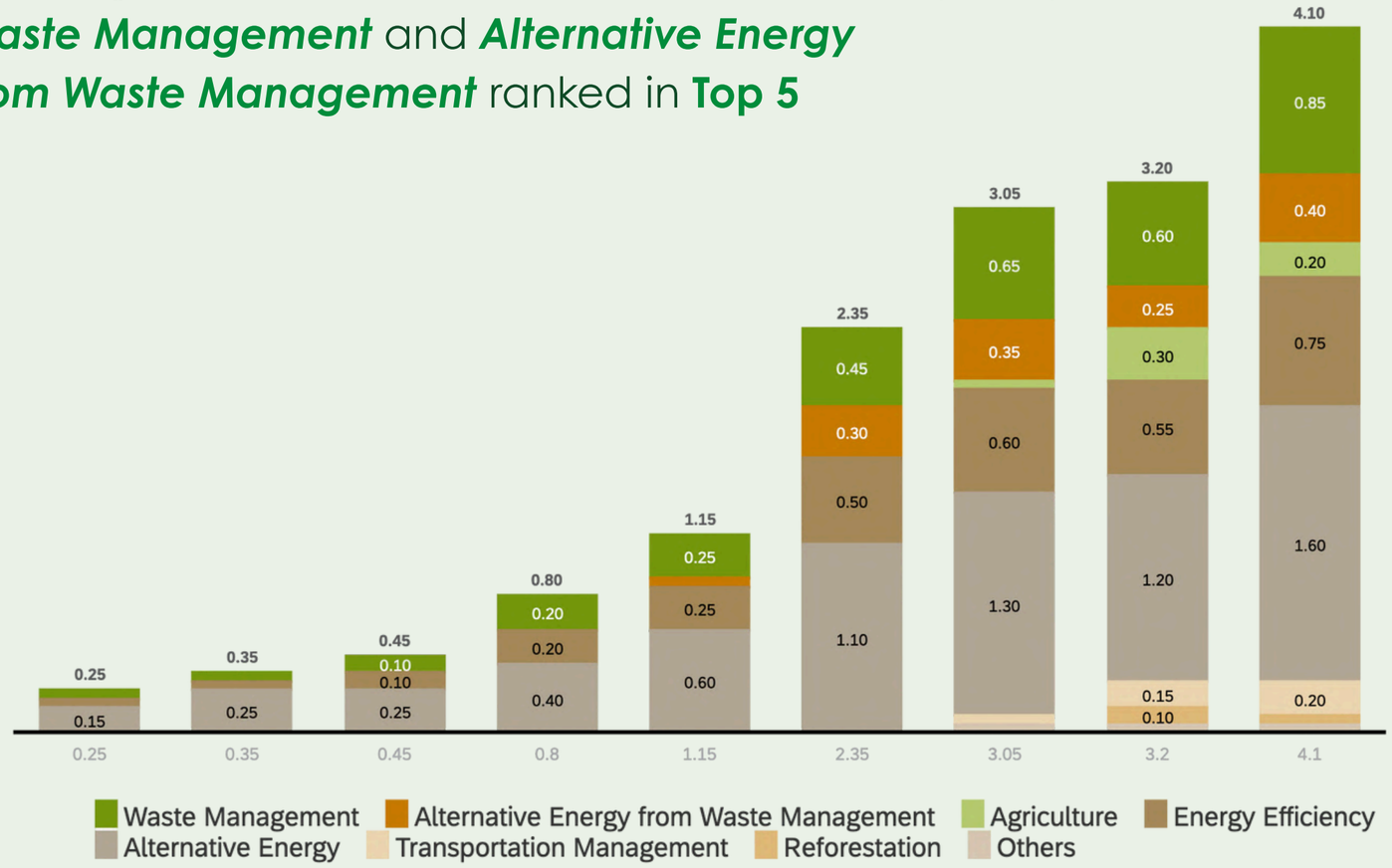
Anaerobic Decomposition

GHG

Methane, Carbon Dioxide

Climate Change

Growing Carbon Credit Market Certification Capacity with ***Waste Management*** and ***Alternative Energy from Waste Management*** ranked in **Top 5**



Source: UNEP (2024), KrungSri (2023)

Feasibility of Carbon Markets in ASEAN Landscape.

Market Feasibility in Thailand

Kasikorn Research (2024) said Thailand's total **GHG emissions** from **Waste** was

12.9 MtCO2e

Accumulated **Carbon Credit Sales** from Waste Management Programs

39.9 Million THB

Examples of Initiatives in ASEAN

ASEAN's focus on developing **national carbon markets** will benefit **future climate mitigations project**

