brief

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No. 43, September 2018 DOI: 10.17528/cifor/006602 | cifor.org

# Bioenergy development in Central Kalimantan

## Current research findings and potential areas for future study

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## Key messages

- Stable, robust policies and governmental support at both national and local levels, are needed to promote successful bioenergy research and its application, and avoid repeating past failures in developing bioenergy crops. The potential of local tree species should be considered in bioenergy project development; in particular, consideration should be given to the ability of each species to adapt to typical environments such as highly acidic peatlands, nutrient-poor soils and soils with high levels of organic matter.
- The participation of local communities is of paramount importance, as well as the consideration of local preferences and context; by introducing community-relevant species, familiarity with such species and their potential uses is also increased.
- Further study is necessary on local bioenergy species that are suitable for peatland restoration to answer the following questions: What concrete actions would allow a provincial government-driven working group to further develop sustainable bioenergy within Central Kalimantan? What would an appropriate business model for bioenergy production look like? and Which agroforestry systems have the potential to combine bioenergy crops with other-purpose crops (e.g. food, aromatics and medicines).

## Central Kalimantan Government's Bioenergy Development Plan

The Indonesian Government has set a target of sourcing 23% of the national energy supply from renewable resources by 2025. Such a target cannot be met by addressing fossil fuel deficiencies alone; it is essential for Indonesia to also develop alternative energy sources. In response to current UN-driven sustainable development goals (SDGs), the international community is seeking affordable and clean renewable energy sources, including energy from biomass. In addition to transformative change in the energy sector, biomass-sourced energy could equally prove to be an appropriate solution in helping Indonesia to meet its target.

Studies show varying estimates of total degraded land in Indonesia, ranging from 6–55 million ha (Gingold 2010) to nearly 80 million ha (Indonesia Climate Change Center (ICCC) 2014). The Indonesian Government through Badan Restorasi Gambut (BRG, Peatlands Restoration Agency) has a target of restoring 2.4 million ha in the period 2016–2021 to rectify the damage caused by the severe forest and peatland fires of 2015, which caused 0.9 million ha of peatland to burn (Hergoualc'h et al. 2017). Peatland has an important function in climate change mitigation, with the average Indonesian peat swamp forest storing carbon at around 220 ± 28 t C/ha (Hergoualc'h and Verchot 2011). Vast numbers of degraded and marginal lands in Indonesia have the potential to be transformed to produce bioenergy (ICCC 2014; Borchard et al. 2017).

Plants with well-designed agroecosystems have high potential to produce energy while also restoring degraded and marginal land (Baral and Lee 2016). A multifunctioning program to restore degraded lands, including peatlands, is necessary. Well-managed bioenergy plantations might also provide an opportunity to improve local livelihoods (Croft-Cusworth 2016). With these concepts in mind, the purpose of the workshop discussed here was to communicate progress within research on increasing biomass in degraded post-fire peatlands for bioenergy production and peatland restoration.

## Previous bioenergy research and projects in Central Kalimantan

Several projects on bioenergy have been implemented within Central Kalimantan in the past. Of note are:

a. **The Energy and Environment Partnership (EEP)**. This is supported by the Government of Finland. The National Development Planning Agency (Badan Perencanaan Pembangunan Nasional, BAPPENAS) and the Ministry of Energy and Mineral Resources (MEMR) were government actors in the Indonesian program, which took a specific focus on the two provinces of Riau and Central Kalimantan. Running during the period of 2011–2014, the program aimed to promote renewable energy, with a focus on bioenergy and mitigating climate change as a contribution to the Millennium Development Goals (MDGs). It improved capacity building and supported pilot and demonstration activity; however, the program was constrained by factors such as a short timescale for implementation and the limited number of provinces targeted.

