

Celebrating MTEC's 40th Anniversary
Strong Foundation, Materials Innovation & Sustainable Future

The 5th Biochar Consortium - NbS & High-Value Biochar Applications
Time: November 13, 2026 Venue: IMPACT Muang Thong Thani, Thailand

Limited distribution. No citation

Biochar Carbon Sequestration Management in Japan

Ayaka Kishimoto

Institute for Agro-Environmental Sciences, NARO



Outline

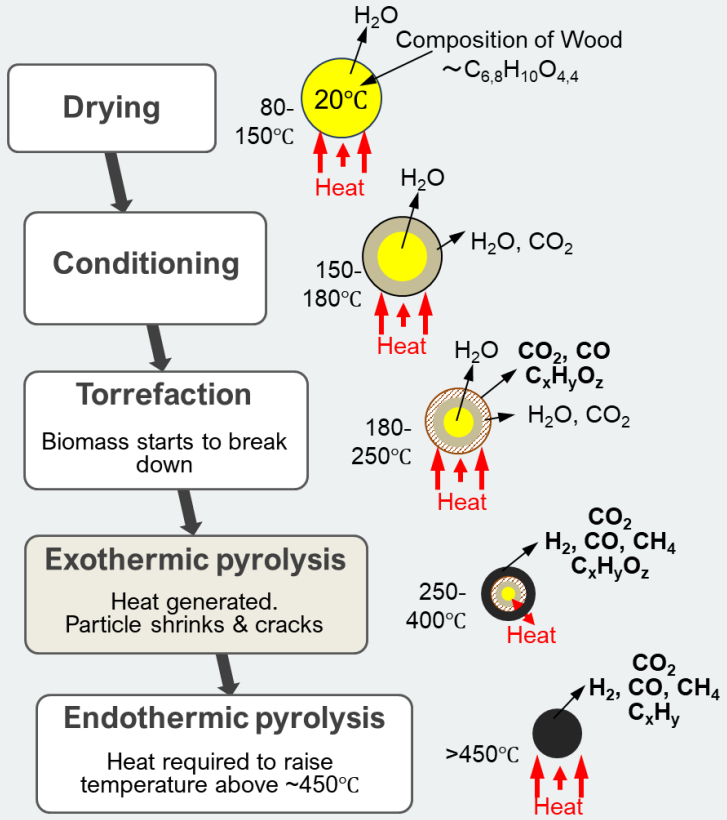
1 **Revisiting biochar use in Japan**
- History and Development

2 **Scaling Up Biochar in Japan**
- From Research to Economic Implementation

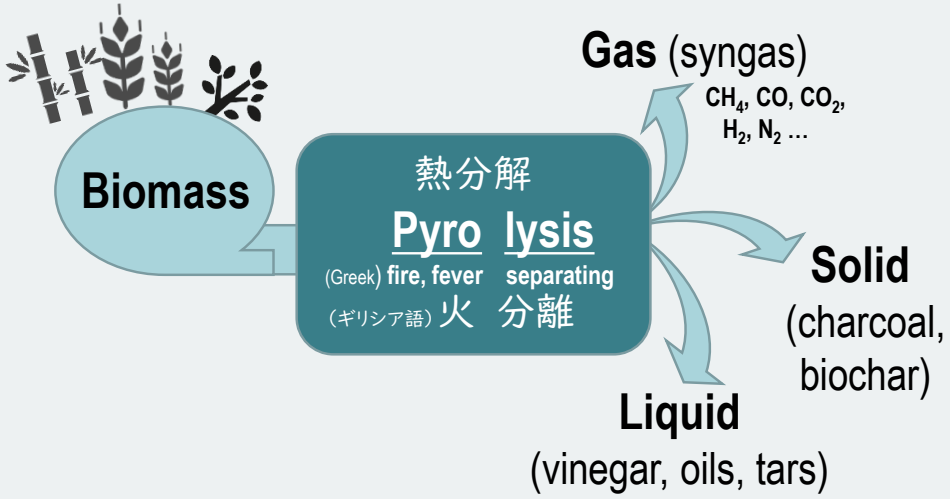
1 Definition of biochar

Pyrolysis

5 Stages of Pyrolysis



Modify from https://anzbig.org/farmers-guide-2024/



Biochar

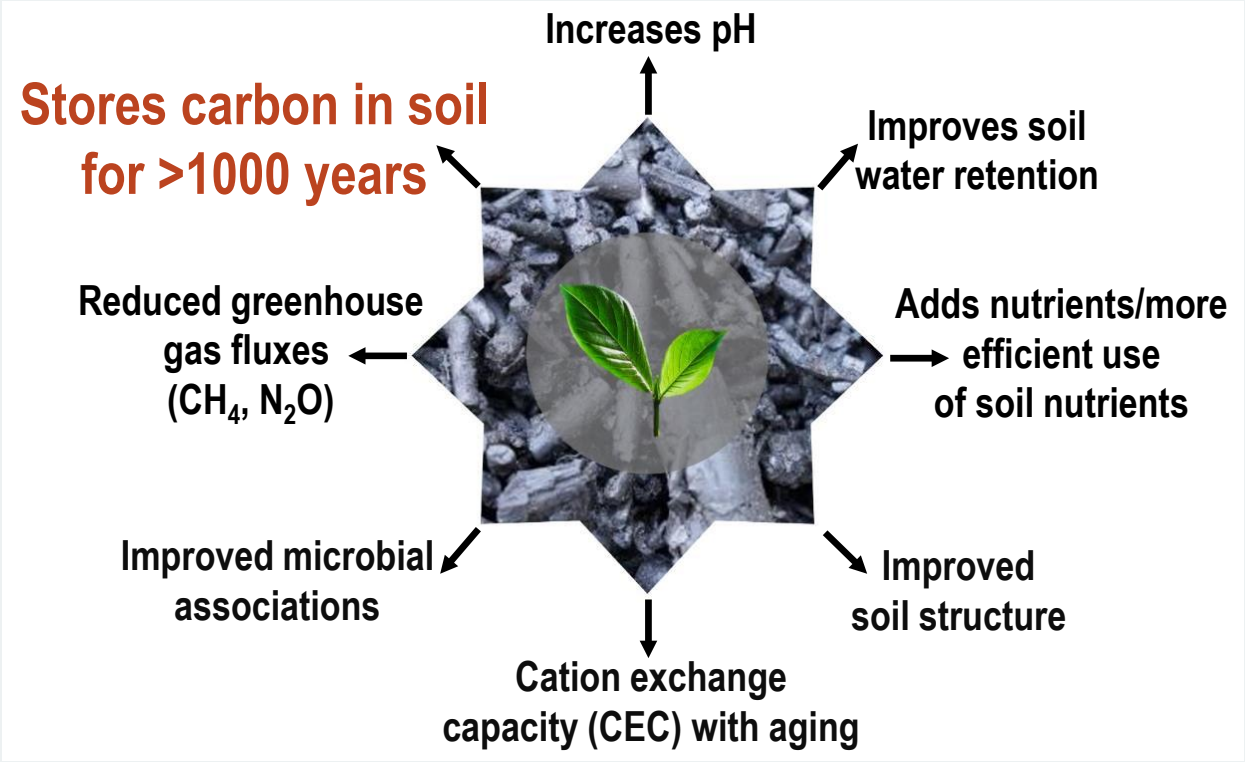


IPCC 2019 Refinement, Vol.4, Chapter 2, Annex 2A.2, p.2.82

Biochar is a solid material generated by heating biomass with temperature **exceeding 350°C** and **limited O_2 to prevent combustion**. These processes are categorized as **pyrolysis** (without oxidants) and **gasification** (with low oxidant to generate syngas).

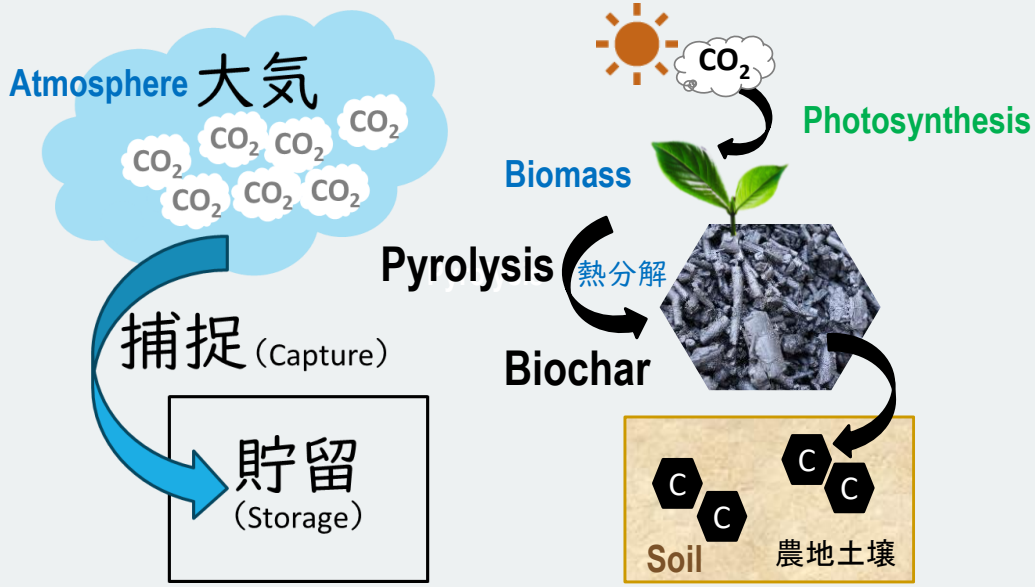
1 Functions of biochar in soil

Functions of biochar in soil



Adapted from Lopez-Capel et al. (2016)

Biochar Carbon Removal



Biochar is a promising CDR for climate change mitigation (Shrestha et al. 2023), **with co-benefits for soil improvement** (Schmidt et al. 2021) **and food security** (Xia et al. 2023).