T-VER

Climate Impact X

Climate Action Data Trust

carbon market

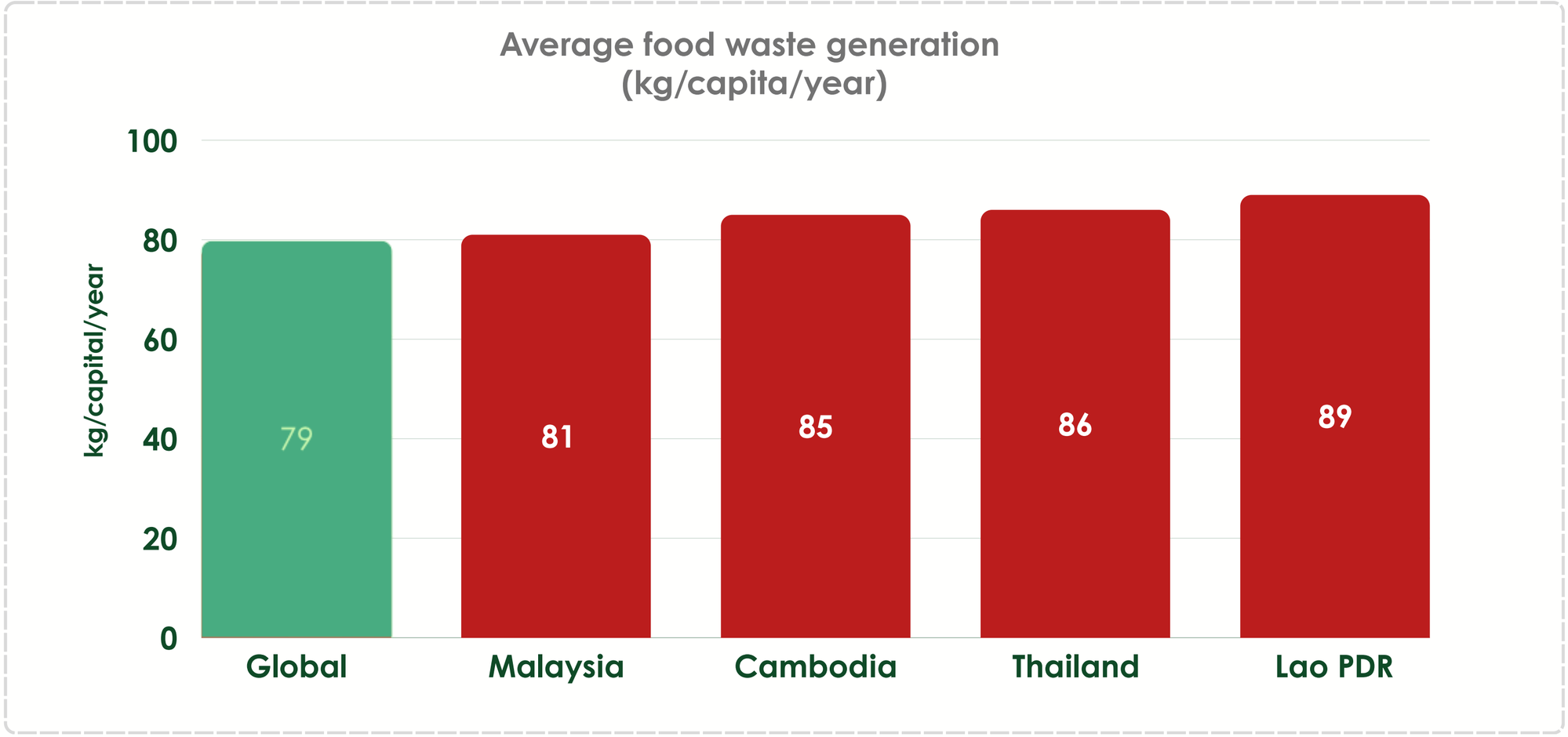
Source: ASEAN Capital Market Forum (2024), KasikornResearch (2024)

Key Takeaway #1:

Proper waste management drives economic growth.

Individual contribution to food waste generation in ASEAN.

ASEAN counties exceeded the global average 79 kg per person each year.



Source: United Nations Environment Programme, (2017)

The High Composition of Food Waste in ASEAN Nations.

In 9 out of 10 ASEAN nations, food waste is the largest component of municipal solid waste, with **over 50% of the total amount.**

	Food/organic	N/A (unclassified)	Plastic	Paper	Others	Metal	Glass	Textile	Grass/wood etc.	Construction debris
Singapore	10.5	89.5	11.6	16.5	11.9	20.8	2.1	2.1	8.6	17.0
Malaysia	45.0	55.0	13.2	8.2	27.3	0.0	3.3	0.0	0.0	0.0
Philippines	52.0	48.0	10.6	8.7	10.2	14.6	2.3	1.6	0.0	0.0
Indonesia	60.0	40.0	14.0	9.0	2.4	4.3	1.7	3.5	0.0	0.0
Brunei Darussalam	36.0	64.0	16.0	18.0		4.0		0.0	0.0	0.0
Lao PDR	64.0	36.0	12.0	7.0	0.0	1.0	7.0	5.0	0.0	0.0
Viet Nam	55.0	45.0	10.0	5.0	0.0	5.0	3.0	3.0	8.0	0.0
Thailand	64.0	36.0	17.6	8.0	0.0	2.0	3.0	2.0	1.0	0.0
Cambodia	60.0	40.0	15.0	9.0	0.0	0.0	3.0	1.0	0.0	0.0
Myanmar	73.0	27.0	17.8	2.2	5.2	0.5		1.1	0.0	0.0

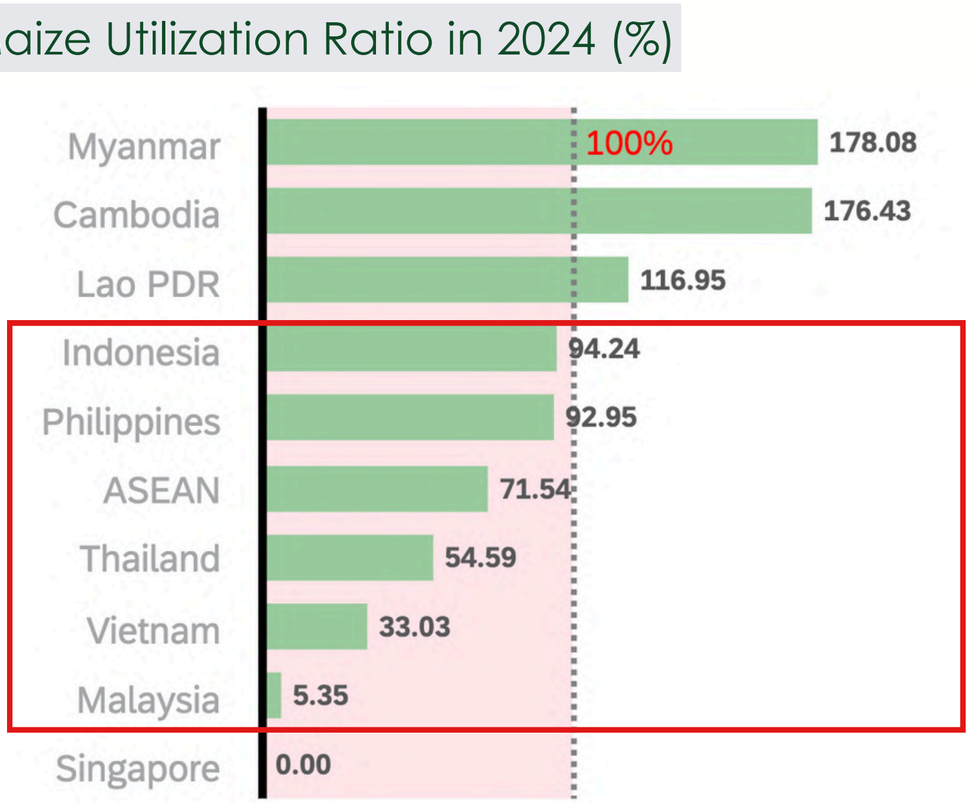
Source: United Nations Environment Programme, (2017)

Key Takeaway #2:

Focus on Food Waste Reduction First

Insufficient Animal Feed Production in ASEAN.

