IEA Bioenergy e-Workshop

Bioenergy for landscape restoration and livelihoods in Indonesia

Himlal Baral

23 May 2023

CIFOR

CGIAR

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Challenges: the food, fuel, fiber or environment?

Tilman et al 2009, *Science*

CIFOR

World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

International/national goals and commitments

Actions and inputs

Results

Outputs, co-benefits

Impacts

UNITED NATIONS PARIS CLIMATE AGREEMENT SIGNING CEREMONY 22 APRIL 2016

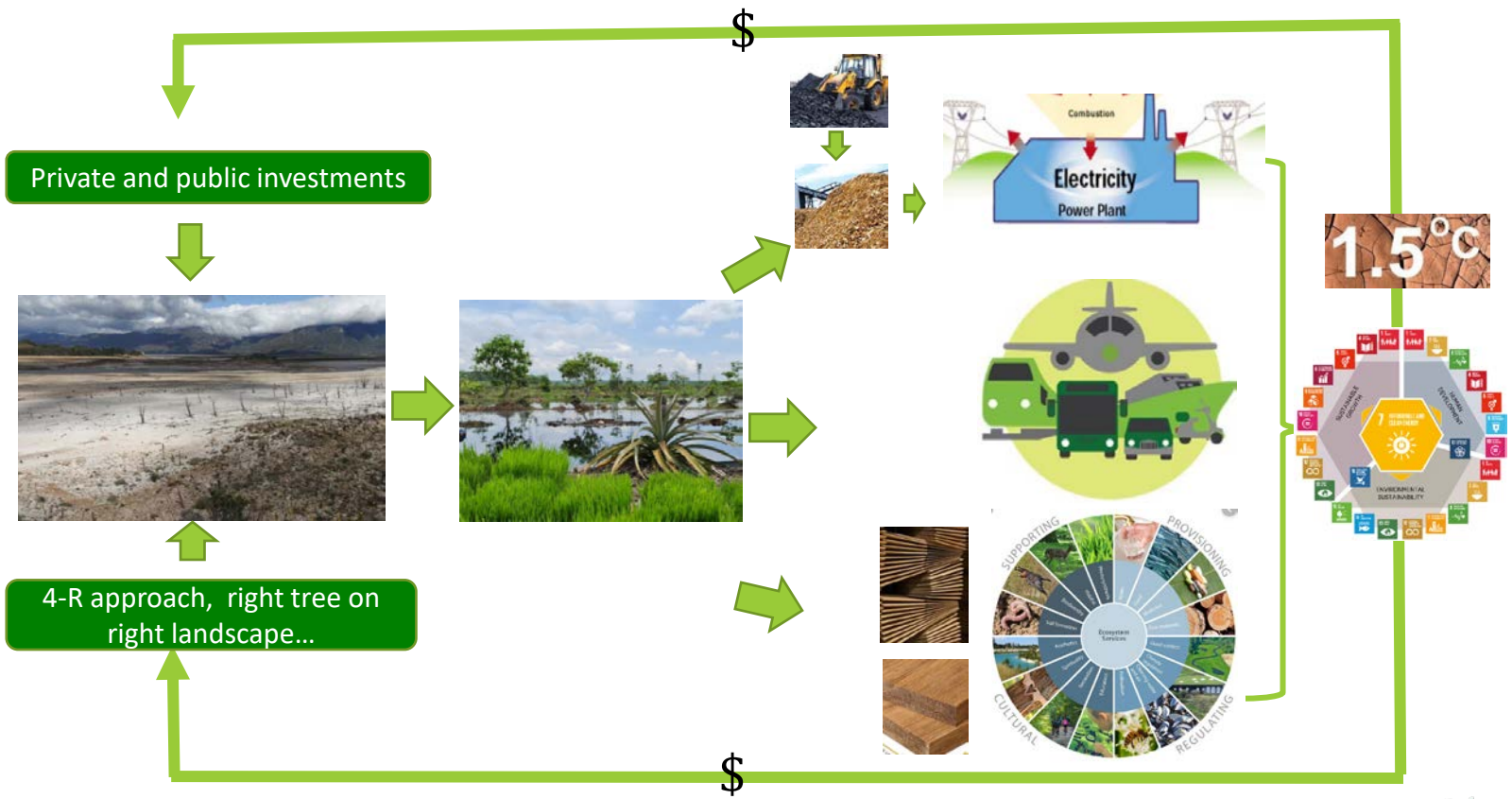
United Nations Convention to Combat Desertification

Convention on Biological Diversity

BONN CHALLENGE

7 AFFORDABLE AND CLEAN ENERGY

STRATEGY FOR IMPLEMENTATION OF NDC (NATIONALLY DETERMINED CONTRIBUTION)



If we design and manage appropriately - we can balance all within the landscape

CIFOR

World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

About CIFOR-ICRAF

A world-class research institution delivering actionable solutions on the role of trees, forests and landscapes in solving the global crises of land degradation and biodiversity loss, climate change, unsustainable food systems and value chains and inequity.

CIFOR

World Agroforestry

Global Landscapes Forum

Resilient Landscapes

Working to solve global challenges

Our research addresses the following global challenges and offers actionable, game-changing solutions to achieve sustainable transformation.

- Deforestation and biodiversity loss
- A climate in crisis
- Unsustainable supply and value chains
- Transforming food systems
- Extreme inequality

CIFOR

World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

Our research expertise

Our research is organized around the following topics:

Trees and forests genetic resources and biodiversity

Sustainable value chains and investments

Climate change, energy and low-carbon development

Soil and land health

Governance, equity and wellbeing

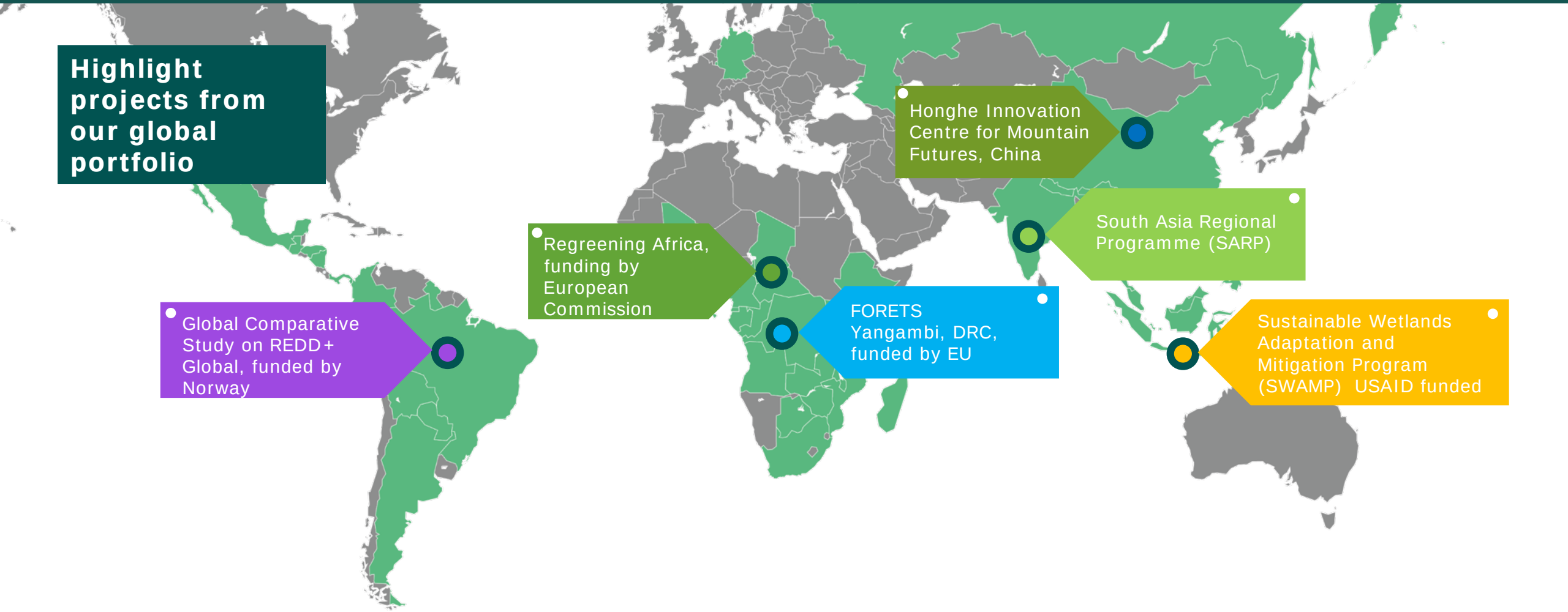
CIFOR

World Agroforestry

Global Landscapes Forum

Resilient Landscapes

Worldwide presence and impact



USD $2bn
total invested in research

750
staff in 30 countries

+2,200
projects completed in 92 countries

+190
active partnerships

25,000
research products

Energy from Forests and Trees

- Forests and trees are a vital natural resource upon which people rely for firewood, shelter and to power machinery and industrial activities.
- Globally, some 2.5 billion people use traditional biomass, such as wood and charcoal, for cooking and heating. It can also be converted into heat, electricity and liquid fuels.
- In recent years, a modern form of energy derived from biomass, known as bioenergy, has become more common.
- Bioenergy offers the potential to sustainably meet growing energy needs with the added benefits of restoring degraded land and providing food and livelihoods for local communities.

CIFOR

World Agroforestry

CGIAR Research Program on Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

GROWING INTEREST ON BIOENERGY

- 30% rise in global energy demand to 2040 (IEA, 2016)
- Hundreds of millions of people will still left in 2040 without basic energy services (IEA, 2016)
- The Paris Agreement on CC – ‘transformative change in the energy sector’ is key to reach the agreement
- SD is not possible without access to sustainable energy – SDG 7
- National goal/target related to renewable energy including bioenergy… e.g., Indonesia 23% by 2025…
- Potential linkage between bioenergy and restoration goals

CIFOR
World Agroforestry
CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry
Global Landscapes Forum
Resilient Landscapes

AGROFORESTRY LANDSCAPE RESTORATION – FOOD, ENERGY & BIOMATERIALS

- CIFOR-ICRAF and partners investigating the opportunities to restore degraded forests and landscapes while producing bioenergy (and foods) using climate smart agroforestry methods.

- This approach can simultaneously help to achieve other national targets such as food and energy security in rural and isolated locations and greenhouse gas emissions reductions and providing multiple ecosystem services.

- Lessons and good practices can be scaled up and scaled out in many islands in Indonesia and other parts of Asia

CIFOR

World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

KEY QUESTIONS

- Q1: How can **sustainable bioenergy** be developed to avoid the **food-energy-environment trilemma** with alternative feedstocks while **restoring degraded** lands?
- Q2: What are the **most promising species** to achieve **efficient bioenergy** production from degraded land? Species characters, **productivity** and additional **environmental values**?
- Q3: What are the **socio-economic and environmental benefits and challenges** of bio-energy plantation on degraded land?

CIFOR

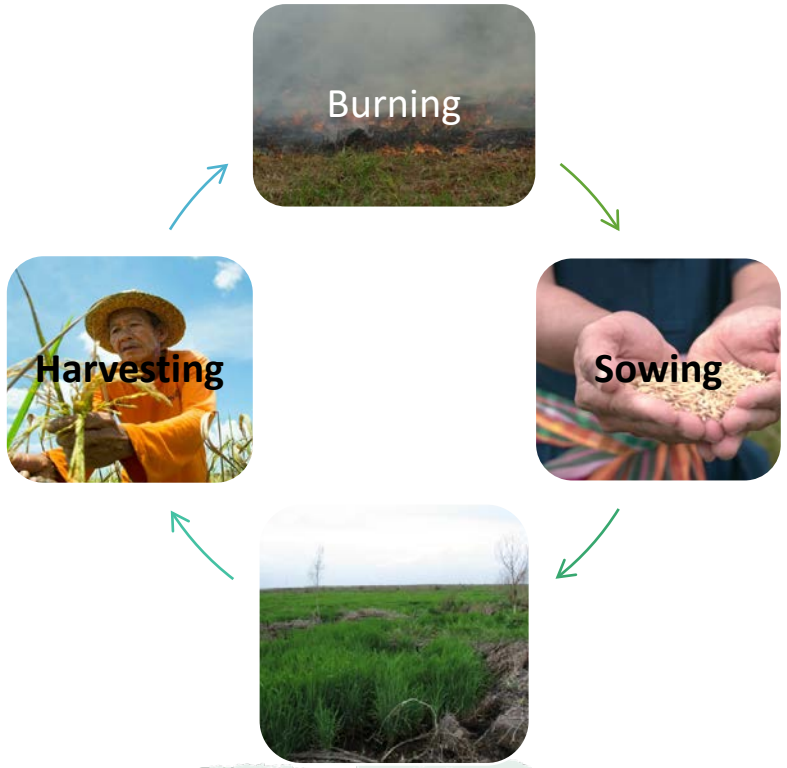
World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

Traditional ‘sonor’ farming system to climate smart agrosilvofishery



Quick and easy: BUT wide range of environmental social economic and political impacts

No burning: growing rice with various timber, fruit and fish species [MORE FOOD, BIOMASS, NO FIRE]

