



Tropentag, September 20-22, 2017, Bonn

“Future Agriculture:  
Socio-ecological transitions and bio-cultural shifts”

## Sustainable Bioenergy Production through Agroforestry Systems in India, Brazil and Kenya

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### Abstract

Poor rural and urban people in developing countries need access to energy to fuel their livelihoods. Energy is required not only for basic household use, but also for water pumping, land preparation, post-harvest management, processing, packaging, transportation and many other activities. Bioenergy production through sustainable practices and integrated approaches, such as agroforestry systems, can contribute not only to improving energy access, but also to several other social and environmental benefits.

Between 2013 and early 2017, the Programme for the Development of Alternative Biofuel Crops tested the hypothesis that biofuels can be sustainably produced, improve livelihoods and contribute to rural development. The initiative was implemented by the World Agroforestry Centre (ICRAF) in partnership with centres of excellence and other stakeholders, including from governments, private sector and civil society. Pilots were established in three main target countries: India, Brazil and Kenya. Pursuing a landscape approach, the Programme developed and/or assessed sustainability aspects of agroforestry-based integrated food-energy systems that provide multiple benefits. These include several bioenergy products (e.g. straight vegetable oil, biodiesel, biogas, briquettes) and valuable co-products (e.g. animal feed, organic fertilisers, biopesticides, biochar) that can provide local clean energy solutions, while boosting food production and incomes. Furthermore, such products were obtained from perennial species (mostly trees with oil-bearing seeds) that often grow on marginal and degraded lands, such as pongamia (*Millettia pinnata*), simarouba (*Simarouba glauca*), mahua (*Madhuca longifolia*), neem (*Azadirachta indica*), calophyllum (*Calophyllum inophyllum*), macaúba (*Acrocomia aculeata*) and croton (*Croton megalocarpus*), inter alia.

Results demonstrated the production of biofuels (and other bioenergy products) from native oilseed trees within agroforestry systems is not only economically viable, but also has a positive social and environmental impact greater than traditional models based on monoculture of annual (and often food) crops. The Programme contributed to reduce energy poverty, increase household income, improve agricultural productivity, strengthen food security and enhance resilience of smallholder farmers, through diversification of production and linkages to innovative value chains — and all this while sequestering carbon and restoring degraded soils.

**Keywords:** Agroforestry, bioenergy, biofuels, Brazil, calophyllum, croton, India, Kenya, macaúba, mahua, neem, pongamia, simarouba

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