50% of ASEAN countries **produced less maize than required for regional consumption.**



Source: AFSIS Secretariat (2023)

Insufficient Animal Feed Production in ASEAN.

Rising fertilizer, energy, and food prices due to the Russia-Ukraine war could result in **soybean shortages for ASEAN nations.**

Soybeans Utilization Ratio in 2024 (%)

Source: AFSIS Secretariat (2023)

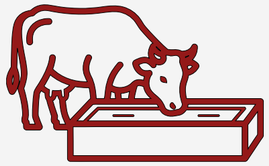
Growing Demand for Livestock Feed.

Global Trends

Growing population

By 2050,

- **9.8 billion people** globally
- **70%** Urbanization rate



Higher Protein Demand

In 2050, compared to 2010,

- **58%** Higher **Meat Demand**
- **70%** Higher **Milk Demand**

Agriculture for Livestock

- **70%** of total **agricultural land used for livestock feed**
- **50%** of **maize** and **80%** of **soybeans** go to animal feed

Environmental Impact

Emissions from feed production is **The second largest** in the global livestock supply chain

41% (3.3 GtCO2e)
of total sector emissions

Synthetic fertilizers
Rely on **fossil fuels**
generating significant
CO2

Agricultural sector
25% (10–12 GtCO2e/yr)
of global GHG emissions
Livestock
80%
of agricultural emissions

Source: Climate and Clean Air Coalition (2025), Kashif ur Rehman (2022)

Key Takeaway #3

Key Takeaway #3:

Food waste offers a solution to ASEAN's animal feed needs.

If they are not addressed, it will result in a variety of growing issues.

Environment	Social	Governance
#1 Issues of Food Waste		
		
Food loss/waste causes 10% of global **GHG emissions** due to decomposition in landfills.	Public health concerns due to **improper waste management.**	**Lack of regulations or incentives** to make businesses tackle food waste seriously.
#2 Issues of Animal Feed		
		
Animal feed crops demand **enormous resources**	Small-scale farmers often **can't access or afford high-quality feed**, affecting their productivity.	**A few large players** dominate feed markets, limiting innovation.

Source: Economic Impacts on Cattle farmers: Forages and Regions in Thailand (2019)

We suggest to implement the Sustainable Alternative for Livestock Feed.

“Black Soldier Fly larvae”



We suggest to implement the Sustainable Alternative for Livestock Feed.

Waste Recyclers

They can reduce organic waste volumes by up to 80%

Large portion of food waste from our partners could be convert into livestock feed

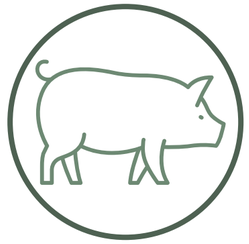
Source: Climate and Clean Air Coalition (2025), researchgate

We suggest to implement the Sustainable Alternative for Livestock Feed.

Waste Recyclers

They can reduce organic waste volumes by up to 80%

Large portion of food waste from our partners could be convert into livestock feed



Highly Nutritious livestock diet

Consisted of 35% protein and 30% fat

Excellent alternative to conventional feeds like fishmeal

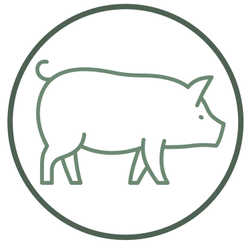
Source: Climate and Clean Air Coalition (2025), researchgate

We suggest to implement the Sustainable Alternative for Livestock Feed.

Waste Recyclers

They can reduce organic waste volumes by up to 80%

Large portion of food waste from our partners could be convert into livestock feed



Highly Nutritious livestock diet

Consisted of 35% protein and 30% fat

Excellent alternative to conventional feeds like fishmeal

Cost-effective animal feed

Raw worms cost at 5 THB/kg plus cost-effective larvae feed from BioLoop

Farmers could implement on-farm livestock feed for more sustainable alternative

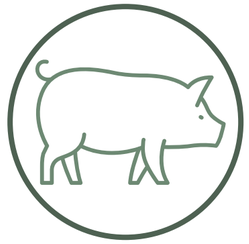
Source: Climate and Clean Air Coalition (2025), researchgate

We suggest to implement the Sustainable Alternative for Livestock Feed.

Waste Recyclers

They can reduce organic waste volumes by up to 80%

Large portion of food waste from our partners could be convert into livestock feed



Highly Nutritious livestock diet

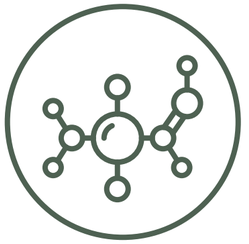
Consisted of 35% protein and 30% fat

Excellent alternative to conventional feeds like fishmeal

Cost-effective animal feed

Raw worms cost at 5 THB/kg plus cost-effective larvae feed from BioLoop

Farmers could implement on-farm livestock feed for more sustainable alternative



Lauric acid-antioxidants

Its compounds that protect against harmful microbes

Improve livestock health and reduce antibiotic dependence through natural antimicrobial compounds.

Source: Climate and Clean Air Coalition (2025), researchgate

We suggest to implement the Sustainable Alternative for Livestock Feed.

BSFL are an excellent solution for the challenges of food waste and animal feed.

BSFL feeding requirements

Fruit and Vegetable waste

Food Scraps

Why?

- Readily available
- Nutritionally rich
- Easy for the larvae to digest

Our ideal stage for harvesting as animal feed is larvae.

Egg to larvae

Highest waste consumption

larvae to Prepupa

Increasing their biomass and nutrient content

Pupal to Adult Fly

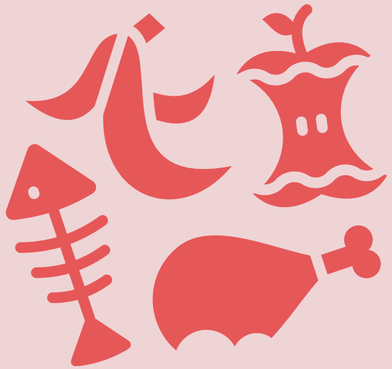
Completing the life cycle and entering mating phase

Optimal Temperature are in between 25C-30C
Humidity Level
60-80%

Thrive in ASEAN's geographical characteristics

Source: Climate and Clean Air Coalition (2025)

With the Protein Worms, we can avoid GHG emissions.