CIFOR

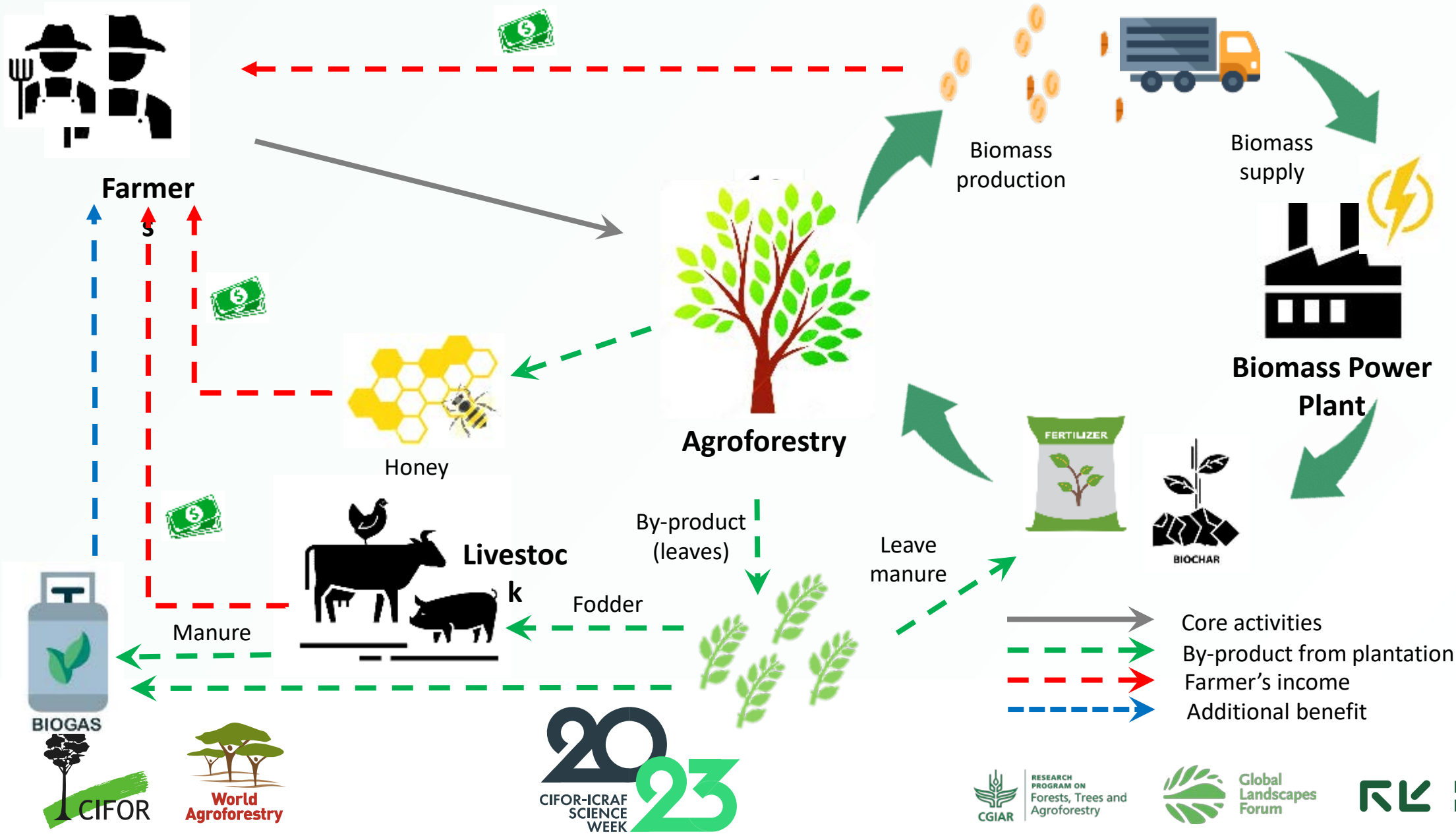
World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

Sustainable Market Transition from Coal to Biomass (SMART)



CIFOR

World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

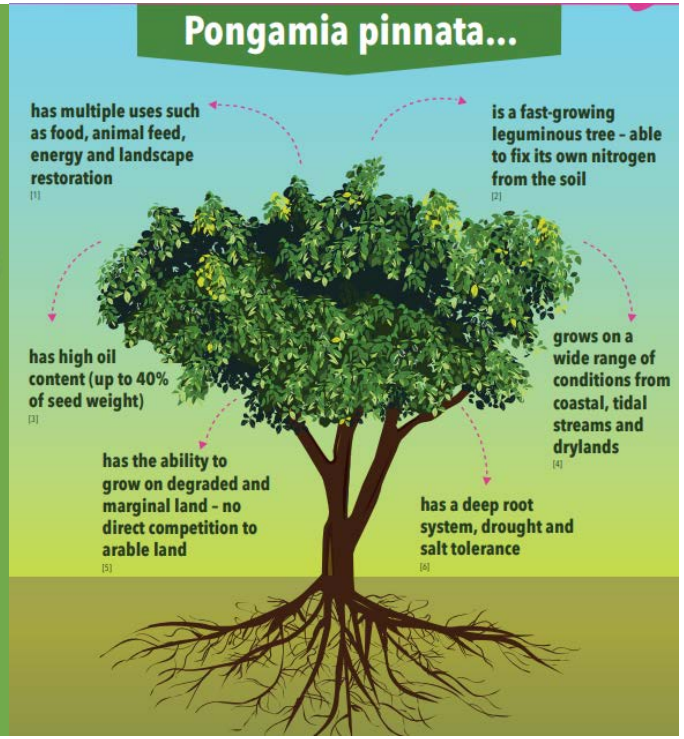
Global Landscapes Forum

Resilient Landscapes

NYAMPLUNG / TAMANU TREE

BAMBOO

PONGAMIA



- **Easy to grow**
- **Multifunctionality**
- **Native to the region**
- **Bioenergy and restoration**

CIFOR

World Agroforestry

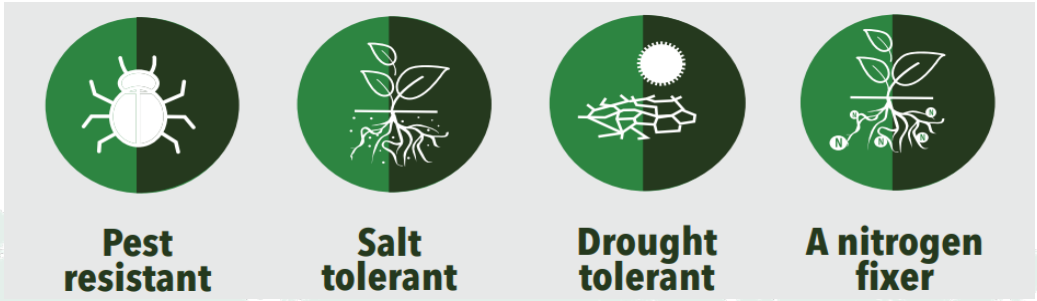
CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