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b. ***Jatropha curcas.*** In 2007, the Indonesian Government established *Jatropha curcas* (Barbados nut) in some areas of Central Kalimantan as part of the Desa Mandiri Energi[1] (Independent Energy Village) program, an interdepartmental government program for villages to have a self-sufficient basic energy supply. However, this initiative was not successful due to a lack of local support, infrastructure and coordination between central and local governments.
c. **Peat pellets as alternative energy**. Research was conducted by the Central Kalimantan Government's Energy and Mining Agency (Distamben, Dinas Pertambangan Dan Energi) into the possibility of forming peat into pellets for bioenergy purposes. It was deemed to be feasible at a local level though not at scale, and the research was later stopped due to new regulations on peatland protection.
d. **Elephant/napier grass** (*Pennisetum purpureum*). The government planted elephant grass to supply a steam power plant (PLTU) in the Pulang Pisau Regency, although the program was discontinued when the power plant was then constructed as a coal-based plant.

Such projects provided useful lessons for future planning and development, particularly on the need for supporting regulations to guarantee effectiveness beyond a project's lifetime; the need for stakeholder coordination to balance upstream–downstream effects; and the need to consider market demand when developing new commodities.

## Current research into bioenergy in Central Kalimantan

CIFOR, in partnership with Universitas Muhammadiyah Palangkaraya (UMP), is conducting research to examine potential bioenergy production on degraded lands. The project aims to answer three main questions:

1. How can sustainable bioenergy be developed to avoid the food–energy–environment trilemma using alternative feedstocks while simultaneously restoring degraded landscapes?
2. What are the most promising species to achieve efficient bioenergy production from degraded land in Indonesia, from the perspective of species characteristics, productivity and additional environmental values?
3. What are the socioeconomic and environmental outcomes of energy plantations on degraded land?

A demonstration trial plot was set up and planted with four potential bioenergy species (listed in the section titled Project component I) to produce bioenergy and to restore post-fire degraded peatlands. In future, the project also aims to address the food–energy–environment trilemma by building a trial plot to examine the possibility of intercropping between bioenergy and food crops.

Three distinct project activities have now been conducted at the trial plot, located in Buntoi, Pulang Pisau Regency, Central Kalimantan:

1. reviewing and mapping policies, land availability, species suitability, potential productivity, and community perceptions on opportunities and challenges
2. demonstrating research at the trial plot by establishing key bioenergy species in degraded peatland in Central Kalimantan
3. Analyzing the fuel/energy productivity and efficiency by laboratory and chemical means, as well as examining suitable business models aimed at smallholders/small and medium enterprises (SMEs).

1 The literal translation is Independent Energy Village, an interdepartmental government program allowing villages to have a self-sufficient basic energy supply.

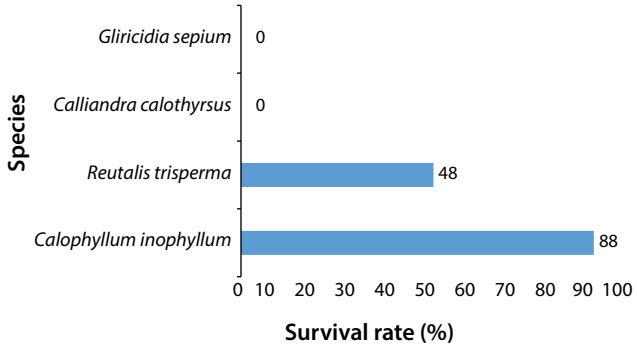


**Figure 1. Survival rate of observed species in CIFOR's trial plot.**

Progress made on two of these project activities was presented during the workshop:

## Project component I – Growth of bioenergy in degraded peatlands, CIFOR trial plot

Four selected species – *Calophyllum inophyllum* (*nyamplung,* Alexandrian laurel, beach calophyllum), *Calliandra calothyrsus (kaliandra,* red calliandra*)*, *Gliricidia sepium* (*gamal,* tree of iron) and *Reutealis trisperma (kemiri sunan,* airy shaw) – were tested to see whether they grow in post-fire degraded peatlands. These species were selected based on their potential to grow in unfavorable conditions. In the trial, the species were grown under two different conditions: as a monoculture and within an agroforestry system. Intercropping, or the integration of agroforestry, was undertaken to find out the likelihood of land optimization, producing bioenergy while also producing food, to address the trilemma problem. *Ananas comosus* (pineapple) was used as the food crop in the intercropping treatment.