1 Long history of biochar use in Japan

Traditional "charcoal"

Terra Preta -Brazil

Agricultural encyclopedia –Japan (1697)

Biochar 1990-2000's

IBI – International Biochar Initiative

JBA – Japan Biochar Association

Biochar for CDR 2015-

European Biochar Industry – EBI consortium

IPCC 2019 Refinement



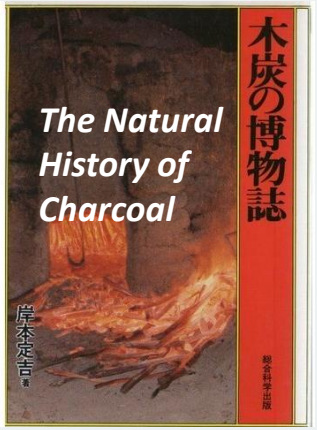
Over 2,500 yrs agon, Indigenous people in Amazon created Terra Preta (dark earth) by smoldering plant matter in pits with little oxygen. These soils are **still fertile today.**



Using charcoal and ash to improve soil is a practice rooted in Japan's agricultural traditions.



1976→1998
(Expanded edition)



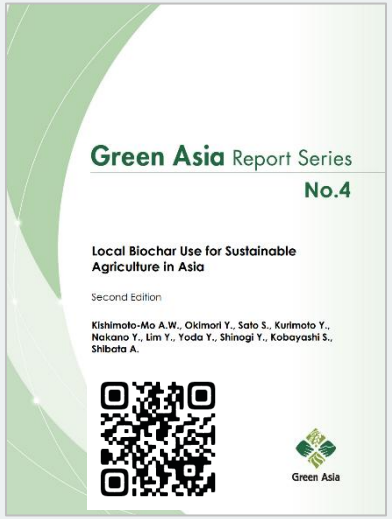
1984



2008



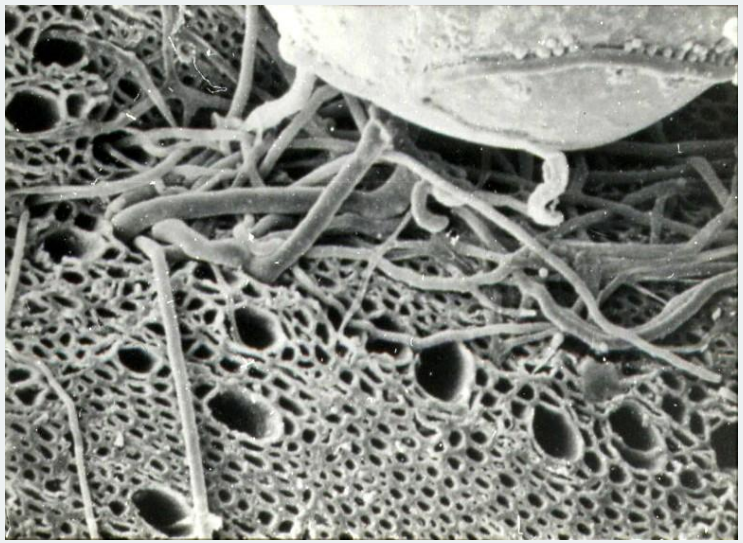
2025 Guidebook in Japanese



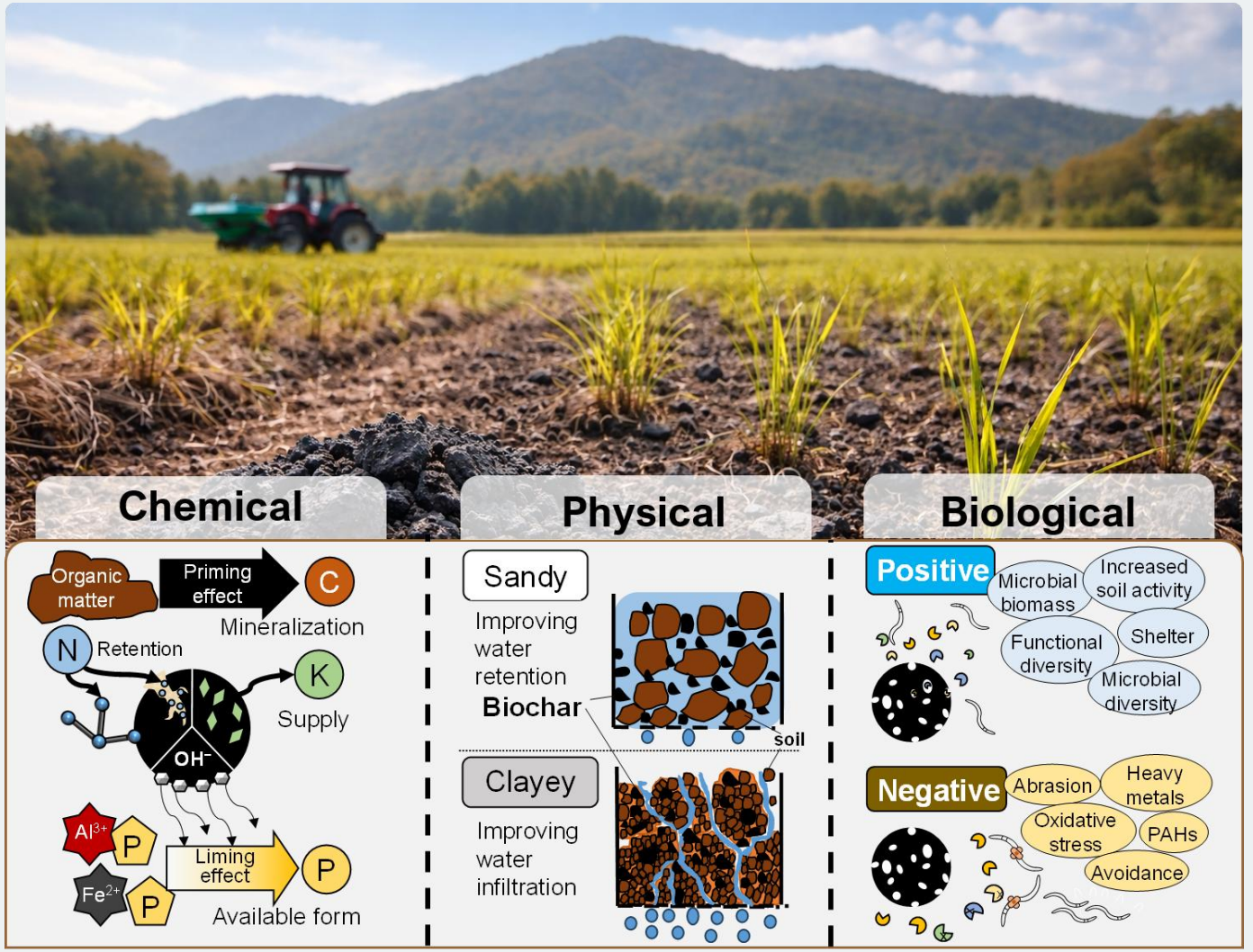
2026 Biochar Technical Report

1 Long history of biochar research in Japan





Ogawa & Okimori (2010) https://doi.org/10.1071/SR10006



Soil improvement with biochar (Kishimoto-Mo et al. (2026))

1 Long history of biochar research in Japan

Biochar in Japan: Makoto Ogawa recalls a lifetime of work on biochar, fungi, and plant growth interaction

the Biochar Journal

www.biochar-journal.org/en/ct/75
Version of 16 th January **2016**





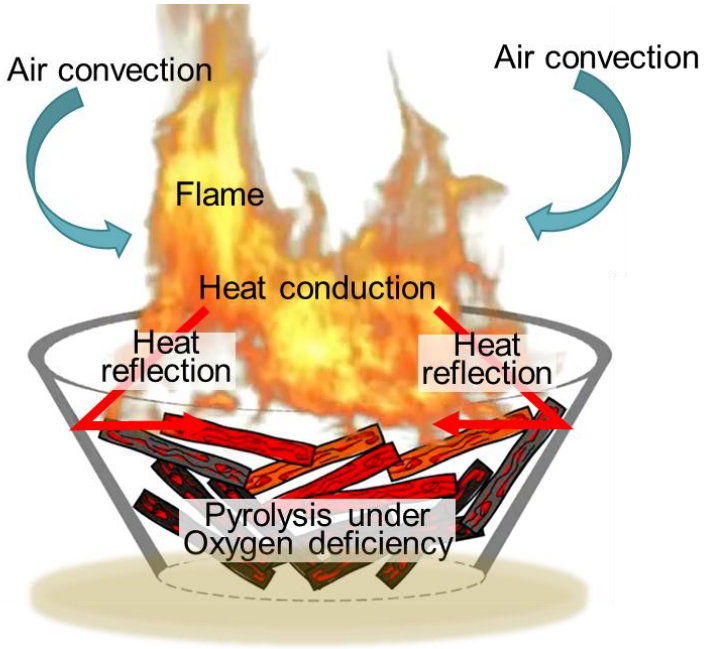
> "While biochar seems a young science, OGAWA Makoto （小川真）, Japan's most influential biochar researcher, looks back on his 60 years of biochar trials and research. His younger colleagues and successor of the Japanese Biochar Association interviewed his chareminence about his life growing up in war-time Japan, his early encounters with biochar, and how these experiences shaped his large body of work on the relationship between biochar and soil organisms.