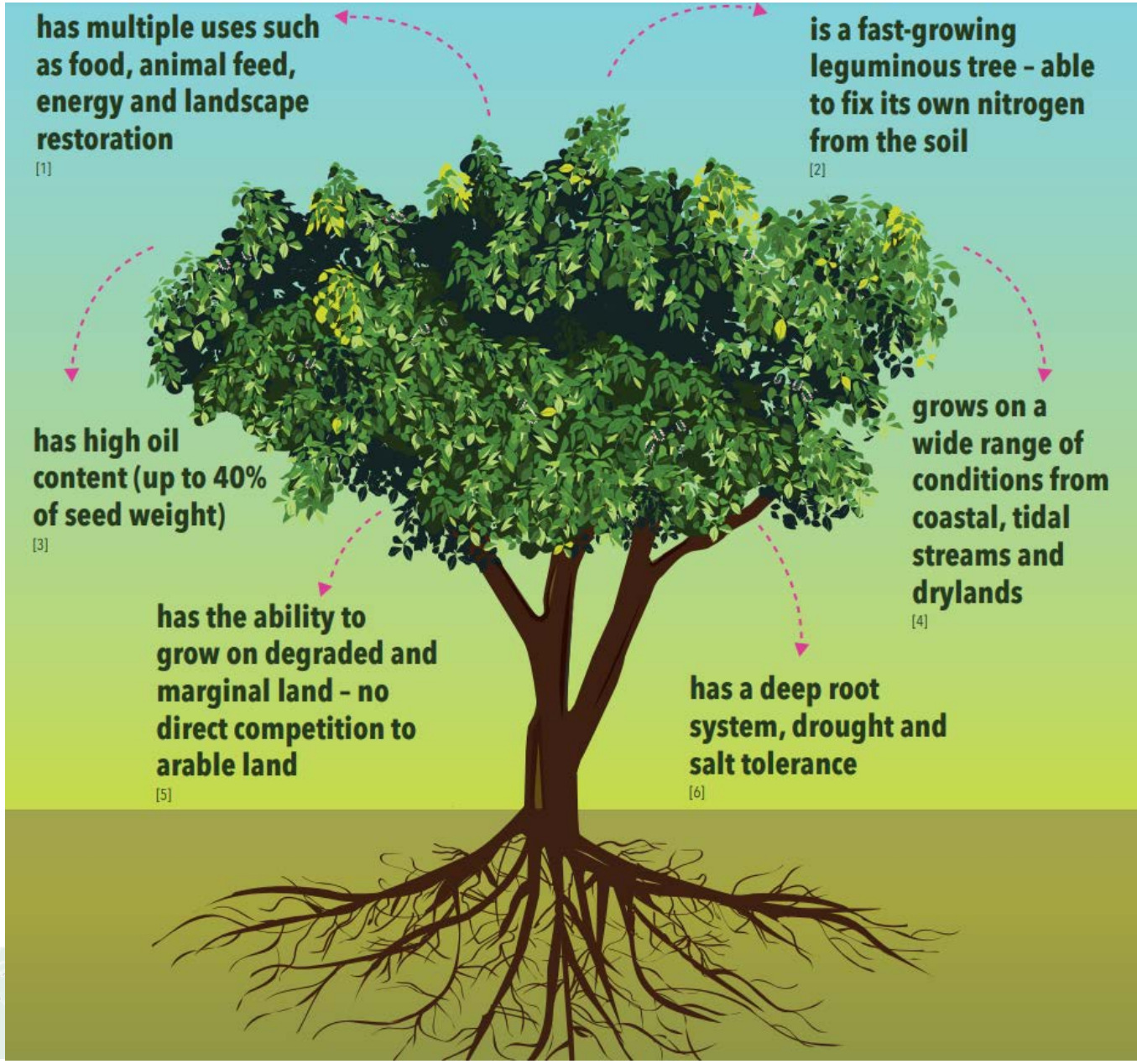
Global Landscapes Forum

Resilient Landscapes

ABOUT PONGAMIA

- Pongamia pinnata, (syn. Millettia pinnata), also known as the malapari or karanja tree, has a large native distribution including India.
- The species is also cultivated in India, Africa, Australia, the United States, and other countries.
- Grows well on degraded and marginal land.





CIFOR

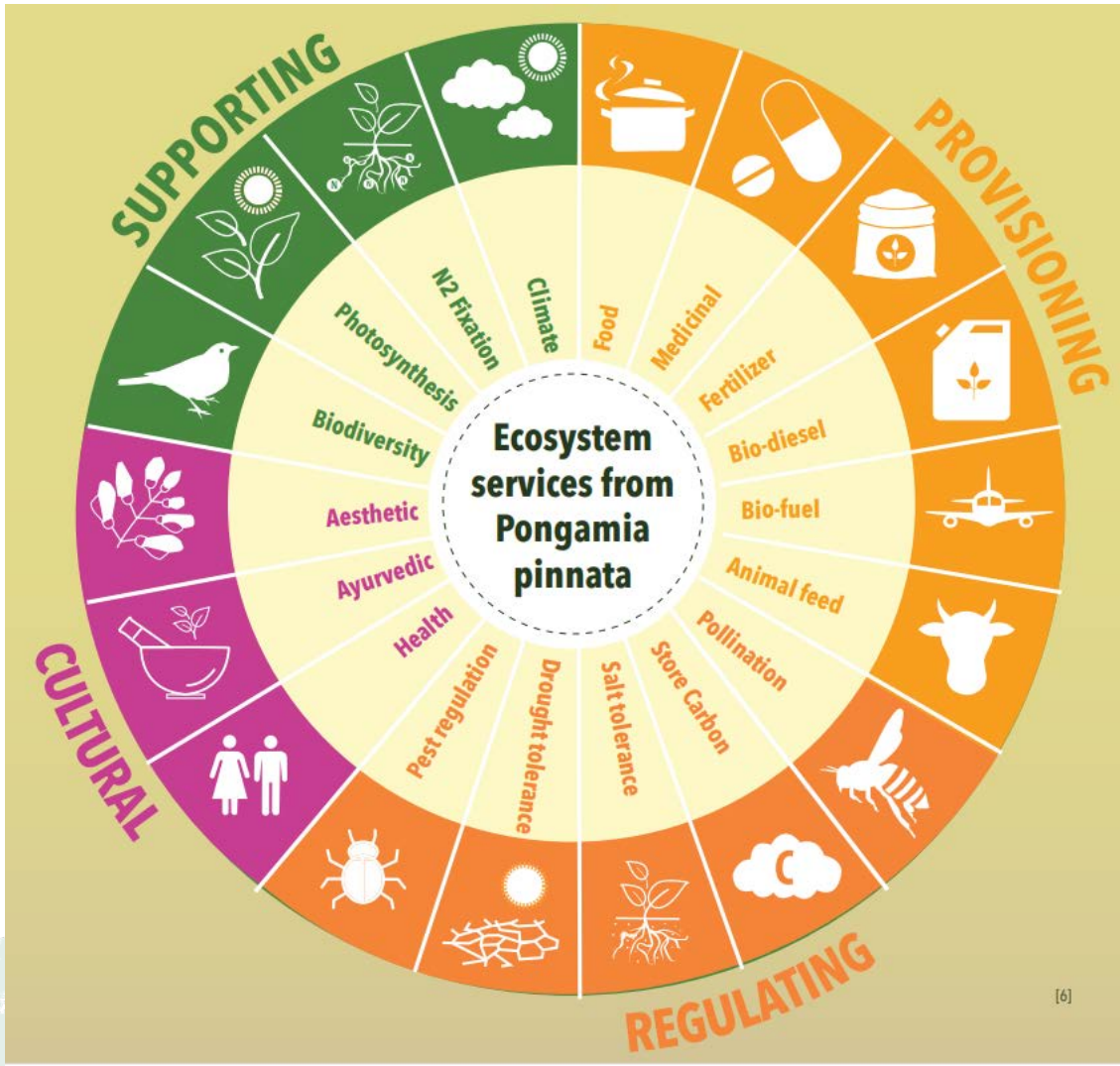
World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

