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Hypothesis: Biofuels can be sustainably produced, improve livelihoods and contribute to rural development.

- **Bioenergy products:** Straight Vegetable Oil (SVO) and biodiesel for running agricultural machinery (e.g. tractors, irrigation pumps) and power generators. Biogas and briquettes for cooking.
- **Co-Products:** Animal feed, organic fertilizer, biopesticides and/or other bio-based products, depending on the species and household preferences.

India

- **Strategy:** Support government efforts to improve and scale up a promising biofuel initiative in the State of **Karnataka**, as well as to adapt it to **Maharashtra**. Smallholder farmers in energy-poor villages were provided with quality plant material, processing equipment and technical assistance for growing local oilseed trees in their plot borders and bunds, communal marginal lands, or intercropped with regular crops.
- **Oilseed trees:** Pongamia (*Millettia pinnata*); Simarouba (*Simarouba glauca*); Mahua (*Madhuca longifolia*); Neem (*Azadirachta indica*); Calophyllum (*Calophyllum inophyllum*), Jatropha (*Jatropha curcas*) and others.
- **Partners:** University of Agricultural Sciences – Bangalore; Karnataka State Biofuel Development Board; Dr. Panjabrao Deshmukh Krishi Vidyapeeth university (MH); and the Jawaharlal Nehru Agricultural University (MP).

Brazil

- **Strategy:** Address research gaps that limit the development and scaling up of pro-poor macaúba value chains in the **Northeast region**, especially in Piauí and Ceará states. Investments focused on developing a technological package for domestication of macaúba and its adaptation to the region's (mostly semi-arid) agro-climatic conditions, based on agroforestry systems with integrated food crops and/or livestock.
- **Oilseed tree:** Macaúba (*Acrocomia aculeata*), a Latin American species that can be more productive than oil palm.
- **Partner:** Embrapa

Kenya

- **Strategy:** Assess the sustainability of the croton value chain in the **Central highlands** and address challenges limiting its upscaling, while maximizing the positive impact on rural livelihoods.
- **Oilseed tree:** Croton (*Croton megalocarpus*), an East African species commonly found on boundaries and marginal lands, and traditionally used for firewood and shade. The croton nut is inedible and largely remains a wasted natural resource.
- **Partner:** Eco Fuels Kenya (EKF Group Ltd).



Example of an agroforestry model supported by the Programme in India – perennial oilseed species are incorporated into traditional annual crop systems for an integrated food-energy production.
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Lessons learnt:

Biofuel production from tree species, through agroforestry systems, can:

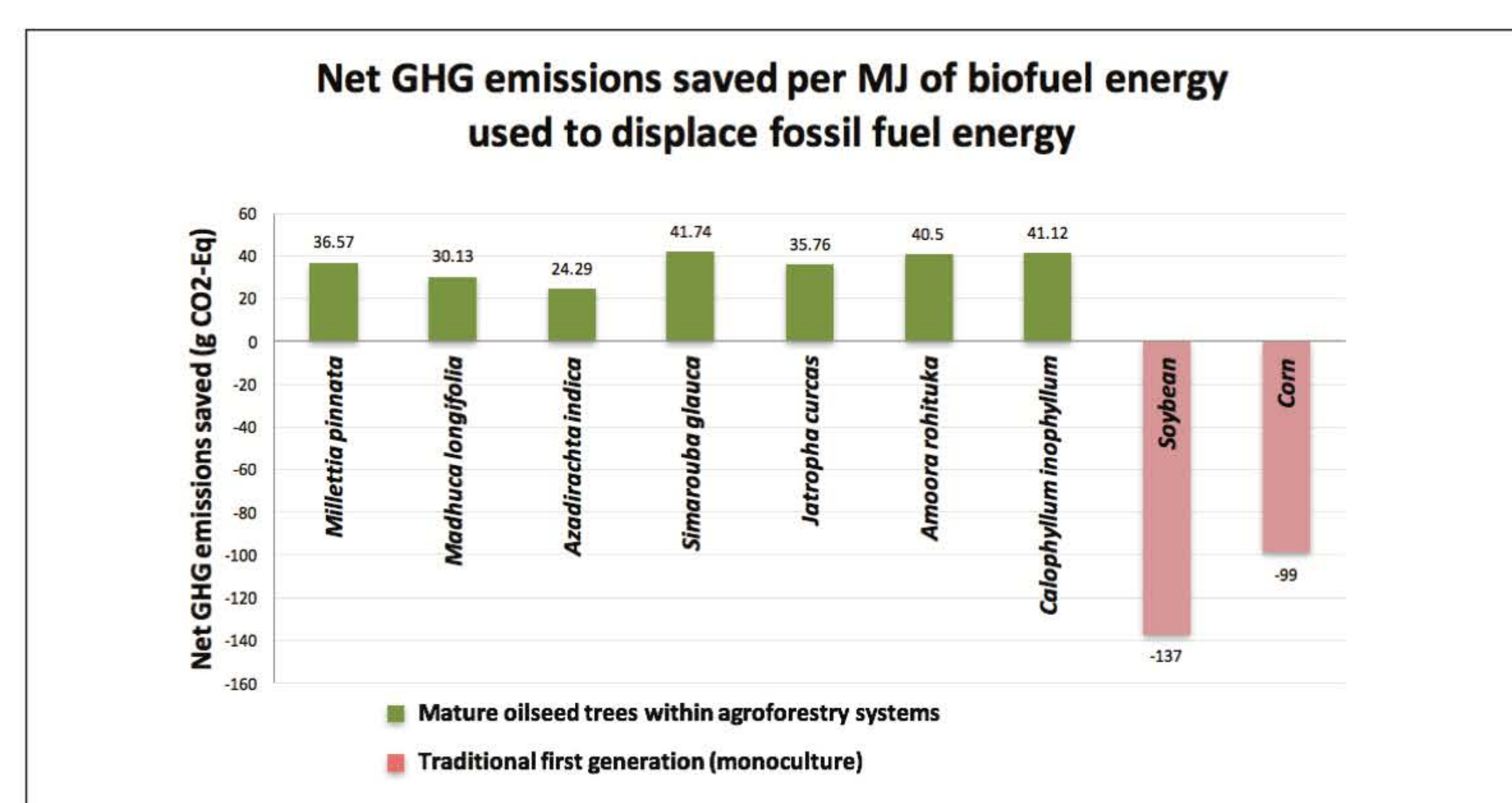
- Reduce **energy poverty** by offering clean and affordable fuels for agricultural machinery, power generation and cooking.
- Increase **household income and improve resilience** to shocks by offering smallholder farmers opportunities to diversify production and be linked to innovative value chains and markets.
- Offer **valuable co-products** for farm use or sale, such as animal feed and