Preliminary results for *C. inophyllum and R. trisperma* show that they are promising candidates for development as bioenergy crops in degraded post-fire peatlands (Figure 1). In addition, statistical calculations show no significant differences between monoculture and agroforestry treatment. Thus, there is potential for growing bioenergy and food crops using an agroforestry system.

## Project component II – Community bioenergy species' preferences in Buntoi, Pulang Pisau Regency, Central Kalimantan

Farmers show high levels of interest in replanting post-fire degraded peatlands. Market demand influences the farmers' choice of species; thus, they show a strong preference for planting *Falcataria moluccana* (*sengon*) because of the plans to develop a pulp factory in Pulang Pisau. In contrast, limited information on the economic benefits of bioenergy crops such as *C. inophyllum* make the farmers hesitant to choose them as plantation crops. The interim result shows that economic factors strongly influence community preferences for which commodity to develop.

The results show that, in addition to environmental benefits, the selected species should provide economic benefits. Community access to finance in order to establish a plantation should also be considered within bioenergy or other related degraded land restoration development plans. Free prior and informed consent (FPIC) processes should be incorporated into bioenergy development plans to ensure effective community participation.

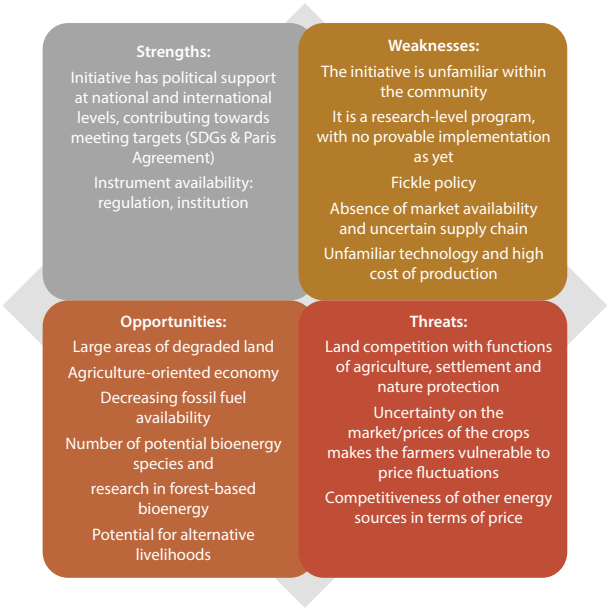


**Figure 2. SWOT analysis of bioenergy research and applications in Central Kalimantan Province.**

## SWOT analysis

Workshop participants discussed various issues regarding current interim research results and the possibility of bioenergy expansion at a commercial scale in Central Kalimantan. Key messages from these discussions were identified and summarized into a SWOT table (Figure 2).

### Strengths

One of the strengths of undertaking bioenergy development in Central Kalimantan Province is the support of government departments at provincial and district levels. The Central Kalimantan Government has formed a working group named *Bioenergi Lestari* (sustainable bioenergy) to guide a program developing bioenergy on degraded land in Central Kalimantan. The Katingan district government has also designated an area of 37,300 ha for tree plantation, including community forests and bioenergy species.

Another identified strength is that, in line with the national government's bioenergy policy, the provincial government in Central Kalimantan is willing to support bioenergy research and development through its mining- and energy-focused agency Distamben, in order to examine potential uses of bioenergy. The international community equally supports the use of clean and sustainable energy, as seen with SDG7, Affordable and Clean Energy. Changes within the energy sector provide the biggest opportunity to achieve the aims of the Paris Agreement; decreasing oil reserves in Indonesia (and perhaps globally) sees new opportunities for bioenergy to be Indonesia's potential future energy supply.