MULTIPLE USES OF PONGAMIA



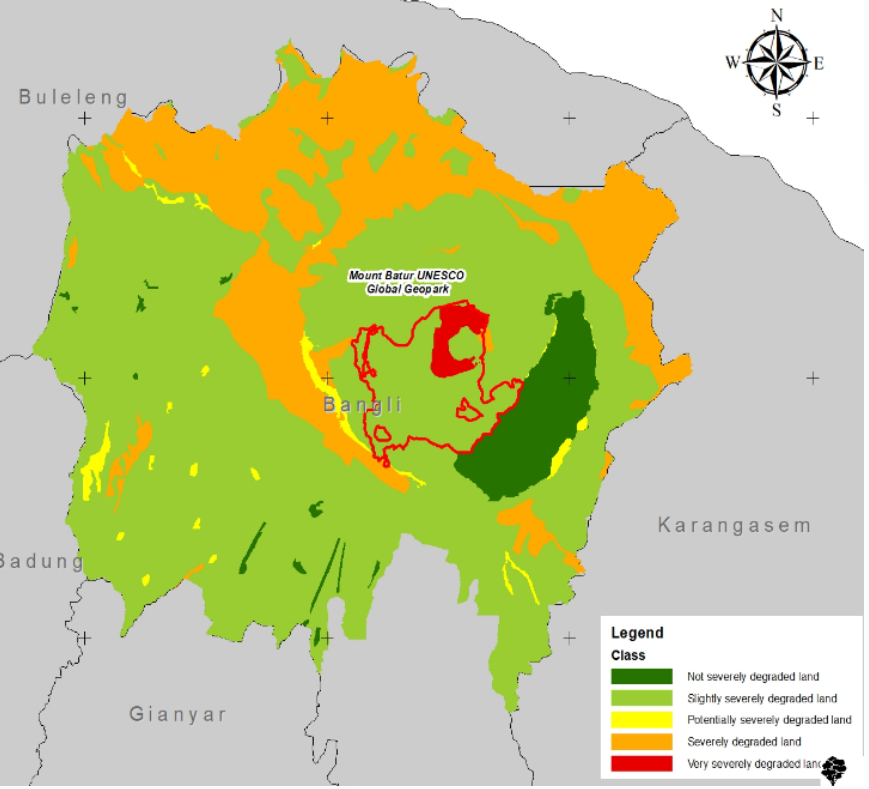
CIFOR

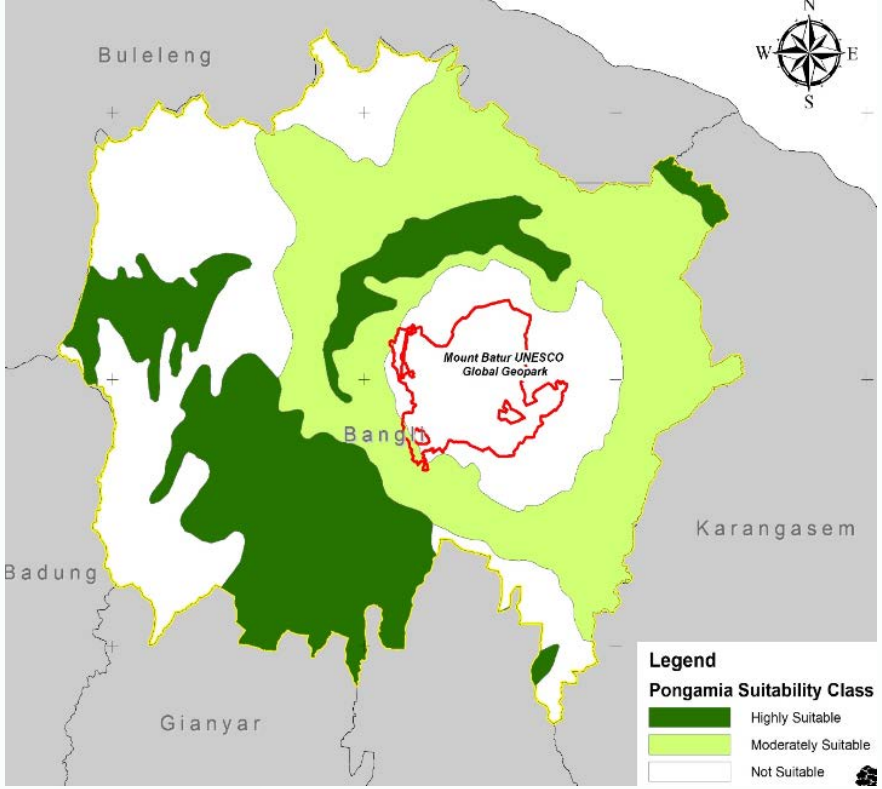
World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes





	Suitbale Land Criteria	*Pongamia pinnatta*		
No.	**Attributes**	**Range**		
		Highly suitable	**Moderately Suitablee**	
		Optimun	**Lower Limit**	**Upper Limit**
1	Annual Rainfall (mm)	500 - 2000	400-500	2000-2500
2	Temperature (C)	16 - 40	10 - 16	40 - 50
3	Altitude (m)	0 - 1200	0	
4	Soil pH	6.5 - 8.5	6.0 - 6.5	8.5 - 9.0
5	Soil depth (cm)	> 150	50 - 150	
6	Soil slope (%)	< 20		

No.	**Species**	**Class**	**Area**	
1	*Pongamia pinnatta*	Highly Suitable	*9409.73*	25%
2		Moderately Suitable	*22365.72*	60%
3		Not Suitable	*15029.969*	40%
	Total		*37395.69*	100%

CIFOR

World Agroforestry

CIFOR-ICRAF SCIENCE WEEK 2023

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

Pongamia oil tree
Yield: 18 tonnes/hectare

Pods, 9 t/ha

Seed, 9 t/ha

Meal, 5.4 t/ha

Biomass to liquid

Oil, 1.8 t/ha

Cattle feed or oil, 1.35 t

Oil, 3.4 t/ha

Oil yield with pods and meal conversion: 6.5 t/ha

Wylie et al., 2023

CIFOR

World Agroforestry

CIFOR-ICRAF SCIENCE WEEK 2023

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

forests

MDPI

Short Note

Screening Potential Bioenergy Production of Tree Species in Degraded and Marginal Land in the Tropics

Nils Borchard [1,2,*], Medha Bulusu [1], Ann-Michelle Hartwig [3], Matthias Ulrich [4], Soo Min Lee [5] and Himlal Baral [1]