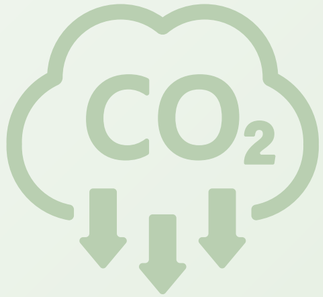
6 kg Food Waste

3 kg CO_2e

+

1 kg Larvae

Bioconversion



Net CO_2 avoided

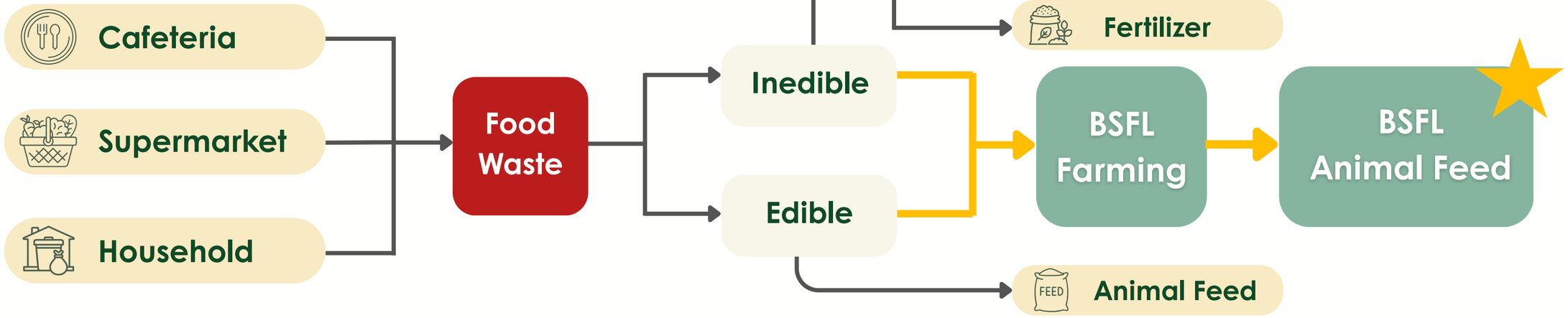
2.8 kg CO_2e

CO_2e avoided (kg) = Waste diverted (kg) × EF food waste ($kgCO_2e/kg$) − Process emissions (kg)

Source: refed (N.A.), Wageningen (2022)

A New Approach to Transforming Waste Management.

Bio Loop's Approach



Advantages

Sustainable waste management alternative

Cost-effective and Highly nutritious animal diet

Farmers are well-equipped with the on-farm livestock feed production from BSFL

Source: Pollution Control Department (n.d.)

BIO LOOP

From Waste to Worth

Solution

Our Target Persona.

Uncle Noi, Thai Livestock Farmer

Age: 58
Location: Nakhon Pathom in **Suburban area**
Occupation: Livestock farmer and operate **BSFL farm as animal feed**

Pain Points

- **Works alone** on the farm.
- Has to learn through **trials and errors**
  - e.g. excessive humidity led to poor BSFL yield.
- Lacks **technology or automated systems** to control humidity, temperature, and feeding schedules.
- Has limited knowledge about **carbon credit** certification and how to access **carbon markets**.

Goals

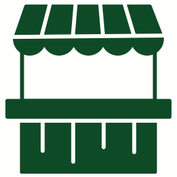
- Scale BSFL to **industrial level.**
- Qualify for **carbon credit sales**.
- Adopt tech to **automate** farm operations.

Stakeholders.

Food Waste Generators

University

Office

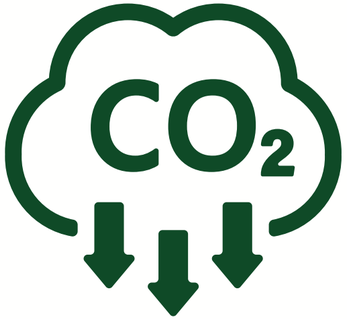


Market

BioLoop

Farmers & Livestock Integration

Credit Buyers / Corporates



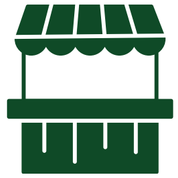
Source: Team's Analysis

Stakeholder

Food Waste Generators

University

Office



Market

Give

Organic Waste

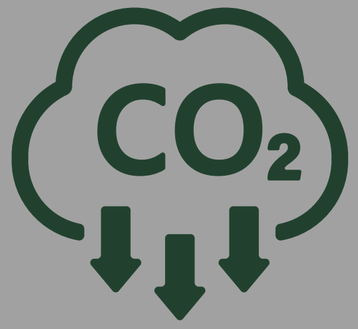
Waste Data

Gain

Lower Disposal Costs

ESG Benefits

Credit Buyers / Corporates



Source: Team's Analysis

Stakeholder

Give

- Fermentation
- Logistics
- Digital Platform

BioLoop

Gain

- Carbon Credit Commissions
- Verified Carbon Data

Farmers & Livestock Integration

Source: Team's Analysis

Stakeholder

Food Waste Generators

Give

BSFL larvae Production Data

BioLoop

Gain

Low-cost Feed

Increased Livestock Productivity

Income from Carbon Credits

Farmers & Livestock Integration

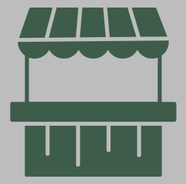
Source

Stakeholder

Food Waste Generators

University

Office



Market

BioLoop

Give

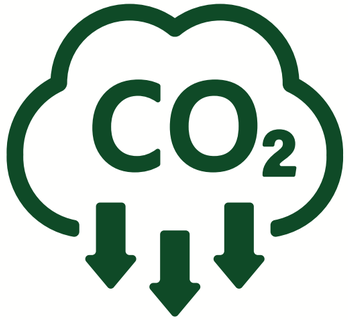
Payment for Verified Carbon Credits

Gain

Certified Carbon Offsets

Opportunity to Green Partners

Credit Buyers / Corporates



Source: Team's Analysis

Organized Waste Collection at the Source.