Source: https://www.biochar-journal.org/en/ct/75

1 Long history of biochar research in Japan

小川先生

Moki - Kon-Tiki



Modified from
Oo et al. (2018) PLoS ONE 13(2): e0192235
https://doi.org/10.1371/journal.pone.0192235

Dr. Makoto Ogawa introduced in December 2009 the western world to **the principle of conical flame curtain kilns** that eventually became known as **Kon-Tiki** and is now in more than 50 countries of the world the main biochar producing device.

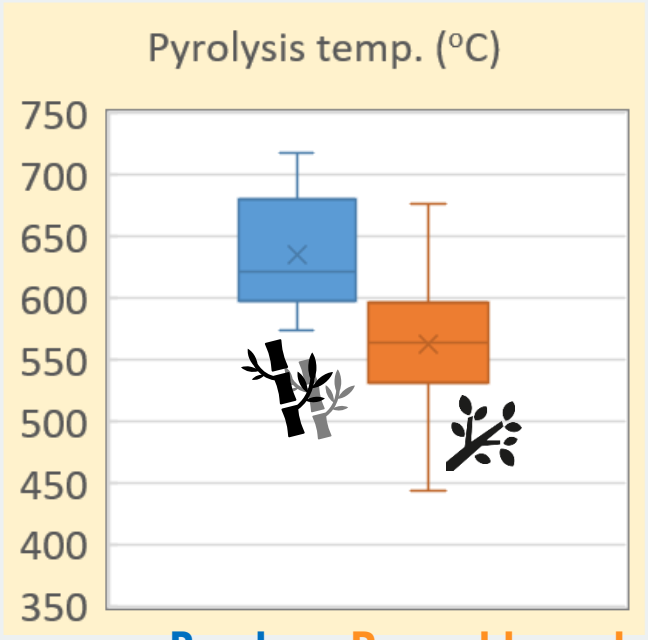
Source: https://www.biochar-journal.org/en/ct/75



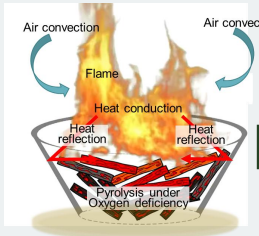
Moki kiln

1 Long history of biochar research in Japan

Moki - Kon-Tiki

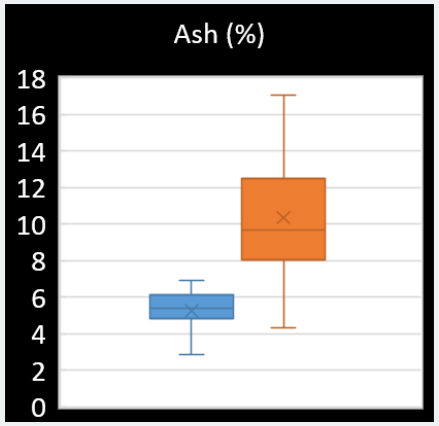


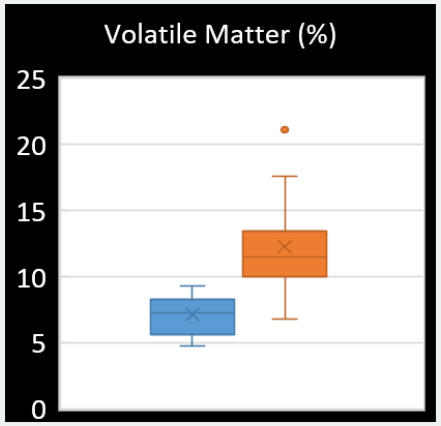
Bamboo **Pruned branched of fruits trees**

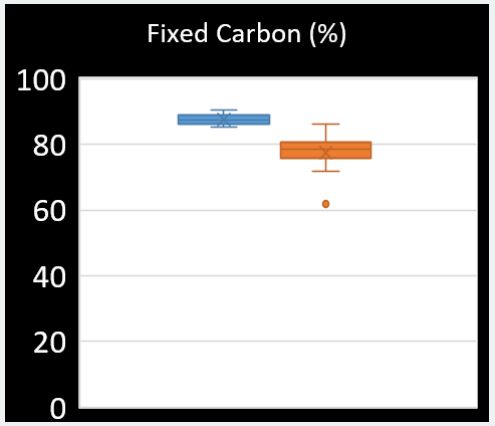


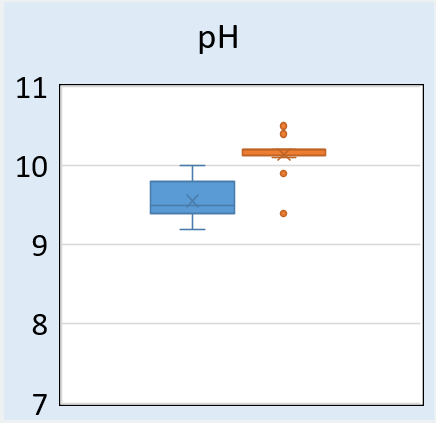


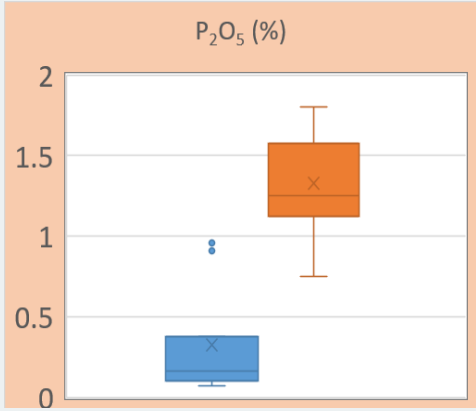
Proximate analysis (JIS M 8812)

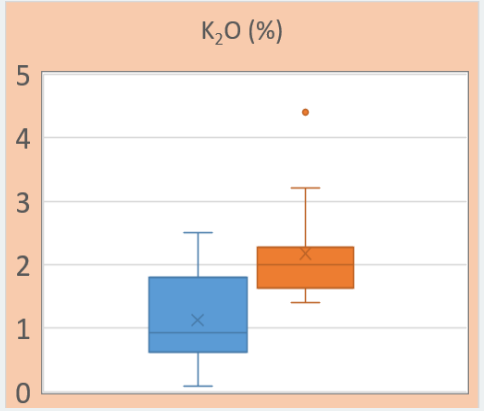




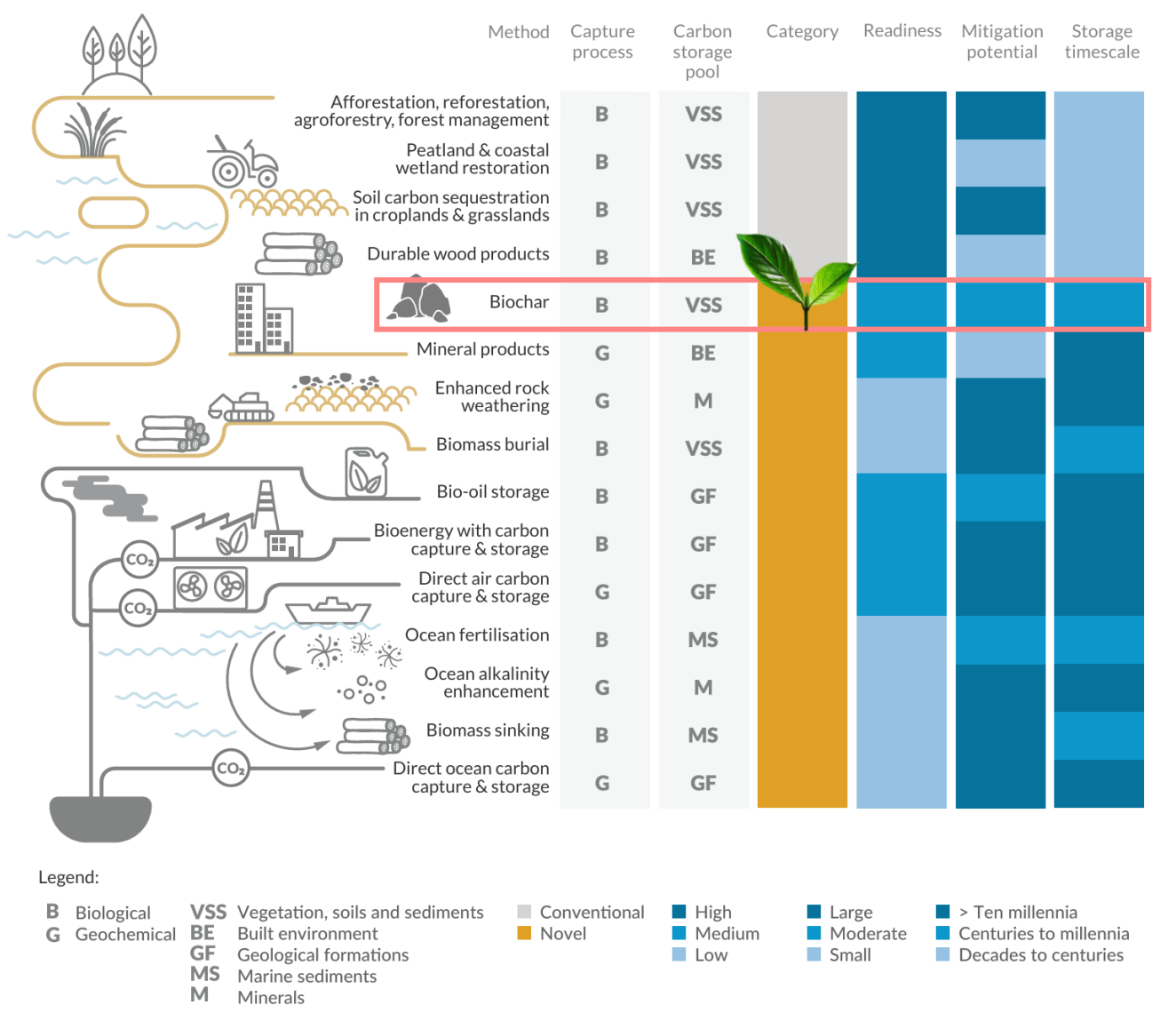








1 Summary of Carbon Dioxide Removal methods, noting their respective capture process and carbon storage pool



Soruce: **Smith et al. (2024) The State of Carbon Dioxide Removal 2024 - 2nd Edition. DOI 10.17605/OSF.IO/F85QJ (2024)**
Figure 1.4 & Figure 7.4