Species	Biomass		Bio-Oil and Biodiesel			Sugar or Starch and Bioethanol		
	Mg ha^{-1} yr^{-1}	GJ ha^{-1} yr^{-1}	Mg ha^{-1} yr^{-1}	kL ha^{-1} yr^{-1}	GJ ha^{-1} yr^{-1}	Mg ha^{-1} yr^{-1}	kL ha^{-1} yr^{-1}	GJ ha^{-1} yr^{-1}
Species that tolerate poor soils, moist and dry environments								
Agathis borneensis (Warb.)	1.0–1.7	19–31	-/-	-/-	-/-	-/-	-/-	-/-
Aleurites moluccana (L.)	3.6–5.7	67–105	0.5–6.0	0.5–6.0	16–194	-/-	-/-	-/-
Arenga pinnata (Wurmb)	-/-	-/-	-/-	-/-	-/-	20 (Su)	2.0–12.8	43–268
Azadirachta indica (A.Juss.)	-/-	-/-	0.1–2.7	0.1–2.7	4–87	-/-	-/-	-/-
Borassus flabellifer (L.)	-/-	-/-	-/-	-/-	-/-	20 (Su)	1.2–12.8	25–268
Calliandra calothyrsus (Meisn.)	6.0–24.0	111–444	-/-	-/-	-/-	-/-	-/-	-/-
Calophyllum inophyllum (L.)	-/-	-/-	2.0–6.0	2.0–5.9	65–194	-/-	-/-	-/-
Ceiba pentandra (L.)	-/-	-/-	1.3–4.8	1.3–4.8	42–155	-/-	-/-	-/-
Croton megalocarpus (Hutch)	-/-	-/-	1.6–4.5	1.6–4.5	52–145	-/-	-/-	-/-
Croton tiglium (L.)	-/-	-/-	0.2–0.9	0.2–0.9	6–29	-/-	-/-	-/-
Gliricidia sepium (Jacq.)	2.0–12.0	37–222	-/-	-/-	-/-	-/-	-/-	-/-
Neolamarckia cadamba (Roxb.)	1.8–12.9	33–239	-/-	-/-	-/-	-/-	-/-	-/-
Pongamia pinnata (L.)	-/-	-/-	0.9–9.0	0.9–8.9	29–290	-/-	-/-	-/-
Reutealis trisperma (Blanco)	-/-	-/-	Yes	-/-	-/-	-/-	-/-	-/-
Vernicia fordii (Hemsl.)	-/-	-/-	0.3–1.0	0.2–1.0	8–32	-/-	-/-	-/-
Zapoteca tetragona (Willd.)	Yes	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Species that tolerate continuously wet and waterlogged or temporarily flooded soils								
Calamus caesius (Blume)	1.5–3.0	28–56	-/-	-/-	-/-	-/-	-/-	-/-
Cerbera manghas (L.)	-/-	-/-	2.2	2.2	71	-/-	-/-	-/-
Combretocarpus rotundatus (Miq.)	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Dyera polyphylla (Miq.)	5.4–14.0	100–259	-/-	-/-	-/-	-/-	-/-	-/-
Erythrina excelsa (Baker)	Yes	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Euterpe oleracea (Mart.)	-/-	-/-	-/-	-/-	-/-	0.2–3.8 (Su)	0.1 –2.4	2–50
Melaleuca cajuputi (Powell)	Yes	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Metroxylon sagu (Rottb.)	-/-	-/-	-/-	-/-	-/-	15–24 (St)	9.6–15.3	201–321
Fleroya ledermannii (K.Krause)	2.7–3.2	49–59	-/-	-/-	-/-	-/-	-/-	-/-
Nypa fruticans (Wurmb.)	-/-	-/-	-/-	-/-	-/-	3–22 (Su)	1.9–14.0	40–295
Palaquium ridleyi (King & Gamble)	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Pentadesma butyracea (Sabine)	-/-	-/-	0.6–8.0	0.6–7.9	20–258	-/-	-/-	-/-
Phoenix reclinata (Jacq.)	Yes	-/-	-/-	-/-	-/-	-/-	-/-	-/-
Sandoricum koetjape (Burm.f.)	-/-	-/-	-/-	-/-	-/-	Yes	-/-	-/-
Sesbania bispinosa (Jacq.)	8.0–17.0	148–315	-/-	-/-	-/-	-/-	-/-	-/-
Spondias mombin (L.)	0.2–0.6	4–10	-/-	-/-	-/-	-/-	-/-	-/-
Symphonia globulifera (L.f.)	Yes	-/-	-/-	-/-	-/-	-/-	-/-	-/-

-/- no data available.

CIFOR

World Agroforestry

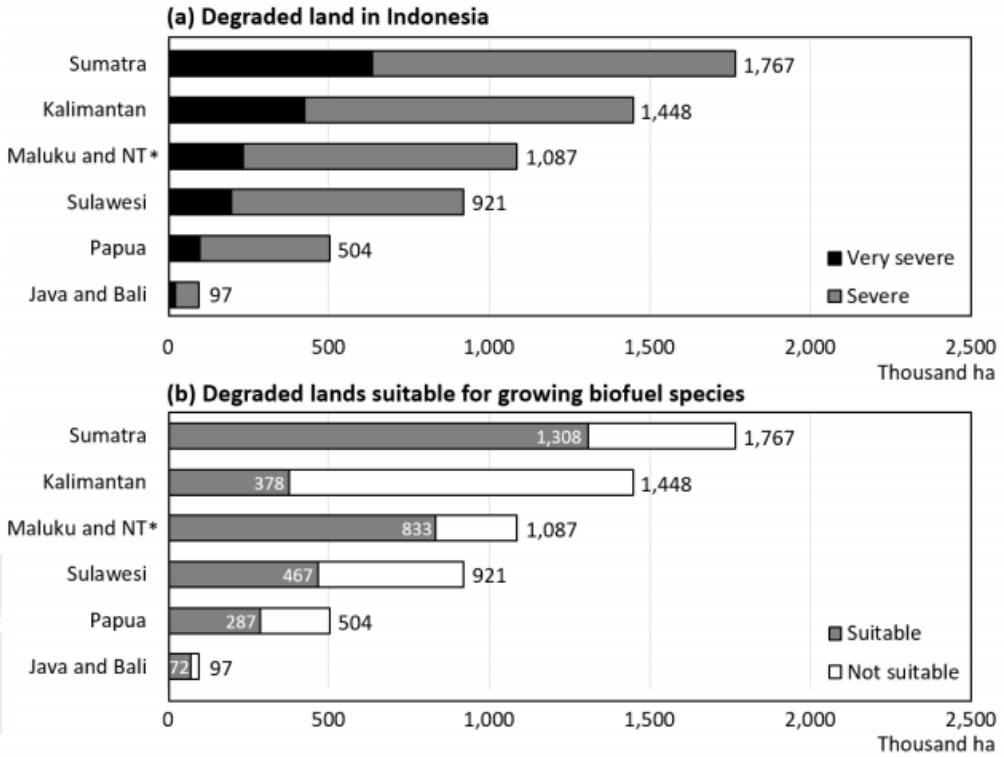
sustainability

MDPI

Article

Spatial Assessment of Degraded Lands for Biofuel Production in Indonesia

Wanggi Jaung [1,2,*], Edi Wiraguna [3,4], Beni Okarda [2], Yustina Artati [2], Chun Sheng Goh [5,6], Ramdhoni Syahru [4], Budi Leksono [7], Lilik Budi Prasetyo [4], Soo Min Lee [8] and Himlal Baral [2]



CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

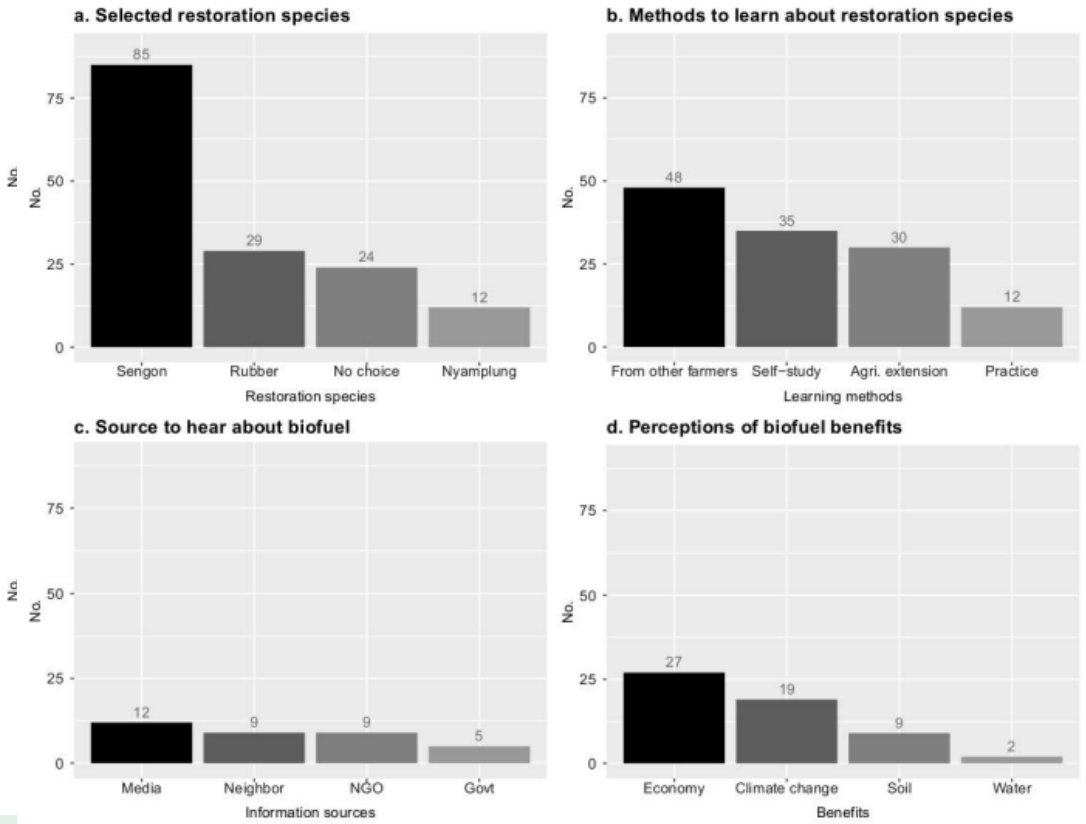
forests

MDPI

Article

Bioenergy Production on Degraded Land: Landowner Perceptions in Central Kalimantan, Indonesia

