

The Sustainability of Biofuels Production in Brazil: the role of Agroforestry Systems

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Mosaic of land use and policy realities



Challenges for sustainability of biofuels in Brazil

- Zoning, command and control, forestry law limited expansion in Amazon while encouraging it in the Cerrado and MATOPIBA
- Socio-environmental conflicts and impacts of large-scale monocrop production systems
- Reconciling conservation and livelihoods
- Balancing trade-offs between economic development, climate change and conservation policies and goals
- Diversified production systems
- Including family farmers (smallholders)

Source: Miccolis et al 2014

The case of oil palm: monocrop vs. Agroforestry-based systems



Conventional oil palm monocrop system



Oil palm + agroforestry experiment, Year 5, Tomé Açu, Pará, Brazil.

Photo: Debora Castellani

Agroforestry with oil palm



Photo: Andrew Miccolis

High biodiversity agroforestry systems with oil palm



Photo: Andrew Miccolis

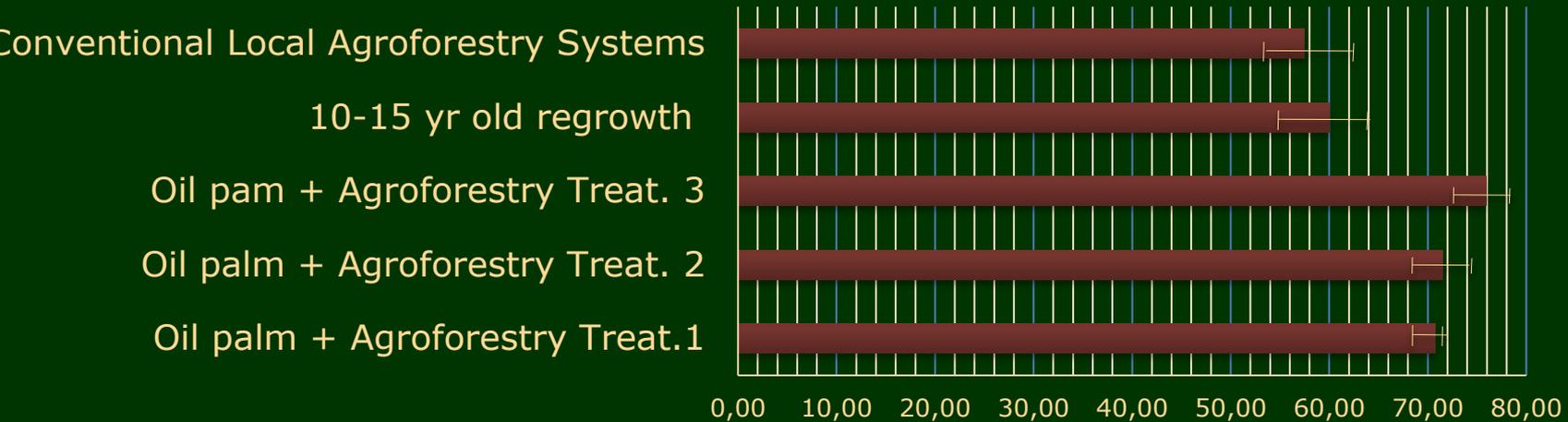
High biodiversity agroforestry systems with oil palm



Photo: Andrew Miccolis

Soil carbon stocks in oil palm + agroforestry vs conventional AFS and regrowth

Soil Carbon stocks at 0-50 cm (Mg C Ha⁻¹)



10-15 yr regrowth	57 ± 4.3 Mg C Ha ⁻¹
Simple Agroforestry Systems	60 ± 4.1 Mg C Ha ⁻¹
Oil Palm + AFS Treatment 3 (low diversity):	75.9 ± 2.6 Mg C Ha ⁻¹
Oil Palm + AFS Treatment 2 (high diversity manual preparation):	71.5 ± 2.6 Mg C Ha ⁻¹
Oil Palm + AFS Treatment 1 (high diversity mechanized preparation):	70.8 ± 1.3 Mg C Ha ⁻¹

Source: Carvalho et al 2014

Data based on field measurements

Oil palm yields and biodiversity

Oil palm yields (FFB) OP + AFS greater than monocrop OP at same age (4.5 yrs) under similar conditions

Plot 1 (81 pl/ha)	Plot 2 (99 pl/ha)	Plot 3 (99 pl/ha)
8 tons ha ⁻¹ yr ⁻¹	6.4 tons ha ⁻¹ yr ⁻¹	8.7 tons ha ⁻¹ yr ⁻¹

- OBS: Data based on actual harvests in year 4.
- Avg. yields of monocrop oil palm (143 pl/ha) at same age in this region:
5 tons ha⁻¹ yr⁻¹

Source: Castellani et al 2013

Biodiversity indicators

- Greater plant species diversity in OP+AFS than in monocrop OP around same age (3yrs) (Kato et al 2011)
- Greater bird species diversity and richness indices (Thom et al 2011) than in monocrop systems at same age (3yrs)

Recent findings from Agroforestry science

SOILS

- Mulch, soil organic matter, ecosystems integrity
- Improving soil fertility and structure, recovering degraded areas

BIODIVERSITY

- Shade, migration corridors, habitats for mammals, birdlife, insects, others.
- Soil biodiversity

CLIMATE CHANGE MITIGATION

- Soil and aboveground carbon storage
- Less net emissions as compared to conventional slash and burn or monocrop systems based on chemical inputs

Environmental/ecosystems services

CLIMATE CHANGE ADAPTATION

- Modifies micro-climate, wind break, reduces erosion, lower temperatures and greater humidity
- Higher plant and farmer resilience, extended harvest seasons, attenuating effects of extreme events (prolonged droughts, flooding)
- Water: regulates flows, greater infiltration, water retention, THUS less runoff, erosion, evaporation

(Mbow et al 2014, ICRAF 2013, Porro and Miccolis 2012)

Socio-economic advantages

- Maintenance and improvement of yields over time
- Intercropping increases efficiency of factors of production
- Optimizing available space and inputs
- Synergistic soil-plant interactions
- Reduces need for external inputs, thus lower smallholder vulnerability
- Lower economic risk on investments due to externalities (market, policies)
- Labor intensive
- Farming systems less susceptible to pests and diseases
- Integrated food and fuel production on same land

Constraints

- Upscaling
- Competition between plant components, lower yields
- Forest component can reduce yields of crops and pastures
- Knowledge and labor intensive (scarce resources)
- **Complexity of management practices**
- Density and complexity makes mechanization difficult
- High initial establishment costs
- Market access for secondary products



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