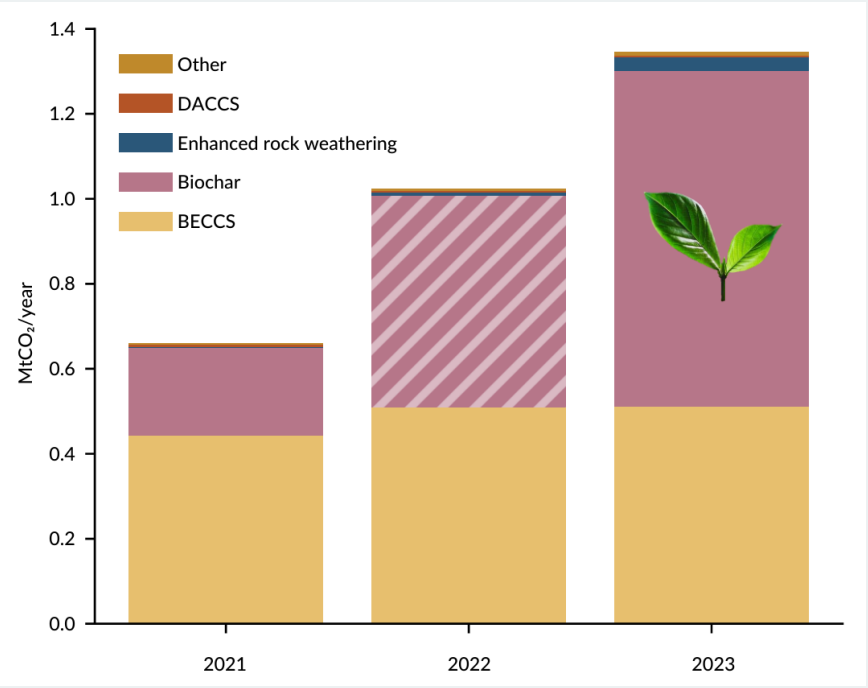


Figure 7.4 Global carbon dioxide removal levels through novel methods.

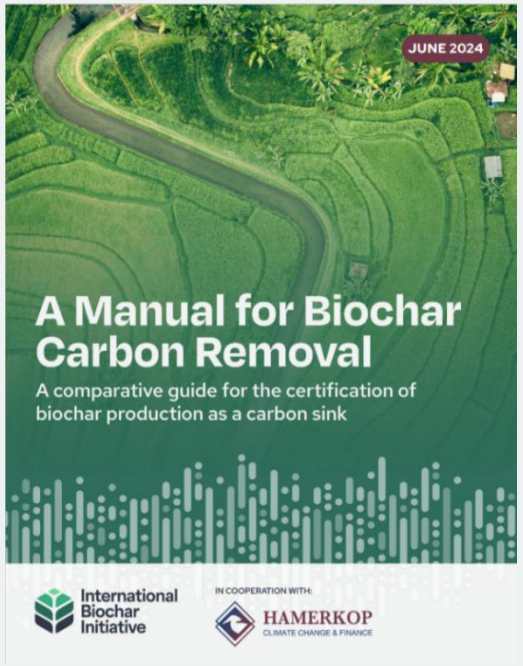
1 Handbooks and guidebooks for biochar: Biochar is ready for global implementation



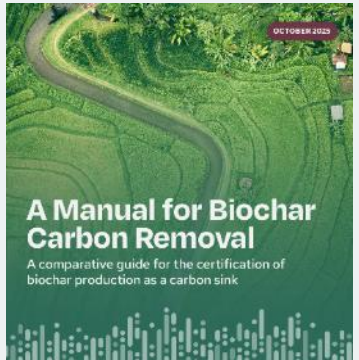
The State of Carbon Dioxide Removal
2nd edition
https://www.stateofcdr.org/



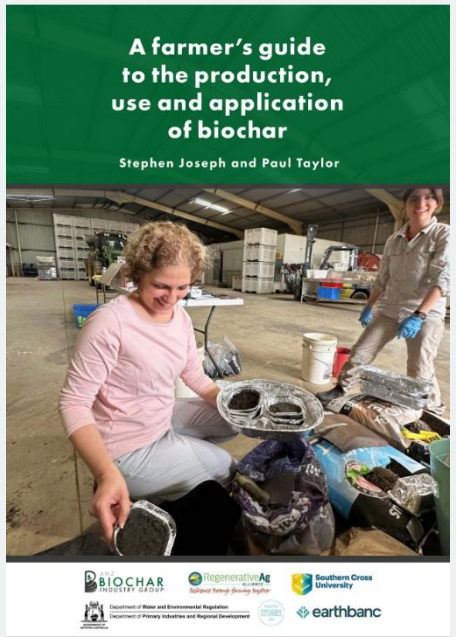
IBI



https://biochar-international.org/manual-for-biochar-carbon-removal/



ANZBIG



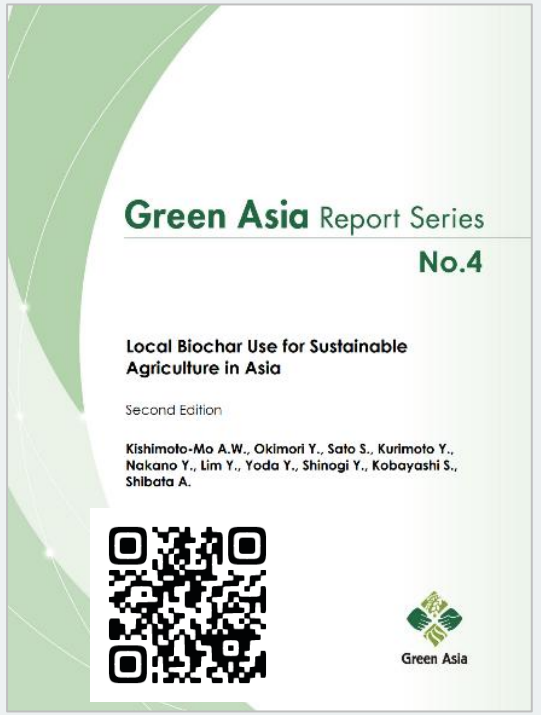
https://anzbig.org/farmers-guide-2024/

USBI



https://biochar-us.org/beyond-application-fact-sheet

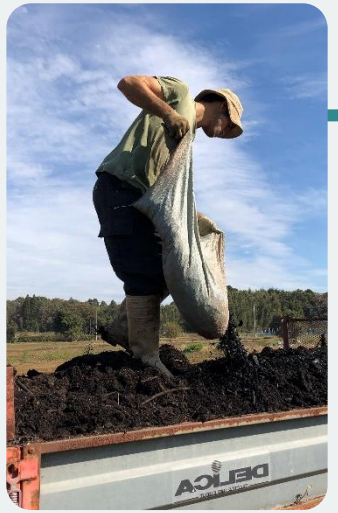
Japan



2025 Apr.
https://www.jircas.go.jp/en/publication/gars-e/4

2026 Mar.
Second edition

2 Japan's Biochar Experience: From Policy Development to Market Implementation Over Two Decades



2000s~ — 1 Environmental Regulation
- Dioxins control policy
- Initial regulations & treatment technologies

2008~ — 2 Japan Biochar Association & Cool-Vege
- Support for standards & branding
- Cool-Vege promotion

2015~ — 3 Agricultural Subsidies
- Direct payment programs (regional menu)
- Support for eco-friendly farming

2019~ — 4 Scientific Recognition
- IPCC Report (2019 Refinement)
- Increasing of scientific publication

2020~ — 5 Carbon Credit System
- J-Credit Scheme
- MRV 6 Compliance

2022~ — 6 Institutional Development
- Japan Biochar Research Center
- Biochar Standards
- Japan Biochar Consortium

2023~ — 7 Carbon Credit Market
- Tokyo Stock Exchange JPX
- Carbon EX
- Biochar Credit Price (¥40,000)

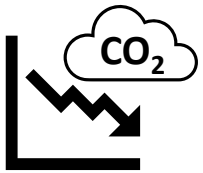
Japan has developed the biochar sector through a policy evolution pathway:

Environmental Regulation → Agricultural Incentives → Scientific Validation → Carbon Credit Methodology → Institutional Development → Carbon Market Implementation