Closed Containers

Prevent odor, pests, and contamination during storage and transport.

Organized Waste Sorting

Clear separation between BSFL Feed Waste, Non-feed Organic, Liquid, and Non-organic.

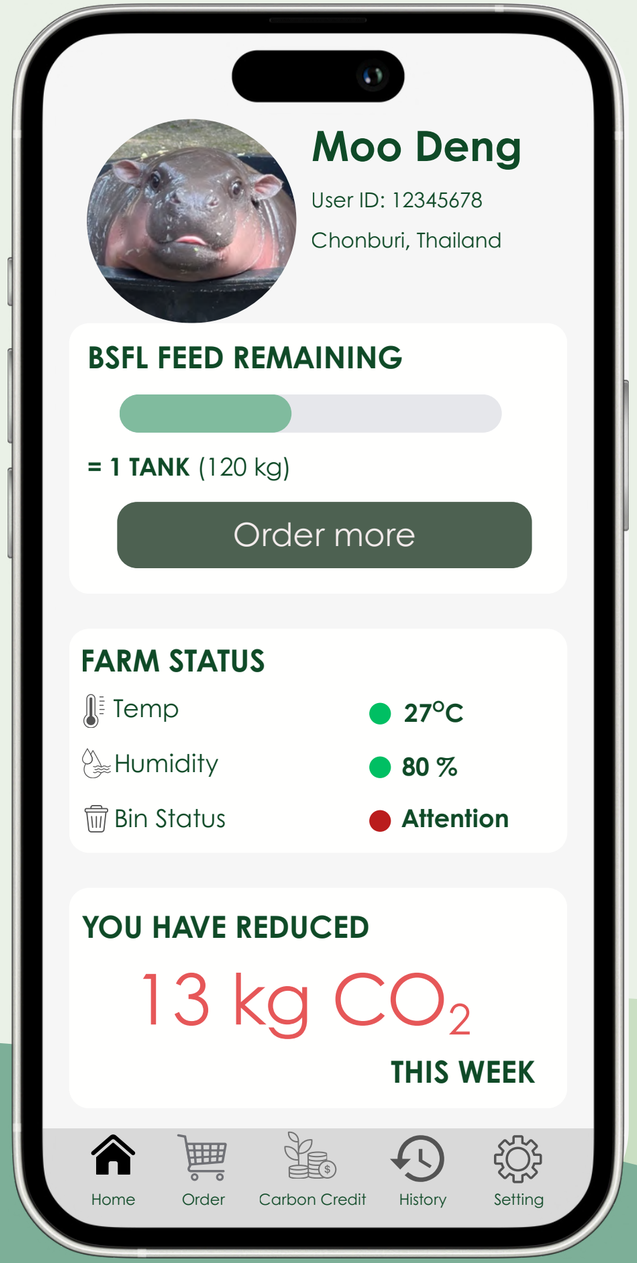
Easy Transfer & Traceability

Containers are modular, labeled, and trackable via BioLoop system

Source: Pollution Control Department (n.d.), Team's Analysis

Solution

Smart Farm Dashboard Powered by AI & IoT.



Real-time data from IoT sensors

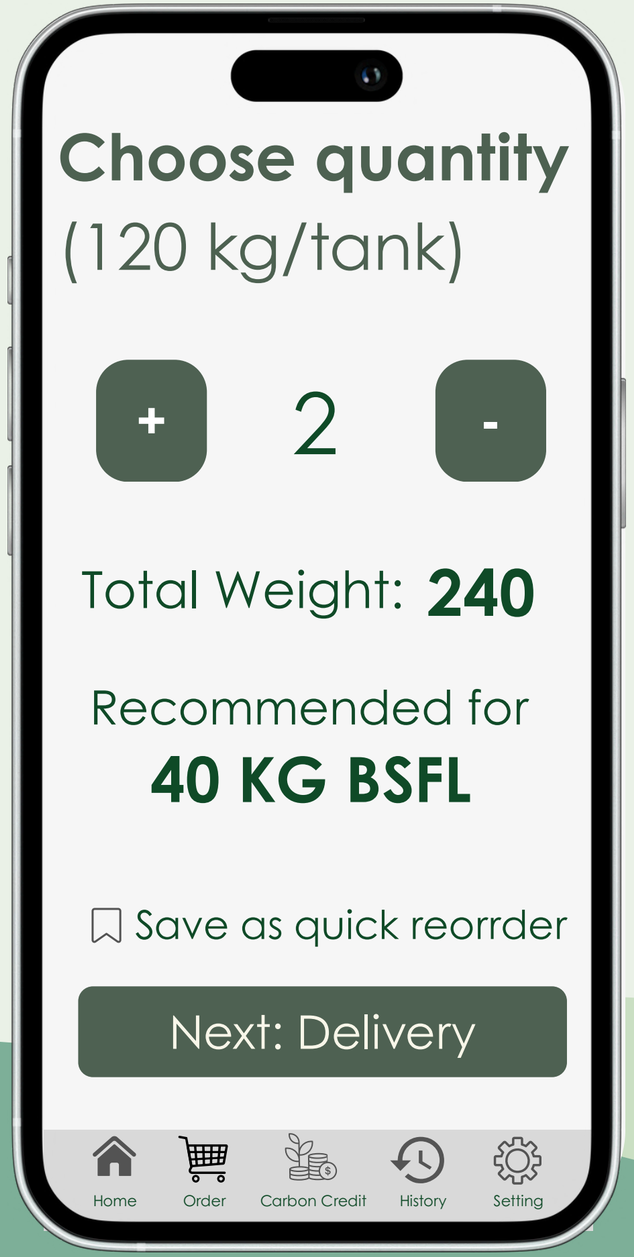
Track **temperature**, **humidity**, and **feed levels** anytime

AI tracks your farm 24/7

Every action you take **reduces real carbon**

Solution

Seamless Ordering with AI-Based Recommendations.