The Indonesian Government and international community's ambition to restore degraded lands further increases the opportunity for bioenergy crops to be developed as alternative, land-restorative crops. The Bonn Challenge targeted the restoration of 150 million ha of degraded land by 2020. As mentioned in Section A, there are 6–55 million ha of degraded land in Indonesia alone. By optimizing land use within a restoration agenda, land not only delivers environmental benefits, but could also yield additional energy benefits, as well as adding value to the local economy. In addition, intercropping some bioenergy species with food crops, or species with varied functions, could increase community livelihoods.

### Weaknesses

However, current research also demonstrates a weakness, in that there is a low level of local community interest in planting bioenergy species. Most community members have not been aware of bioenergy use, even though biomass for bioenergy has been used in their daily lives, i.e. firewood. In addition to a lack of community awareness about the potential economic gains of introduced bioenergy species, another reason for disinterest is that *nyamplung* (*C. inophyllum*) and *kemiri sunan* (*R. trisperma*) are both unfamiliar plants within the community culture and daily use for energy. An unfamiliar plant species becomes the constraint, since farmers are also unfamiliar with its germination, silvicultural treatment and also market potential. With bioenergy development in the Central Kalimantan case study still at the research stage, a more detailed work plan needs to be carried out to move the program into an action plan. A number of other challenges constrain the cultivation of peatlands to develop bioenergy, including nutrient-poor, high-acidity soils, and high cation exchangeable capacity (CEC). As such, it is essential to select a species that is not only suitable for peatland use, but one that is also of economic benefit.

### Opportunities

We identified that large areas of degraded land would create an opportunity to supply bioenergy feedstocks. Further, decreasing fossil fuel availability would also increase demand for alternative energy, including biofuel. Large areas of degraded land would attract parties (government, community, etc.) to utilize it to develop bioenergy. Meanwhile, there are different species that have the potential to be developed as a bioenergy source, which might create opportunities to change market options. The development of bioenergy on degraded land would also create alternative livelihoods for the communities.

### Threats

However, land-use competition could threaten such opportunities. Increased food demand might require larger areas of agricultural fields, and degraded land may present a good opportunity for development in this regard. Meanwhile, a population increase would also require larger land areas to be developed for settlements, including the degraded area. Additionally, land for nature protection has arisen in the debate. A compromise over the food–energy–environment trilemma is required to address the issue.

In addition, markets for the bioenergy tree products are uncertain, putting farmers into a vulnerable position; this also threatens the opportunity for bioenergy development. In addition, competitive prices of other energy sources, such as fossil fuel, would threaten the development of bioenergy.

## Next steps for bioenergy research and development

Drawing from workshop discussions as well as the preliminary research results, we conclude that several areas require further research if Indonesia is to successfully reach its bioenergy target:

a. Further exploration is required on other species with high potential for producing bioenergy, for example, *Pongamia pinnata* (*malapari*), a species native to South and Southeast Asia, which has the potential to produce bio-aviation fuel. Studies are also required on different intercropping combinations of local species such as *Melaleuca cajuputi* (*galam*), *Arenga pinnata* (*aren*), *Metroxylon sagu* (sago), *Calliandra* spp., *Cerbera manghas* (*bintaro*) and *Vitex* sp. (*kalalapa*). Equally, as Leksono et al.'s (2014) study shows, the provenance of *nyamplung* (*C. inophyllum*) from Nusa Tenggara in mineral soil shows superior biodiesel production. Further tests on *nyamplung* (*C. inophyllum*) from different provenances on degraded land need to be conducted.

b. It is expected that greater familiarity with relevant species would increase local community interest in developing bioenergy. An inventory of Kalimantan's local species' potential for bioenergy is thus required. Upon inventory of Kalimantan's local species for bioenergy, further research on the species potential for bioenergy production is required (yield, oil production, market, etc.). It is understood that local communities are more familiar with local species than introduced species.
c. It is important to explore the research-driven development of a business model for burnt peatland that includes bioenergy, as well as to build strategies for developing a green economy model for bioenergy development.