Carbon Credit Methodology ⇢ Carbon Market Implementation

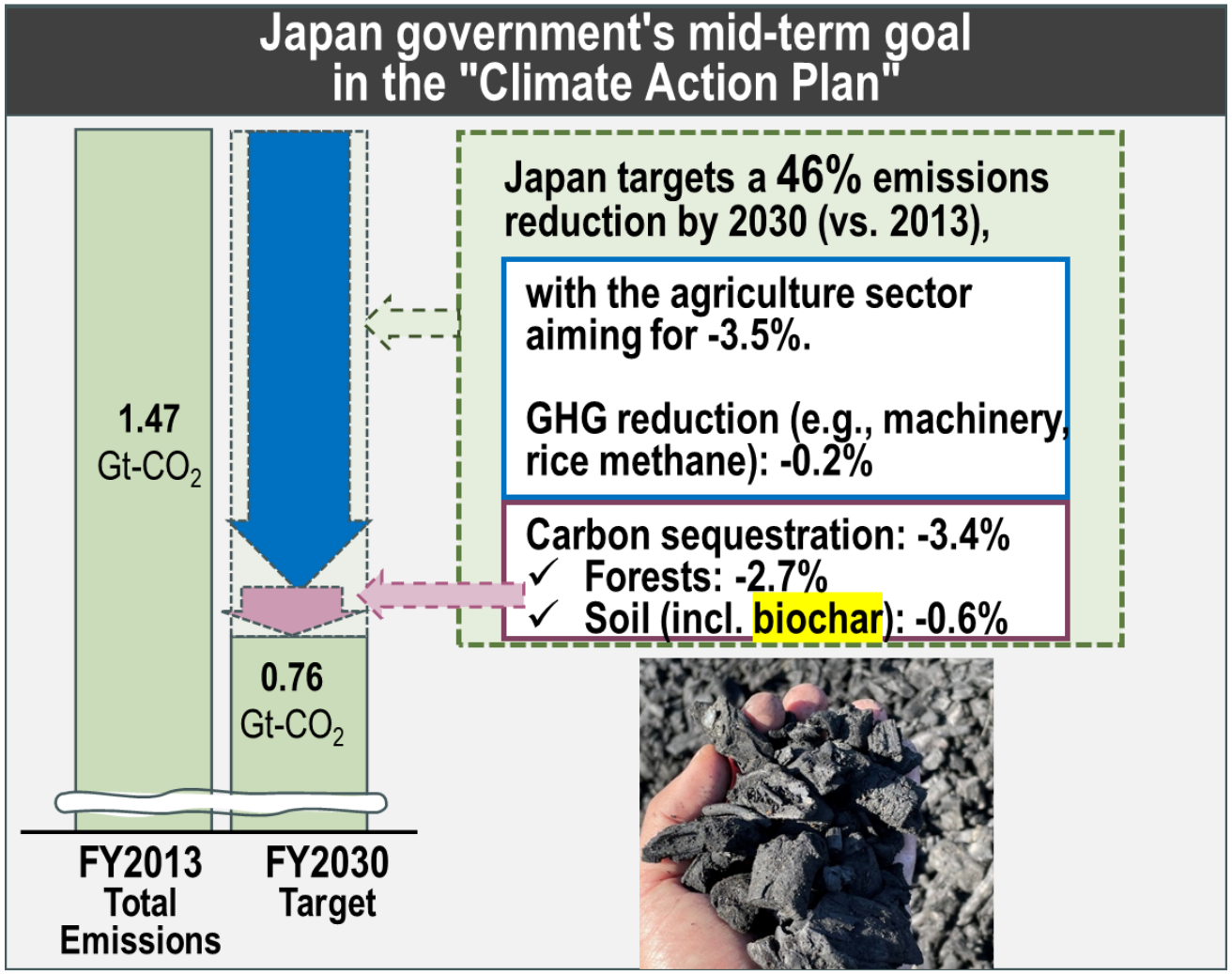
2 Biochar included in Japan's NDC submitted to UNFCCC

Nationally Determined Contribution



- The Climate Action Plan (October 2021) sets targets for agricultural soil carbon sequestration.
- **Biochar application** is included alongside compost and green manure as a key measure.

Source:
https://www.maff.go.jp/j/seisan/kankyo/attach/pdf/biochar-1.pdf



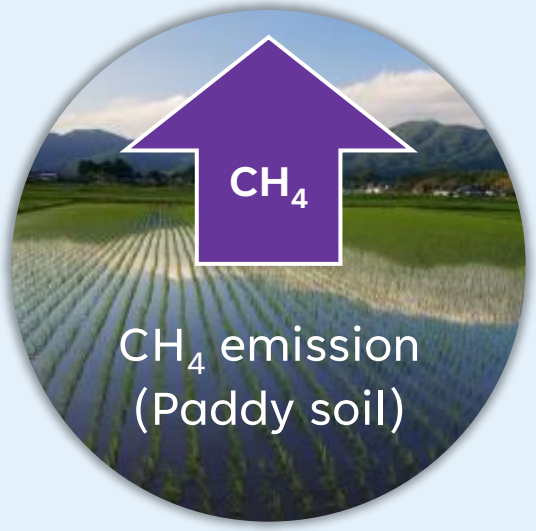
2 Agriculture as a Solution: Integrating GHG Reduction and Carbon Removal Technologies

Reduction



Reduce N_2O emissions through proper fertilization and reduced fertilizer use

J-Credit methodology AG-003
Reduced N_2O from Tea land soil by nitrifier inhibitor



Extending midseason drainage by a week reduces rice paddy CH_4 emissions by 30%

J-Credit methodology AG-005
Extending midseason drainage

Removal



Increase soil carbon with residues, compost, green manure, and **biochar**

J-Credit methodology AG-004
Biochar applying to agriculture soil

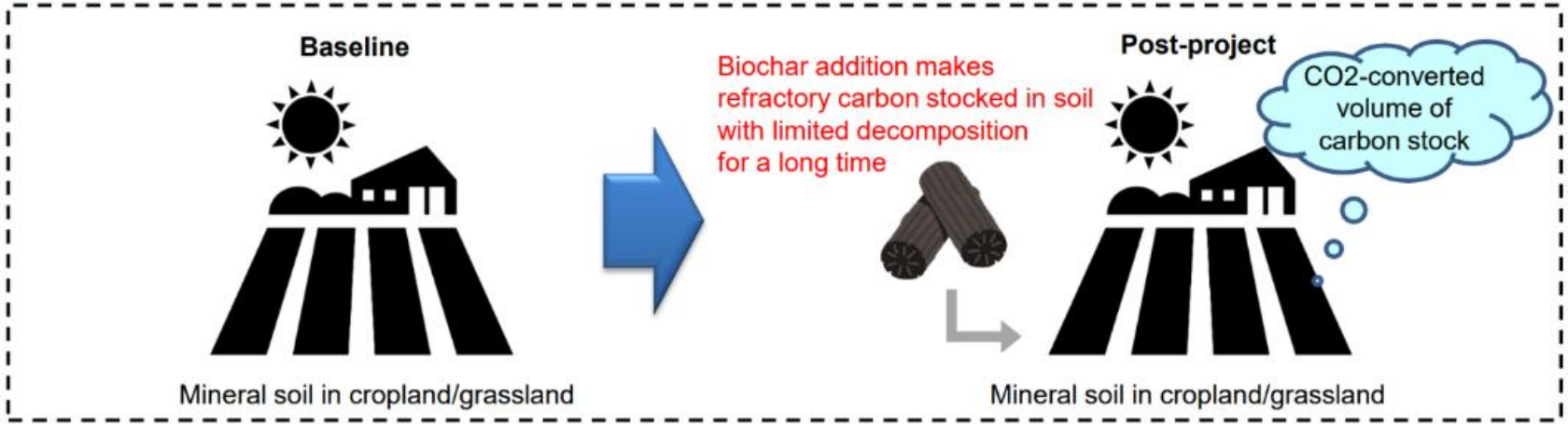
2 Biochar compliance carbon credit -Japan

Agriculture

J-Credit Scheme

AG-004:
Biochar addition to mineral soil in cropland/grassland

[Diagram of methodology]

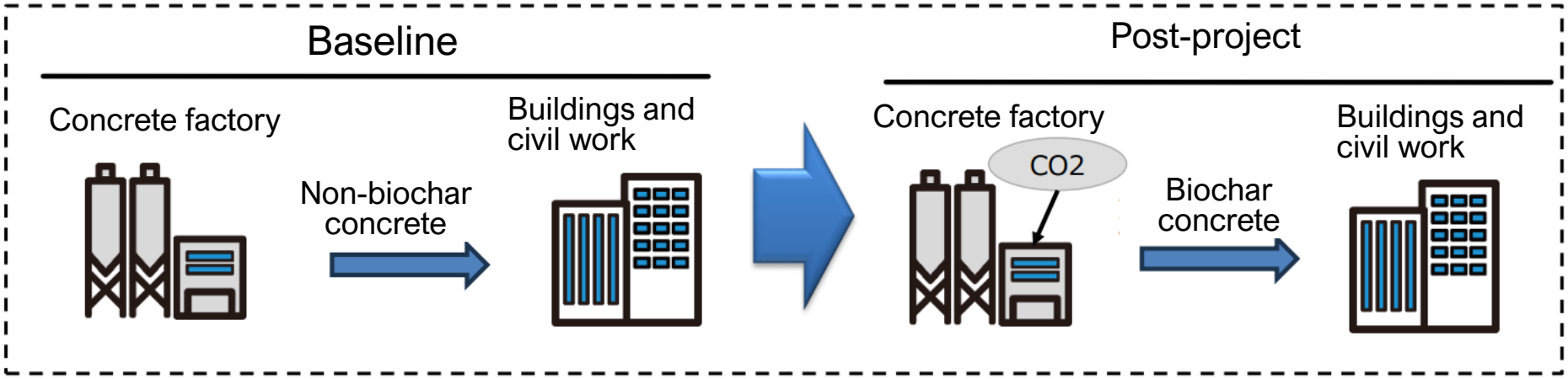


Industrial Process

Credit calculation approach based on IPCC 2019 Refinement:

New! *Oct-10, 2025*

IN-007:
Use of concrete using biochar



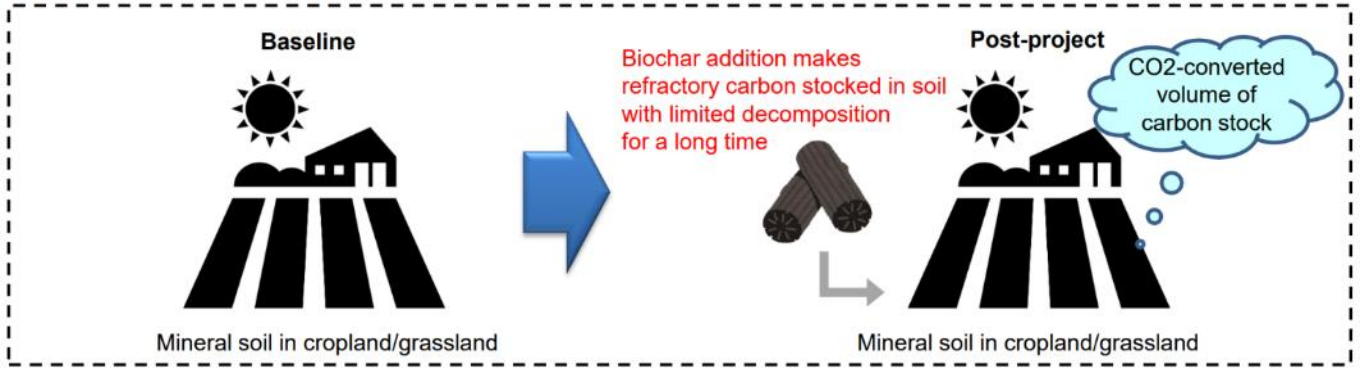
2 Biochar compliance carbon credit -Japan

- Including biochar addition to mineral soil in **J-Credit** Methodology

J-Credit Scheme

AG-004: Biochar addition to mineral soil in cropland/grassland

[Diagram of methodology]



Credit calculation approach based on IPCC 2019 Refinement:

$$CO_2\ \text{stock} = \left[Biochar\ mass \times Biochar\ Fc \times Fperm \times \frac{44}{12}\right] - CO_2\ emissions\ associated\ with\ biochar\ production\ and\ transportation$$

Source: J-Credit Methodology (Accessed on May 19, 2024). https://japancredit.go.jp/english/methodologies/

Biochar types and variables used for credit calculation (based on IPCC 2019 Refinement)

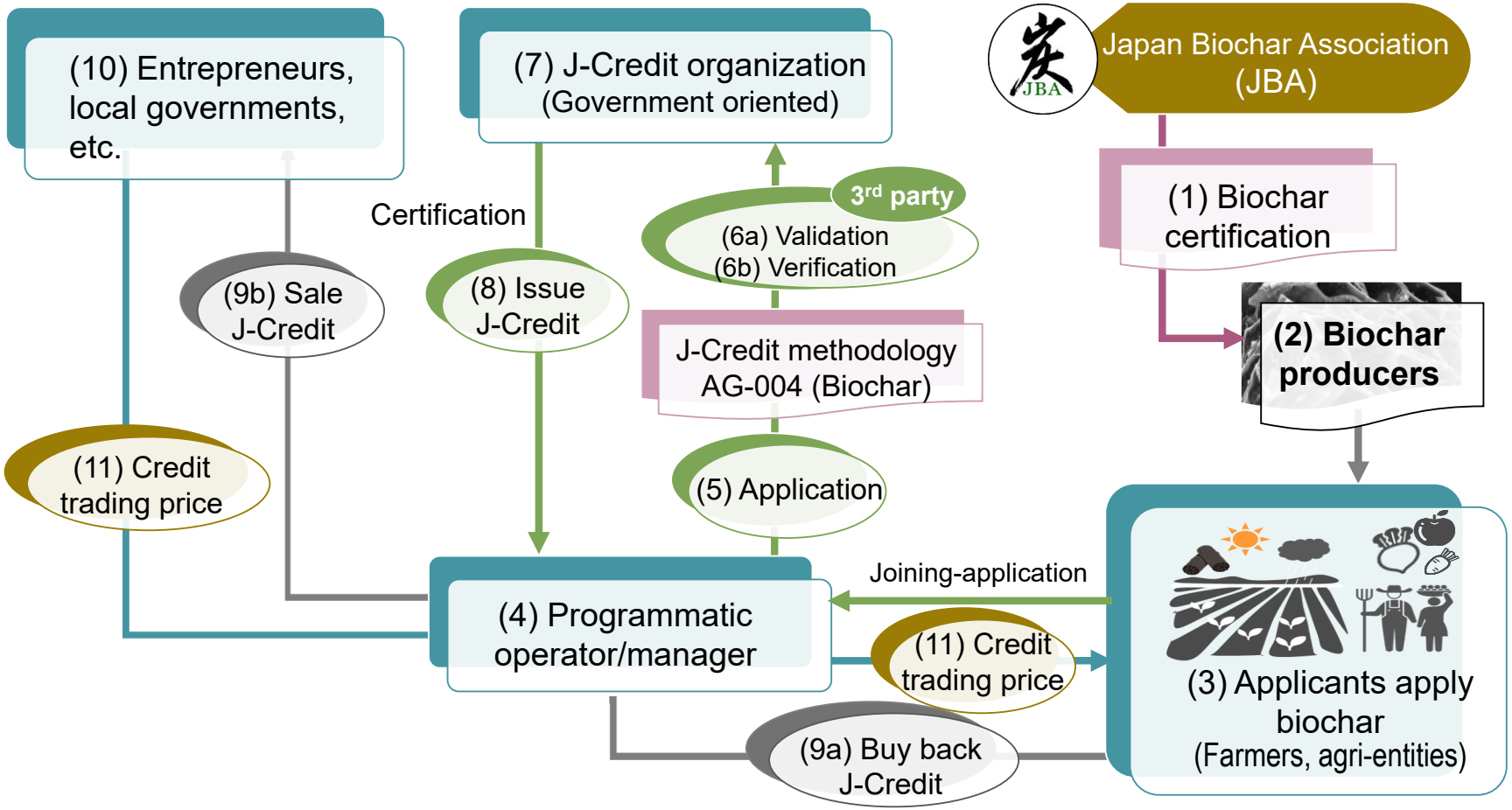
Category	Feedstock type	Fc	Fperm
Biochar for inventory reporting	Wood: Hard charcoal (*Hakutan*)	0.77	0.89
	Wood: Soft charcoal (*Kokutan*)	0.77	0.89
	Wood: Sawdust coal (*Ogatan*)	0.77	0.89
	Wood: Fine coal (*Funtan*)	0.77	0.8
	Bamboo	**0.778**	0.65
Domesti-cally produced and other biochar	Animal manure	0.38 / 0.09*	0.65
	Wood	0.77 / 0.52*	0.65
	Herbaceous	0.65 / 0.28*	0.65
	Rice husk and rice straw	0.49 / 0.13*	0.65
	**Nut shells, pits and stones	0.74 / 0.40*	0.65
	Biosolids (paper/sewage sludge)	0.35 / 0.07*	0.65
*Gasification **Including coffee residues			

Source: J-Credit AG-004 (Ver2.2) biochar methodology eligibility as of December 2024.

2 Biochar compliance carbon credit -Japan

- **Making carbon credit generation accessible to smallholder farmers.**





2 Biochar analysis methodology for carbon credit certification

Research Article
Estimating soil carbon sequestration with woody and bamboo biochar using the Japanese Industrial Standard (JIS) M 8812
Yasuji Kurimoto, Ayaka Wenhong Kishimoto-Mo, Takeshi Kajimoto, Fumihiro Ozawa & Akira Shibata
Article: 2438228 | Received 16 Feb 2024, Accepted 25 Nov 2024, Published online: 10 Dec 2024
Cite this article https://doi.org/10.1080/17583004.2024.2438228 Check for updates

Kurimoto et al. (2024) Carbon Management
https://doi.org/10.1080/17583004.2024.2438228





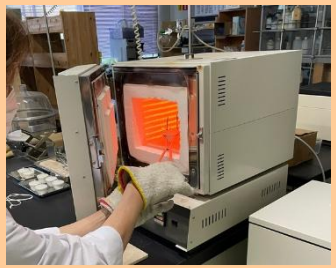
Biochar

Method based on Proximate analysis

Method based on IPCC2019 refinement

Proximate analysis (JIS M 8812)

- Volatile matter (VM, %)
- Fixed carbon (FC, %)
- Ash content (Ash, %)



- Low cost
- Simple and quick analysis
- High reliability

JIS variables (VM, FC)

Ultimate analysis (ISO 29541)

- element C (%)
- H (%)



Inorganic C analysis (ASTM D4373)

- inorganic C (%)



IPCC variables (F_c, F_{perm})

CO_2 removal by Biochar

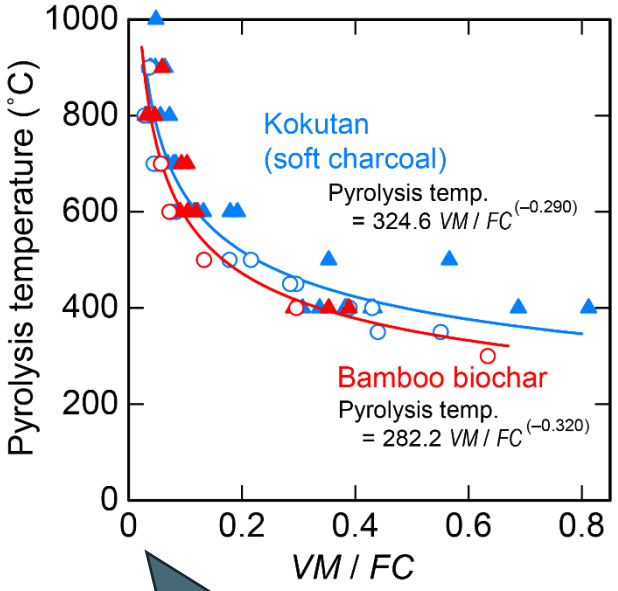
CO_2 removals (ton CO_2)
= BC_{mass}(ton) × JIS value × 44/12)