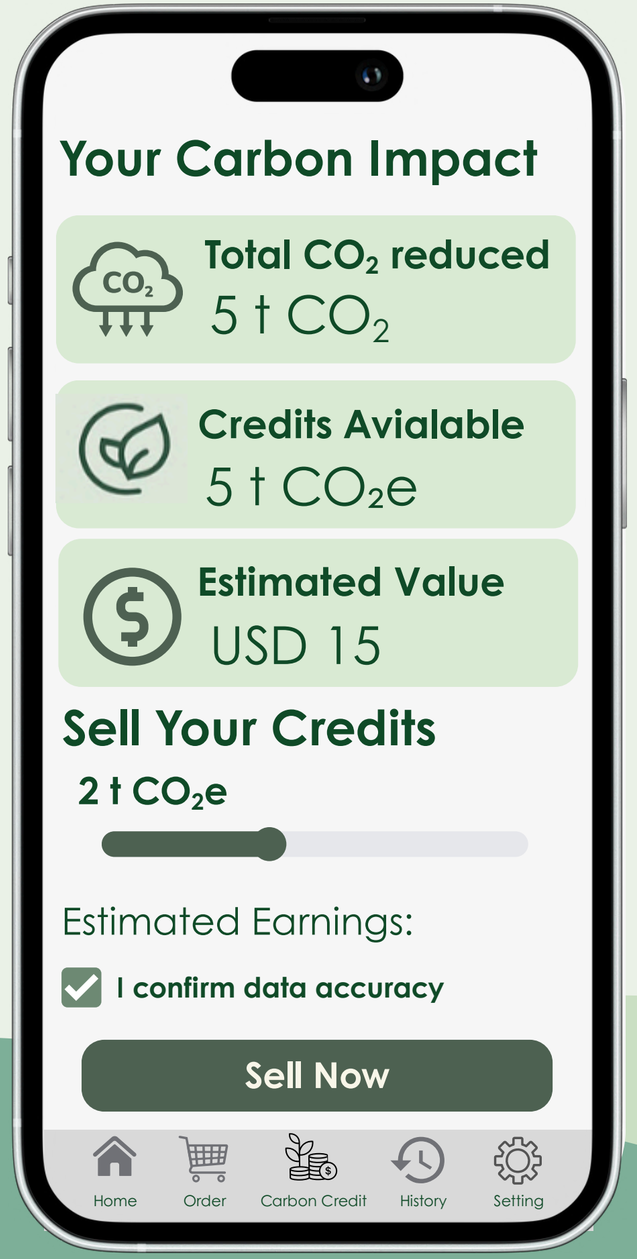


AI recommends the right quantity based on your farm size

Set quick reorders with one tap

Solution

From Waste to Worth AI-Verified Carbon Credits.



Monitor how much **carbon your farm saves every month**

All CO_2 data is **verified automatically** through BioLoop's AI system

See available your **carbon credits** and their **market value**

Solution

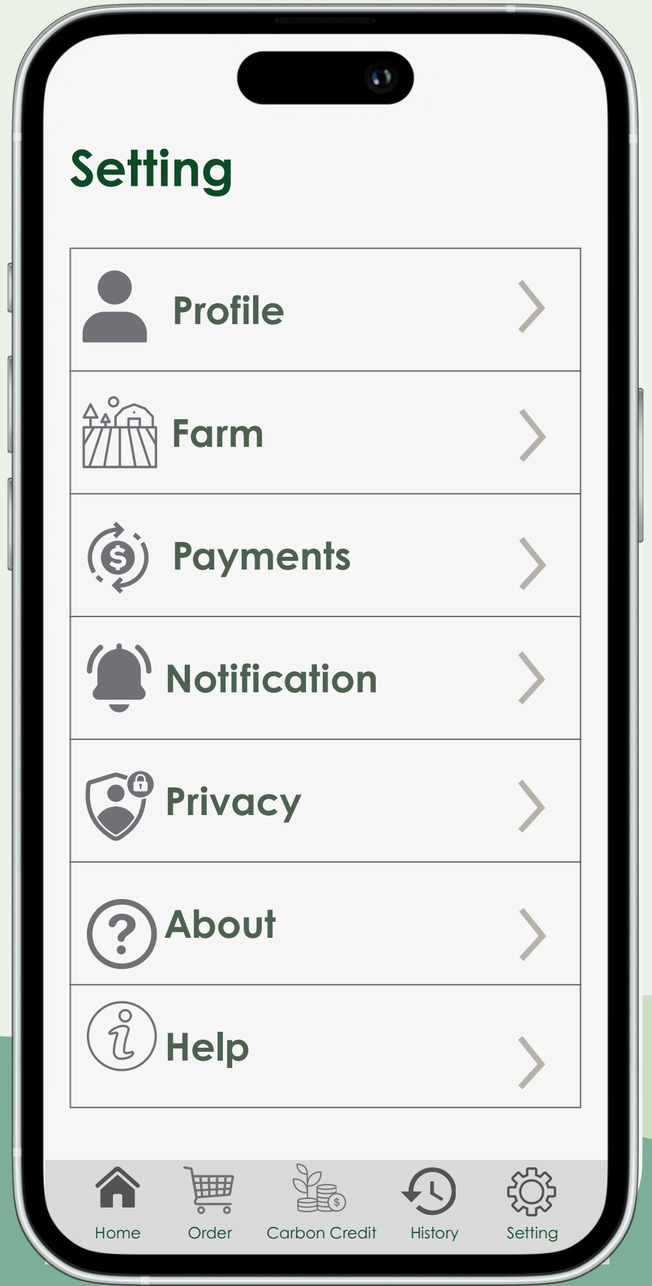
Transparent, traceable, and trustworthy.

View all past carbon credit transactions with **full details**

Check payment status instantly

Solution

Manage everything in one place.



Update your preferences

Built-in AI assistant provides **real-time farming advice** and **troubleshooting**

Transparent privacy and data control

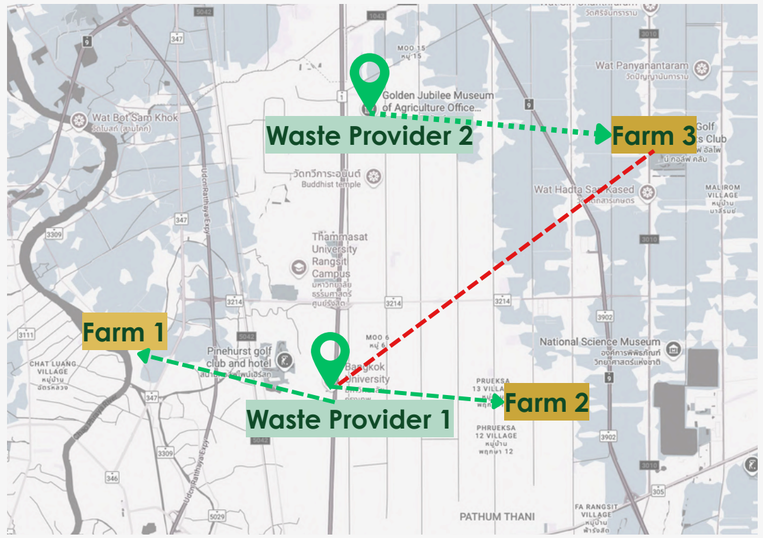
AI Tracking & Real-Time Monitoring.