Demonstration of tractor refueling with SVO produced in Hassan District, Karnataka State, India.
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Achievements in India:

- Over **6000 direct beneficiaries** in **24 villages** in Karnataka and Maharashtra (covering an area of more than 700 ha).
- Approximately 100 events for **capacity development** organized, with over 2,000 smallholder farmers trained.
- **79% of smallholder farmers willing to adopt biofuel tree species.**
- At least **10-30% projected annual income increase** after five years (depending on the adopted distribution of trees). Highest earnings from **Pongamia** and **Simarouba**.
- **Landless women** dedicated to tree-based oilseed collection and trade are able to **multiply their daily earnings by 2-4 times** for almost one third of the year, having an **extra income of up to INR 30,000 (~ USD 465) per year.**
- **Savings on fuel expenses of INR 40,000 (~ USD 620) a year** for a single tractor.
- **Calophyllum** and **neem** identified as the best species for **improving food yields** of selected crops (e.g. tomato, chillies, capsicum, banana, cabbage): **up to 58%** with use of seedcake as fertilizer.
- **High-yielding varieties** of several oil-bearing trees tested and propagated (with **over 17,000 grafts** having survived). In the case of jatropha, **non-toxic** varieties with **maturation after only 1 year** were also achieved.
- Innovative **oil-expelling machines** developed and distributed to communities.
- **170 new biogas units**, using seedcakes as complementary feedstocks, with **10-37% increase** and greater stability in biogas production.
 - ✓ **5 villages declared "smokeless"**, after replacing firewood with biogas for cooking.
 - ✓ **Women** now have on average **3 more hours per day** available. **Health hazards reduced** after adoption of the cleaner cooking fuel.
- **Links** established with the IFAD-funded **CAIM Programme**, supporting 600 tribal community farmers in Melghat, Maharashtra.
- **Life-cycle assessment:** Biofuels produced from oilseed trees through agroforestry systems, when compared to traditional monoculture models based on food crops, offer:
 - ✓ **3-7 times more energy efficiency.**
 - ✓ **Greater CO₂ savings** (24.3 – 41.7 CO₂-Eq/MJ, compared to -137 and -99 CO₂-Eq/MJ from soybean and corn).



organic fertilizers, which are key to ensuring long-term business sustainability.

- Strengthen **food security**, as a result of the above effects.
- Contribute significantly more to **climate change mitigation and adaptation** (e.g. by restoring degraded soils) than models based on large-scale monoculture plantation and/or with annual crops as energy feedstock.
- Contribute to **gender equality** and women's empowerment, in addition to reducing health hazards that disproportionately affect women and children.