Yustina Artati [1,*], Wanggi Jaung [1,2], Kartika Sari Juniwaty [1], Sarah Andini [1], Soo Min Lee [3], Hendrik Segah [4,5] and Himlal Baral [1]



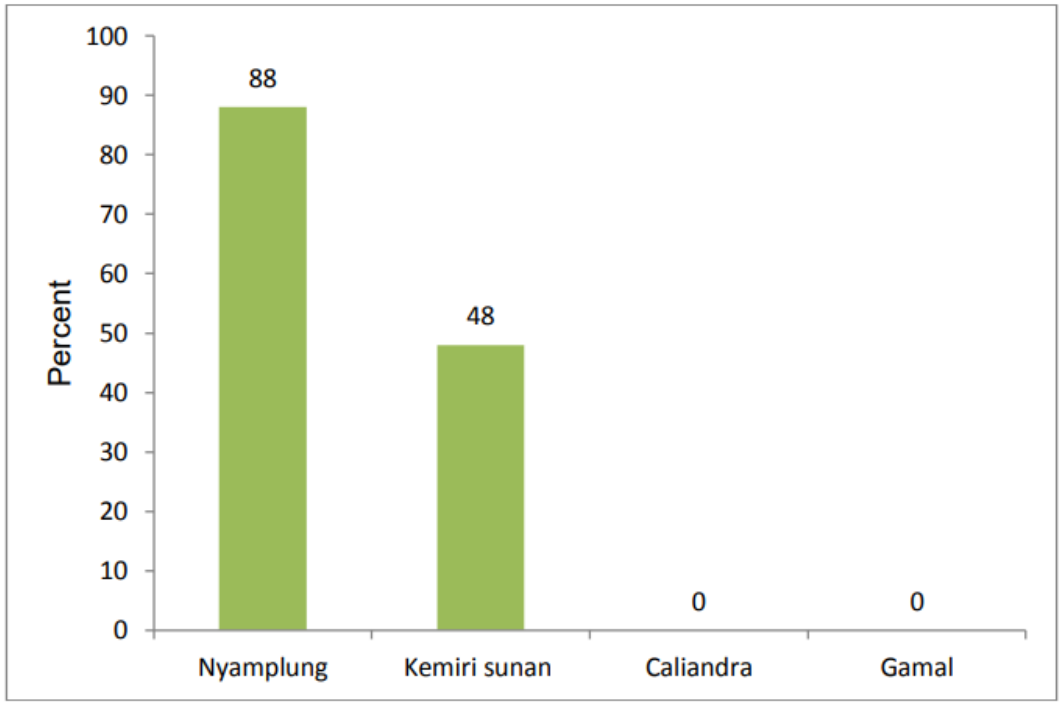
land

MDPI

Article

Assessment of Suitability of Tree Species for Bioenergy Production on Burned and Degraded Peatlands in Central Kalimantan, Indonesia

Siti Maimunah [1], Syed Ajijur Rahman [2,*], Yusuf B. Samsudin [2], Yustina Artati [2], Trifosa Iin Simamora [2], Sarah Andini [2], Soo Min Lee [3] and Himlal Baral [2]



CIFOR

World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

sustainability

MDPI

Opinion

Bamboo as an Alternative Bioenergy Crop and Powerful Ally for Land Restoration in Indonesia

Roshan Sharma [1,2,*], Jaya Wahono [3] and Himlal Baral [2]

1 School of Global, Urban and Social Studies, RMIT University, 124 La Trobe St, Melbourne VIC 3004, Australia
2 Center for International Forestry Research (CIFOR), Jalan CIFOR, Situ Gede, Sindang Barang, Bogor (Barat) 16115, Indonesia; H.Baral@cgiar.org
3 Clean Power Indonesia, Graha Mitra 8th Floor #804 Jl. Gatot Subroto 24, Jakarta 12930, Indonesia; jaywahono@gmail.com
* Correspondence: roshan.sharma@rmit.edu.au

Received: 16 October 2018; Accepted: 20 November 2018; Published: 23 November 2018

check for updates

Table 1. Fuel characteristics of bamboo compared to other biomass sources.

Biomass Type	Ash (%)	Moisture (%)	Volatile Matter (%)	Heating Value (kJ/kg)
Rice husk	12.73	12.05	56.98	14.63
Palm shell	3.66	12.12	68.31	18.44
Corn stalk	3.80	41.69	46.98	11.63
Bamboo	2.70	5.80	71.70	17.58
Acacia *	0.36	11.2	65.7	17.40

Source: [23] and [26]*.

CIFOR

World Agroforestry

Received: 9 January 2018 | Revised: 21 February 2019 | Accepted: 25 February 2019

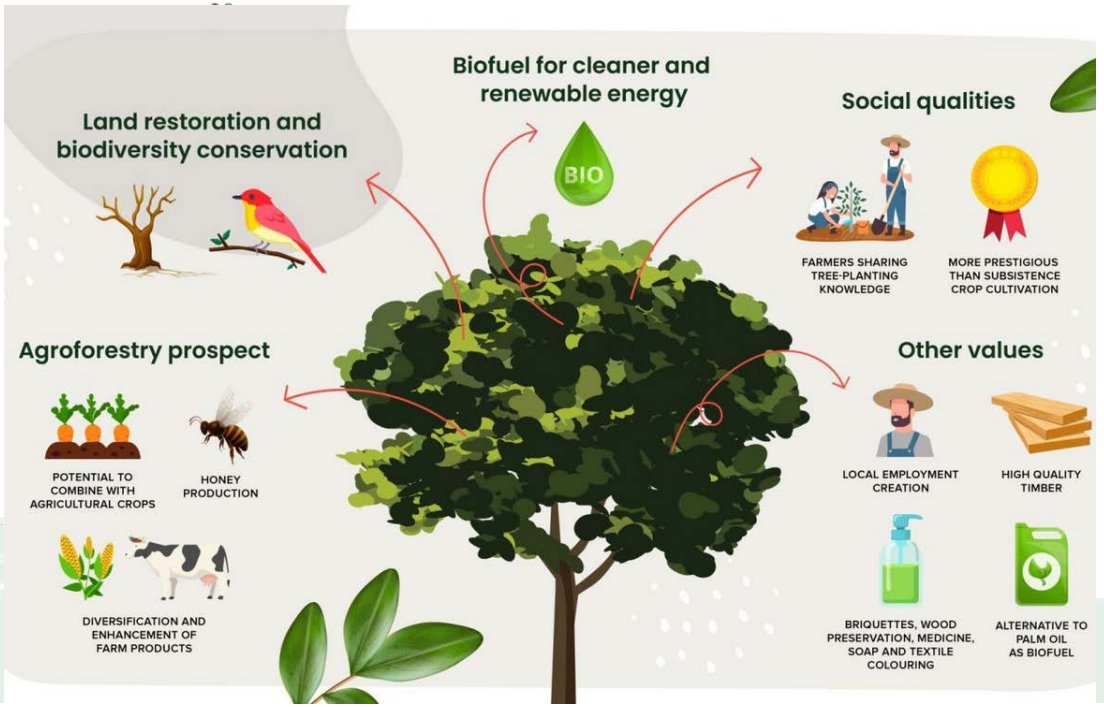
DOI: 10.1002/fes3.165

ORIGINAL RESEARCH

WILEY Food and Energy Security

Integrating bioenergy and food production on degraded landscapes in Indonesia for improved socioeconomic and environmental outcomes