Providing Real-Time Monitoring Dashboard to make every kilogram of food waste and every delivery trip **visible, measurable, and actionable in real-time**

Control Tower

Food Waste
500 ton

Deliveries
3



Farmers

Name	Remaining Level	Prioritization
Pammie	20%	High
Moodeng	60%	Medium
Butterbear	80%	Low

Proactive Alerts

- Almost Full Food Waste at Source 2
- Food Waste is almost out for Pammie
- Delay in Pickup at Source 1

Service Levels

On-Time Pickups	Pickup Success Rate	Cost per kg Delivered
96%	99%	$0.25

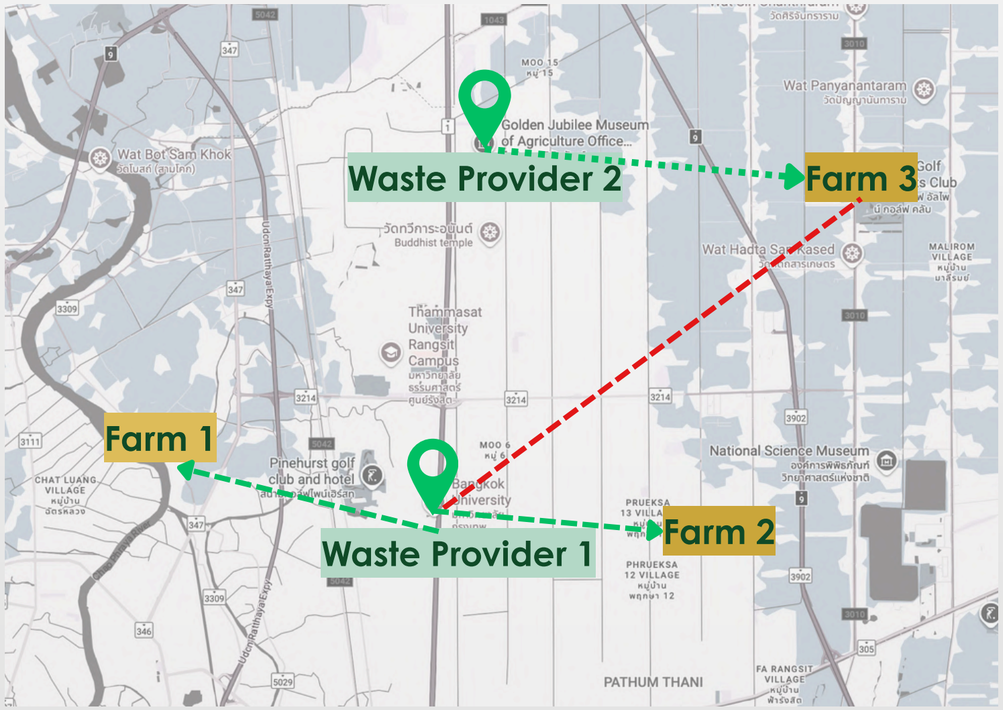
Source: Team's Analysis

Enable Efficient Logistics Route.

Control Tower

Food Waste
500 ton

Deliveries
3



Control Tower

Key Feature

Helps managers decide immediately when conditions change

How does it work?

- Add trucks
- Consolidate trips
- Reroute deliveries

Source: Team's Analysis

Intelligent Demand Alignment.

Farmers			
	Name	Remaining Level	Prioritization
	Pammie	20%	High
	Moodeng	60%	Medium
	Butterbear	80%	Low

Indicates BSFL Feedstock Capacity

Farmers' Profiles

Key Feature

Show **capacity** utilization of farms **receiving** the BSFL feedstock.

How does it work?

Enables **Intelligent Matching**, if one farm is **nearly full (80%+)**, AI redirects waste to another farm to **avoid oversupply**.

Source: Team's Analysis

Urgent Issues Alerts.

Proactive Alerts

Almost Full Food Waste at Source 2

Food Waste is almost out for Pammie

Delay in Pickup at Source 1

Proactive Alerts

Key Feature

Flag risks in advance so managers can act before disruptions occur.

How does it work?

Alerts drive **early corrective action** (rerouting, rescheduling, or consolidating pickups) to maintain **cost-efficiency and feed quality**.

Source: Team's Analysis

Performance Indicators for Management Improvements.

Service Levels Performance Indicators

Key Feature

Display **key performance indicators** regarding the logistical systems

How does it work?

Shows that AI is not just routing vehicles but also **governing performance, cost, and sustainability outcomes.**

Service Levels

On-Time Pickups	Pickup Success Rate	Cost per kg Delivered
96%	99%	$0.25

→ **Key Logistical Performance Indicators**

Source: Team's Analysis

Optimizing Delivery with AI for a Sustainable Supply Chain.

AI-Powered Logistics & Sustainable Delivery

Smarter Routes, Greener Deliveries

AI Tracking
Real-Time Monitoring for Efficiency

Intelligent Matching
Linking Farmers with Nearby Food Waste Sources

AI algorithms
Ensure the fastest, most cost-effective delivery routes.

Key Benefits

- Reduced Transportation Costs
- Environmental Sustainability
- Increased Farmer Convenience

Source: Pollution Control Department (n.d.), Team's Analysis

Our Potential Partners for the Pilot Program.

Stakeholder	What They Provide	What They Gain (Value)	Potential Partners
Food Waste Generators	**Organic waste** for fermentation	• Generate **carbon credits** • Lower **waste disposal** costs	makro PRO, true digital park, Thammasat University
Livestock Cooperatives	**BSFL rearing** and data for **carbon verification**	• **Low-cost** protein feed • **Healthier animals**	BETAGRO, CP
Financial Institutions	Funding and purchase of verified **carbon credits**	• Verified **ESG-compliant offsets** • Reputation as **a green company**	KBank
Technology & Research Partners	**AI, IoT, and carbon verification** R&D	• Access to **BioLoop data & pilot projects** • Collaboration on **circular economy innovation**	SCGC, BANPU, ptt

Source: Team's Analysis

Overview of 5-Year Plan to secure region.