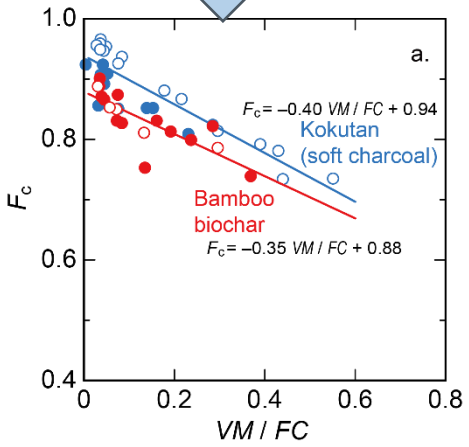
CO_2 removals (ton CO_2)
= BC_{mass}(ton) × F_c × F_{perm} × 44/12

2 Simple biochar methodology for carbon credit certification

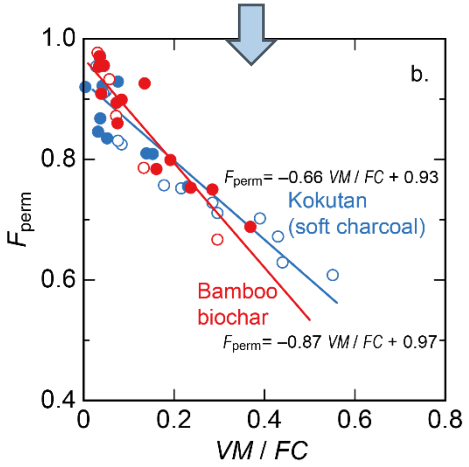
Research Article
Estimating soil carbon sequestration with woody and bamboo biochar using the Japanese Industrial Standard (JIS) M 8812
Yasuji Kurimoto, Ayaka Wenhong Kishimoto-Mo, Takeshi Kajimoto, Fumihiro Ozawa & Akira Shibata
Article: 2438228 | Received 16 Feb 2024, Accepted 25 Nov 2024, Published online: 10 Dec 2024
Cite this article https://doi.org/10.1080/17583004.2024.2438228 Check for updates

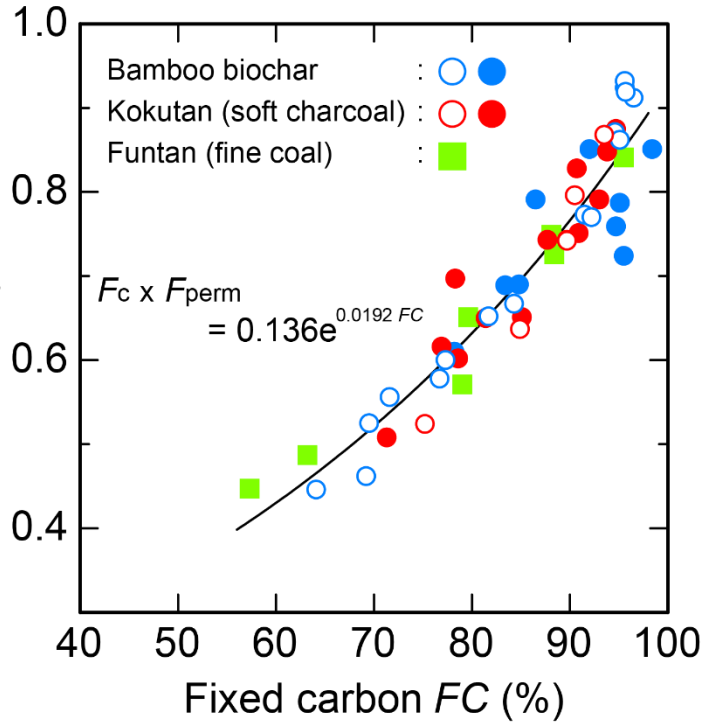
Biochar organic carbon content





Biochar carbon remaining after 100 years





Estimating pyrolysis temperature by biochar proximate analysis

$$CO_2 \text{ removals } (CO_2 \text{ ton}) = BC_{mass}(\text{ton}) \times F_c \times F_{perm} \times 44/12$$

$$= BC_{mass}(\text{ton}) \times 0.0136e^{0.0192FC} \times 44/12$$

Kurimoto et al. (2024) Carbon Management
https://doi.org/10.1080/17583004.2024.2438228

2 Biochar Compliance Carbon Credit - Japan
- Key lessons for international deployment

1 START WITH THE BUYER

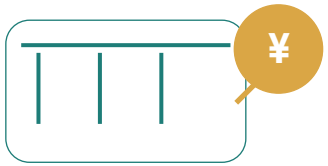
Identify buyer, intended use and eligible crediting rules.

2 BUILD TRUST

Use clear methodology, standardized MRV and verification.

3 MAKE IT WORK AT SCALE

Keep farmer participation practical; aggregate projects and share value.



Market demand first



Credible carbon accounting



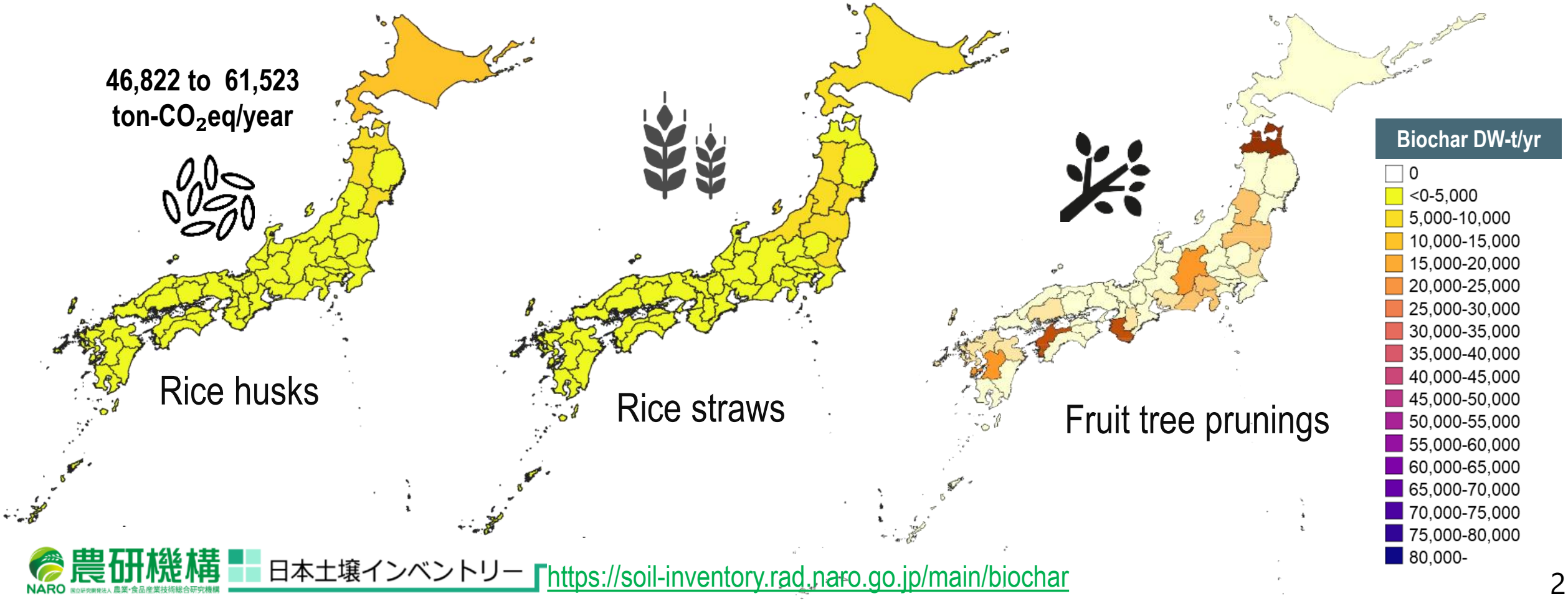
Farmer-centred scale-up

CORE MESSAGE Transfer the approach—not just the methodology: credible rules + government recognition + real market demand.

2 Scaling Up Biochar in Japan: - Estimating biochar potential

稲冨・岸本（*2025*）
https://doi.org/10.34503/naroj.2025.20_3

Kavindi et.al (2025)
https://doi.org/10.1016/j.eti.2025.104657



農研機構 NARO 日本土壌インベントリー https://soil-inventory.rad.naro.go.jp/main/biochar

2 Scaling Up Biochar in Japan: From Research to Economic Implementation

食卓から地球を冷そう！クルベジ®
COOL VEGE https://coolvege.com/

"COOL VEGE®" is a trademarked eco-brand introduced in 2008 for crops grown in biochar-amended fields, representing sustainable farming and CO_2 reduction (soil carbon sequestration).