Syed Ajijur Rahman[1,2] | Himlal Baral[3] | Roshan Sharma[4] | Yusuf B. Samsudin[3] | Maximilian Meyer[5] | Michaela Lo[3] | Yustina Artati[3] | Trifosa Iin Simamora[3] | Sarah Andini[3] | Budi Leksono[6] | James M. Roshetko[7] | Soo Min Lee[8] |



CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

FOREST NEWS… EXAMPLES


FORESTS NEWS "Restoration belongs to the community"

NEWS

"Restoration belongs to the community"

In Central Kalimantan, a village takes its chances on the tamanu tree


FORESTS NEWS The power of peatlands

NEWS

The power of peatlands

Sustainable bioenergy from tropical peat forests

NEWS

Pongamia: Potential benefits for restoration and bioenergy in Indonesia

FEATURE

Bioenergy: A solution to three problems?

Scientists take a comprehensive look into the potential of bioenergy crops, from seeds to sales

Share

NEWS

Biofuel-friendly trees may boost landscape restoration efforts in Indonesia

Research shows nyamplung could be most adaptive bioenergy tree for degraded peatlands

Share

OPINIONS

What bamboo forests do for nature and human well-being

CIFOR

World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Global Landscapes Forum

Resilient Landscapes

LAND AVAILABILITY FOR BIOENERGY PLANTATION

- **Common myth:** There is not enough land on which to grow biofuel crops. Currently, they supplant much needed food crops and environmental conservation areas

- **Fact:** Our research suggests large areas of degraded and underutilized land is available in Indonesia (and globally). The degraded land can be restored with climate-smart agroforestry systems that support food, energy and environmental conservation goals (Jaung et al. 2018)

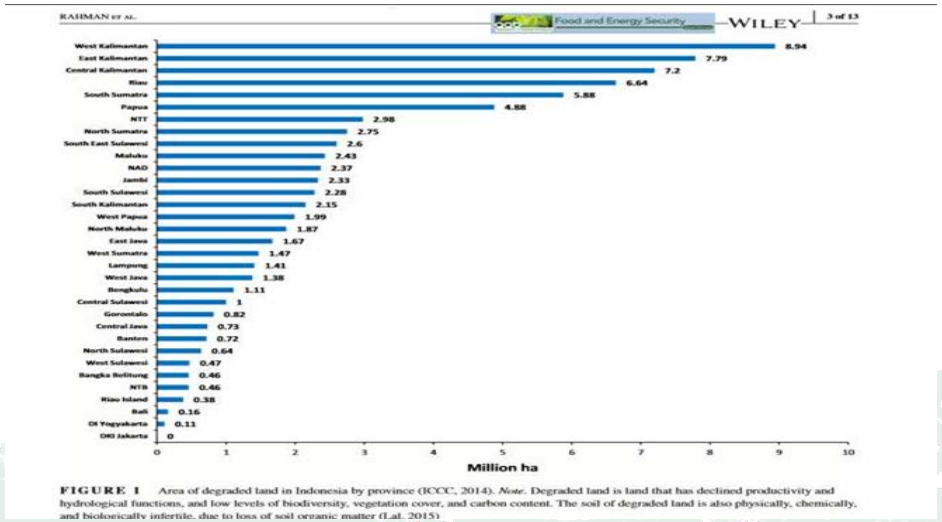


FIGURE 1 Area of degraded land in Indonesia by province (ICCC, 2014). *Note*. Degraded land is land that has declined productivity and hydrological functions, and low levels of biodiversity, vegetation cover, and carbon content. The soil of degraded land is also physically, chemically, and bioloeically infertile, due to loss of soil organic matter (Lal, 2015)

CIFOR
World Agroforestry
CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry
Global Landscapes Forum
Resilient Landscapes

BIOENERGY AND ENVIRONMENT

- **Common myth:** Bioenergy plantations destroy native vegetation and lead to biodiversity loss

- **Facts:** Initial findings from our work in Indonesia demonstrate that bioenergy plantations on **degraded land are a promising approach for land restoration and enhance native biodiversity**. Our two-year-old bioenergy research and demonstration plot is colonized by several bird species and such insects as bees and butterflies.

CIFOR

World Agroforestry

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

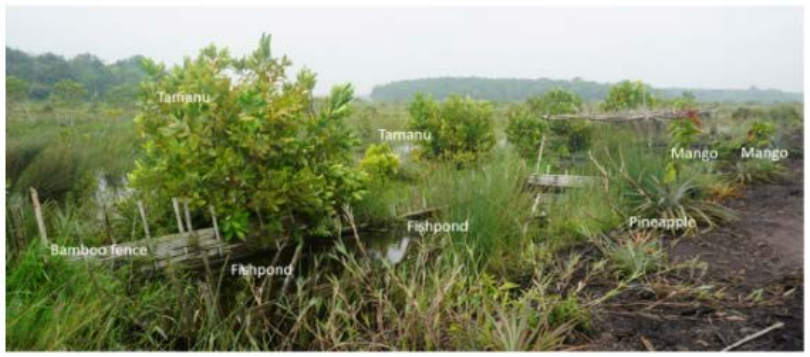
Global Landscapes Forum

Resilient Landscapes

FUEL OR FOOD

- **Common myth:** Bioenergy plantations displace food production areas and increase food prices.

- **Fact:** Our research from Indonesia shows that bioenergy and food production, including rice, pineapple and fish can be combined at plot and landscape scale - increasing the value of the land, enhancing food security and supporting rural livelihoods



KEY MESSAGES

- Fossil-fuel energy is a major contributor to climate change and bioenergy is a viable alternative to address future societies' energy needs sustainably
- If designed and managed appropriately, (such as- climate smart agroforestry system), bioenergy plantation can be an effective means to enhance food and energy security while supporting climate and development goals
- There are wide range of approaches and tools available – for sustainable biomass production
    - Right crops in right landscape
    - Right business model
    - Respecting community rights
- Dissemination of best practices and identify potential for scaling up/improving existing models – through public, private partnership

CIFOR
World Agroforestry
CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry
Global Landscapes Forum
Resilient Landscapes

THANK YOU

National Institute of Forest Science

cifor.org
blog.cifor.org
ForestsTreesAgroforestry.org

CIFOR
CGIAR
RESEARCH PROGRAM ON Forests, Trees and Agroforestry