Additionally, several points on political and decision-making policy action are necessary for success in bioenergy development:

a. A local (provincial and district level) government that is receptive towards national policy on renewable energy is essential. Government support in market design is necessary to make the production and sale of bioenergy species economically feasible. Indonesia can take note of the strong governmental support of European countries that is resulting in successful bioenergy development; robust policies and regulations are required within Indonesia to support an effective, long-lasting bioenergy program that does not repeat past failures. Additionally, government efforts are needed to address land tenure issues.
b. Linking up with the Ministry of Environment and Forestry's social forestry program could be an option to address land tenure issues. In line with the results of the study, a community's preference, as well as market availability, should be considered when choosing a species. Alongside bioenergy trees, other means of forest utilization, such as bee livestock and eco-tourism, should also be further explored to enable the potential for multiple benefits for the local community.

In summary, further study is necessary on local bioenergy species that are suitable for peatland restoration: What concrete actions would allow the *Bioenergi Lestari* working group to progress on sustainable bioenergy within Central Kalimantan? What would an appropriate business model for bioenergy production look like? and Which agroforestry systems have the potential to combine bioenergy crops with other-purpose crops (e.g. food, aromatics and medicines).

## Acknowledgments

The funding partners that have supported this research include the CGIAR Research Program on Forests, Trees and Agroforestry (CRP-FTA) with financial support from the donors that support the CGIAR Fund, and the National Institute of Forest Science, Korea. Special thanks to the workshop participants, for their inputs at the workshop co-organized by CIFOR, the Energy and Resources Bureau of Central Kalimantan (DISTAMBEN), and Universitas Muhammadiyah Palangkaraya, 9 May 2017, Palangkaraya, Indonesia.

## References

Baral H and Lee SM. 2016. *Sustainable bioenergy systems to restore and valorize degraded land*. Brief No. 37. Bogor, Indonesia: CIFOR. doi:http://dx.doi.org/10.17528/cifor/006062

Borchard N, Artati Y, Lee SM and Baral H. 2016. *Sustainable forest management for land rehabilitation and provision of biomass-energy*. Brief No. 41. Bogor, Indonesia: CIFOR. doi:http://dx.doi.org/10.17528/cifor/006384

Croft-Cusworth C. 2016. *Growing new energy*. Blog. Bogor, Indonesia: CIFOR. Accessed 12 June 2017. http://blog.cifor.org/45603/growing-new-energy?fnl=en

Gingold B. 2010. *FAQ: Indonesia, degraded land and sustainable palm oil.* Washington, DC: World Resources Institute. Accessed 9 June 2017. http://www.wri.org/blog/2010/11/faq-indonesia-degraded-land-and-sustainable-palm-oil

Hergoualc'h K and Verchot LV. 2011. Stocks and fluxes of carbon associated with land-use change in Southeast Asian tropical peatlands: A review. *Global Biochemical Cycles 25(2), GB2001.* DOI:10.1029/2009GB003718

Hergoualc'h K, Atmadja S, Carmenta R, Martius C, Murdiyarso D and Purnomo H. 2017. *Managing peatlands in Indonesia: Challenges and opportunities for local and global communities.* Infobrief No. 205. Bogor, Indonesia: CIFOR. DOI: 10.17528/cifor/006449

ICCC [Indonesia Climate Change Center]. 2014. *Crop to energy on degraded land as a step toward energy independence, carbon sink, agriculture and protection of REDD+ designated areas.* Jakarta: Indonesia Climate Change Center.

Leksono B, Hendrati RL, Windyarini E and Hasnah T. 2014. Variation in biofuel potential of twelve *Calophyllum inophyllum* populations in Indonesia. *Indonesian Journal of Forestry Research* 1(2), 127–38.

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The CGIAR Research Program on Forests, Trees and Agroforestry (FTA) is the world's largest research for development program to enhance the role of forests, trees and agroforestry in sustainable development and food security and to address climate change. CIFOR leads FTA in partnership with Bioversity International, CATIE, CIRAD, ICRAF, INBAR and TBI.

FTA's research is supported by CGIAR Fund Donors: cgiar.org/funders/

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