The "COOL VEGE" scheme constitutes an integrated model that includes biochar production, sustainable agriculture, and environmental branding. McGreevy and Shibata (2010) Annuals of Environmental Science, 4: 11-22

Open eco-branding concept:

Kishimoto-Mo & Shibata (2023) https://doi.org/10.56669/UGGX7681

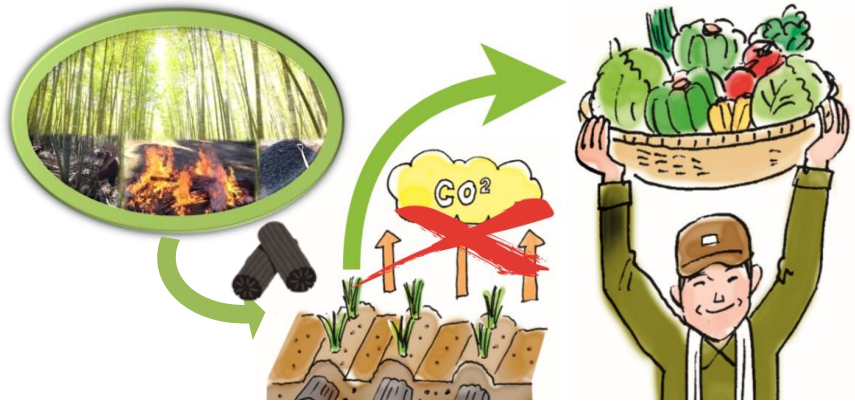






Photo credits:
Hokusou COOL VEGE farmers

- **Biochar made from locally unused biomass like overgrown bamboo;**
- **Certification requires 1 ton CO_2 ha^{-1}**

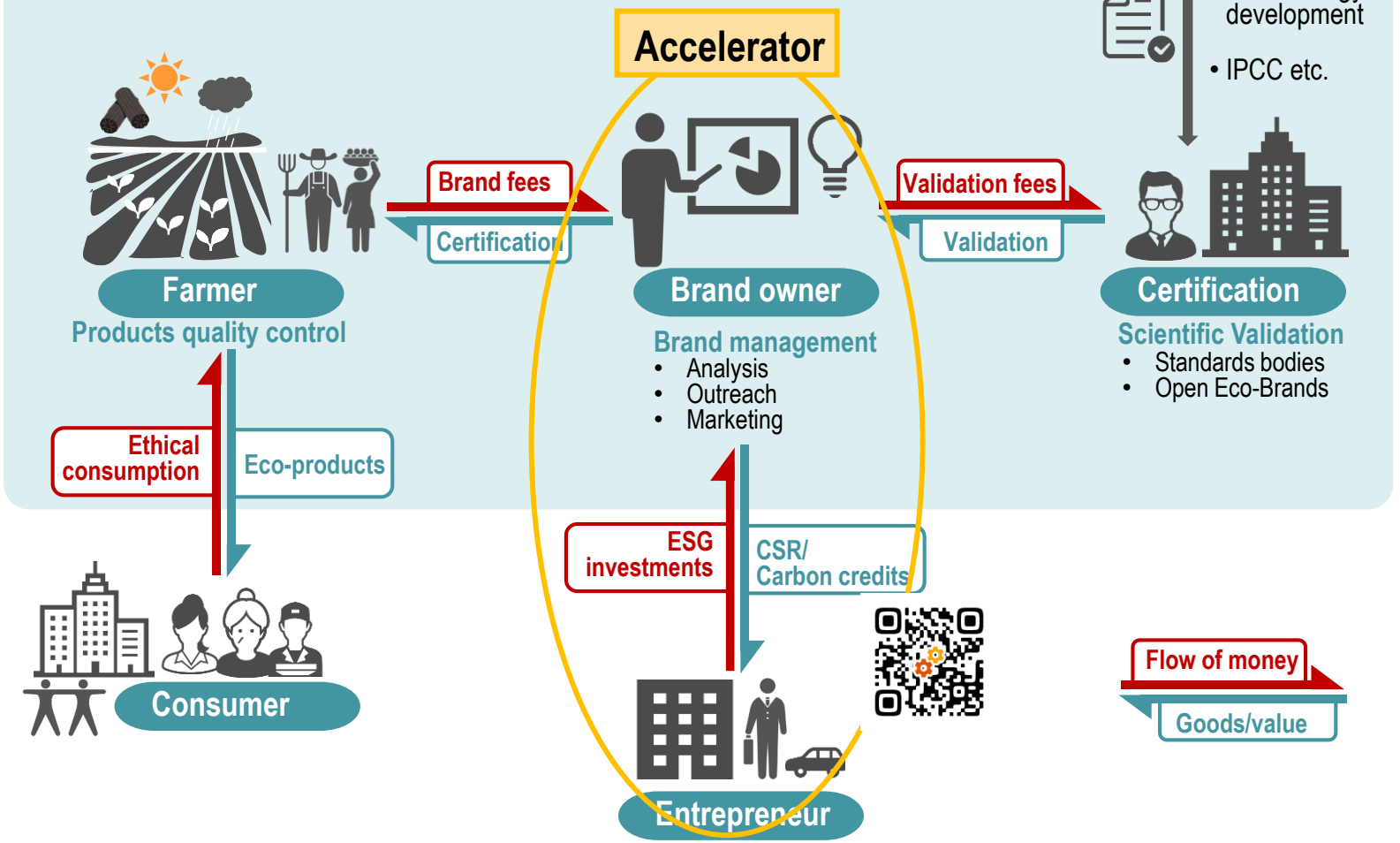
2 Scaling Up Biochar in Japan: - Open Eco-branding Concept

FEAST
Enough is as good as a feast

This concept draws parallels with the “open data”, encouraging **unrestricted** utilization, modification, and dissemination by entities sharing it vision to establish eco-friendly brands.

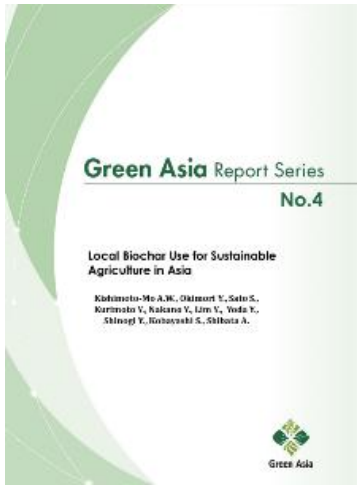
Only need to acknowledge the concept’s origin by citing 柴田ら(2021) or Kishimoto-Mo and Shibata (2023) https://doi.org/10.56669/UGGX7681 to use it.





2 Scaling Up Biochar in Japan: - Platform and Networking

■ **Developing platform and business ecosystem** for promoting biochar use



https://www.jircas.go.jp/ja/greenasia/report

【Biochar-based Business Ecosystem for Carbon Minus】

＜Supply side＞

Production side
- Biomass resources
- Biomass electricity generation
- Biochar production

Storage side
- Farmer
- Agricultural corporation
- Carbon sequestrator

Accelerator A

Carbon Credit

Carbon Minus Platform

Distribution of biomass resources and carbon credits

- Quality assurance
- Carbon credit application
- Database
- Eco-brands
- Technical support, Information sharing

Accelerator C

Accelerator B

＜Demand side＞

Carbon offsetting side

Companies and organizations

Eco-brands utilization side
- Food industry
- Retail industry

Consumer

2 Ongoing Biochar Project

Our BRIDGE initiative focuses on biochar within the project "International Standardization of GHG Reduction and Absorption Technologies in the Agriculture and Food Sector", which is part of the Standard Utilization Acceleration Support Project.

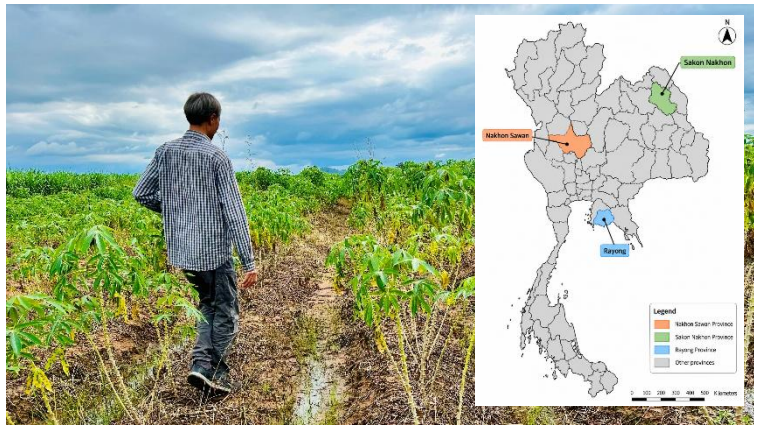
BRIDGE
研究開発とSociety 5.0との橋渡しプログラム
programs for Bridging the gap between R&d and the IDeal society (society 5.0) and Generating Economic and social value

NARO

RITSUMEIKAN sojitz New way, New value KDX KMUTT JGSEE

Kyutech Kyushu Institute of Technology

สถาบันวิจัยสิ่งแวดล้อมเพื่อความยั่งยืน
SUSTAINABLE ENVIRONMENT RESEARCH INSTITUTE
Chulalongkorn University



Pilot study: Carbon credit generation from cassava field via biochar application

①Cassava residue collection



②Biochar production with flame-curtain kiln









④Cassava planting

③Biochar application to cassava field at different rates



Take Home Message

- **Japan's experience** offers a pathway for translating **biochar research and policy into practical, scalable carbon sequestration solutions**.
- **Biochar** is ready for global implementation—**Together, we can shape a more sustainable future with biochar.**

01	02	03	04
Soil improvement	**Soil microbial activity**	**Economy benefit**	**Sustainable environment**
• Physical • Chemical • Nutrient management	• Habitat for microbes • Root growth	• Job creation • Yield • Quality • Resilience	• Carbon sequestration • Soil remediation • **Avoid residue burning**



Thank you for your attention.

Any question?

Our research mission is to advance the sustainable use of biochar for climate mitigation, guided by **robust** and **up-to-date** scientific principles.

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