Carbon sequestration by coconut plantations

A major asset for profitability and sustainability

Coconut plantations are suffering from a downward trend in copra prices and a drop in fertility during rotations. Reinvigorating the supply chain will call for intercrops, higher added-value products and by-products, and sustainable and ecological management. Carbon lies at the heart of those challenges, through its applications: coconut oil-energy (one of the best natural substitutes for diesel oil), carbon sinks (carbon market) and management of by-products and litter (sustainability).

Since 2000, CIRAD has been carrying out research on the carbon balance considered on a coconut plantation scale, but also for eucalyptus and natural rubber.

Towers equipped to measure flows of energy, H_2O and CO_2 above a 20-year-old coconut plantation (Vanuatu).
© E. Malézieux.

From carbon balance to fertility management

Today, CIRAD proposes a combined appraisal and technical assistance:

- Agro-physiological balance of plantations, leaf analysis, fertility.
- Bioclimatology, water balance.
- Net primary production and production/decomposition of litter.
- Measurement of the stocks and flows of energy, H_2O, CO_2 on a plantation scale.
- Modelling of those flows depending on climatic parameters.
- Integrated carbon balances on a plantation scale.
- Recommendations for litter and fertility management.
- Feasibility studies for CDM (Clean development mechanism) projects.

For more information

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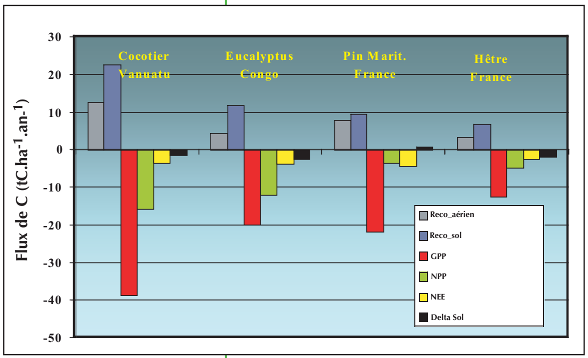
The carbon balance of plantations is becoming a major steering tool for:

- Adding value to the supply chain: coconut plantations are now eligible under the clean development mechanism (CDM) of the Kyoto Protocol as renewable energies (biomass, energy oil). Eligibility as a carbon sink is subject to conditions, but carbon fixation by coconut plantations has already been demonstrated.
- Optimization of productivity: there is around 50% C in plant matter. C is therefore at the heart of primary productivity, of allocation in the plant and its reserves, of harvest yields, etc.
- Sustainability: 80% of coconut primary productivity is accounted for by litter (fronds, husks, etc.). The organic matter in the soil and the future of plantation fertility depends on the management of that litter–by windrowing, burning on site or removal–and on planting methods, rotations and intercrops.



C balance for a 20-year-old coconut plantation compared with three other plantations.

Aerial EcoR: ecosystem respiration (aerial part); Soil EcoR: ecosystem respiration (underground part); GPP: gross primary productivity; NPP: net primary productivity; NEE: net ecosystem exchange; Delta soil: soil C balance.
By convention, positive flows leave the ecosystem and negative flows enter it (fixation).

Carbon balance applications

Comparative carbon flows in tree crop plantations

Incoming carbon flows (photosynthesis of the cover) and outgoing carbon flows (ecosystem respiration) are easily greater in a coconut plantation under virtually optimum conditions than for other tropical or temperate plantations. However, the net carbon balance remains comparable.
This study clearly proves that there is true C fixation by 20-year-old coconut plantings.

Positive effect of windrowing on organic matter in the soil

Windrowing litter every other interrow has a very significant effect on horizontal organic matter gradients. Moreover, windrowed zones show better porosity, more intense soil respiration, and a higher fine coconut root density. The results confirm that windrowed zones are islets of fertility, preferential nutrition zones, or even refuge zones in the event of stress, notably water stress.

Comparison between interrows with and without windrows. © C. Jourdan

Smallholder planting system on Malo (Vanuatu). © C. Jourdan

Variation in carbon stocks depending on age

In Vanuatu, all agropastoral systems involving coconut palms have shown significant losses of organic matter from the soil when compared to the original medium. It is therefore essential to find methods likely to minimize them (cover crops or progressive planting, agroforestry with legumes, etc.) or compensate for them (fallow between rotations, improved farming systems for sustainability, etc.).

Partners...

- CEFE (Centre d'écologie fonctionnelle et évolutive, UMR), Dream team (Dynamique réactionnelle des écosystèmes, analyse spatiale et modélisation), CNRS, France
- INRA-Ephyse (Institut national de la recherche agronomique, Ecologie fonctionnelle et physique de l'environnement), France
- INRA-Université Henri Poincaré, Nancy, Ecologie et écophysiologie forestières (UMR), France
- VARTC (Vanuatu Agricultural Research and Training Centre), Vanuatu

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