Initial Phase
2026

Local validation in Thailand

- Launch **pilot farms and AI dashboard**
- Build **food waste partnerships**
- Begin **carbon credit data collection**

Circular Innovation
2027-2028

Biofuel & energy utilization

- Pilot BSFL **oil-to-biodiesel conversion**
- Partner with **PTT / EA for biofuel R&D**
- Launch **dual carbon and energy credit** model

Scale & Expansion
2028-2030

Regional growth & partnership

- Create **ASEAN carbon credit network**
- Onboard **300+ farms and regional hubs**

Platform & Impact
2030-2031

Digital ecosystem

- Certify **“BioLoop Farm Standard”**

Source: Team’s Analysis

The BioLoop will empower us to create a more sustainable world.

Key Implementation Indicatiors in 2026

Total Downloads

>5,000
users

Number of Participating Areas

>20
areas

Average App Usage/ Farmer/ Week

>2
times

Amount of Waste Managed

15,000
Tons

Reduce Carbon Emission

3,500 *Tons CO_2e*

Increase the utilization rate of food waste to

90%

Help users reduce their animal feed costs by

8-12%

Source: Team's Analysis

The BioLoop will empower us to create a more sustainable environment.

Proposition	Circular Food System	Organic Waste Valorization	Localized Feed Security
Key Issues	Food Waste Crisis	Rising Feed Import Dependency	High GHG Emissions from Landfills

Expected Impact

12.3: Halve global per capita food waste at the retail and consumer levels

- **Increase** the food waste reduction rate to **>15%**
- **Increase** the utilization rate of food waste to **90%**
- Help users **reduce** their animal feed costs by **8-12%**

ASEAN ECONOMIC COMMUNITY BLUEPRINT 2025

Driving ASEAN's **circular economy** through **decentralized, inclusive bio-innovation**

ASEAN CENTRE FOR ENERGY • ACE •

"In line with ASEAN's pursuit of a **Bio-Circular-Green (BCG) Economy**, decentralized waste-to-feed innovation like BioLoop is becoming an indispensable strategy for **regional sustainability, energy resilience, and inclusive economic growth**"

Source: Team's Analysis, Department of Trade Negotiations (2021)

For every kilogram of food waste we manage properly, we can

feed animals, fuel economies, and heal the planet.

Appendix

Financials

Capital Budgeting

Year	2025 (Y0)	2026 (Y1)	2027 (Y2)	2028 (Y3)	2029 (Y4)	2030 (Y5)
Operating Revenue	–	111	222	417	694	750
Operating Costs (COGS + OPEX)	–	(103)	(180)	(291)	(445)	(490)
Operating Cash Flow	–	8	42	126	249	260
Capital Expenditure (CAPEX)	(417)	–	–	–	–	–
Net Operating Cash Flow	–417	8	42	126	249	260
Residual / Salvage Value	–	–	–	–	–	222
Total Cash Flow per Year	–417	8	42	126	249	482
Cumulative Cash Flow	–417	–409	–367	–241	8	490

Financials

5-Year Income Projection in USD.

Year	Revenue	COGS	Operating Expenses	Net Profit
2025	42	28	28	–14
2026	111	61	42	8
2027	222	111	69	28
2028	417	194	97	69
2029	694	306	139	139

Financials

Capital Budgeting

Parameter	Assumption
Initial Investment (2025)	$417K (includes fermentation unit, IoT setup, AI dev)
5-Year IRR	**16%**
Payback Period	~ 4.3 years
Breakeven	Between Year 4 (2028) and Year 5 (2029)

References

Atharvasoundankar. (2025). *Global Food Wastage Dataset 2018-2024*. Kaggle. Retrieved from https://www.kaggle.com/datasets/atharvasoundankar/global-food-wastage-dataset-2018-2024

United Nations Environment Programme. (2017.). *Waste Management in ASEAN Countries: Summary Report*. Retrieved from https://www.rrcap.ait.ac.th/Publications/Waste_Management_in_ASEAN_Countries_Summary_Report.pdf

Statista. (2022). *Global food waste by sector.* Retrieved from https://www-statista-com.eu1.proxy.openathens.net/statistics/1219836/global-food-waste-by-sector/

AFSIS Secretariat (2023). *ACO Report 1/ACO31*. Retrieved from https://aptfsis.org/uploads/normal/ACO%20Report%201/ACO31/ACO%2031%20final%202.pdf

Economic Impacts on Cattle farmers: Forages and Regions in Thailand. Veridian E-Journal, Silpakorn University. Retrieved from https://he02.tci-thaijo.org/index.php/Veridian-E-Journal/article/view/164450

Climate and Clean Air Coalition (CCAC) & Technology and Economic Assessment Panel (TEAP). (2025). *Transforming Organic Waste with Black Soldier Flies: A Guide for Decision Makers, Entrepreneurs and Implementers to Unlock Organic Waste Potential with Black Soldier Fly Systems*. Retrieved from https://www.ccacoalition.org/resources/ccac-teap-report-transforming-organic-waste-black-soldier-flies-guide-decision-makers-entrepreneurs-and-implementers-unlock-organic-waste-potential-black-soldier-fly-systems

Pollution Control Department (PCD). (n.d.). *คำแนะนำแนวทางการจัดการขยะอาหารสำหรับองค์กรปกครองส่วนท้องถิ่น*. Retrieved from https://www.pcd.go.th/wp-content/uploads/2025/04/pcdnew-2025-04-17_08-17-31_632789.pdf

Gameball. (2024). *Do Customer Loyalty Programs Really Work?.* Retrieved from https://www.gameball.co/blog/do-customer-loyalty-programs-work

Rehman K ur, Hollah C, Wiesotzki K, et al. Black soldier fly, Hermetia illucens as a potential innovative and environmentally friendly tool for organic waste management: A mini-review. Waste Management & Research: The Journal for a Sustainable Circular Economy. 2022;41(1):81-97. doi:10.1177/0734242X221105441