Life cycle assessment

Elucidating the links between agriculture and the environment

Defining systems and describing practices with producers.
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Life cycle assessment (LCA) serves to assess the environmental impacts of human activity along a supply chain. In the case of tropical cropping systems, researchers are working to understand and model emissions into the environment, and the links between those emissions and their impacts depending on the different systems. Cropping system LCAs have shown that the impact on climate change varies significantly according to the crops, environments and practices involved. LCA serves to steer production systems in order to reduce their environmental impacts. However, it is not always easy to make the appropriate choices.

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A simple framework for a multitude of scientific challenges

Life cycle assessment is based on a conceptual framework that defines the environmental impacts of a product as the linear resultant, along the production chain, of the contribution to various impacts of the resources used and the substances emitted. The resulting methodology comprises four standardized stages (ISO 14040 2000-6):

- definition of the objectives of the study and the system;
- inventory of flows entering and leaving the system;
- characterization of impacts;
- interpretation of results.

LCA poses various challenges for scientists as regards:

- defining a system that is representative of the function being studied, taking account of the variability of practices, soils and climate conditions;
- modelling biogeochemical processes at the soil-plant-atmosphere interface, and the transfer mechanisms behind emissions into the environment;
- characterizing the impact chains linking emissions and environmental impacts;
- allocating impacts to different products, notably in crop rotations or agroforestry systems;
- analysing the results and their uncertainties so as to steer production methods towards agro-ecological systems.

Cocoa-oil palm-coconut agroforestry systems: complex systems and flows.
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What are the results for tropical crops?

Jatropha. © A. Benoist/CIRAD

Since 2009, CIRAD has been compiling a database, LCA-CIRAD©, on products from southern countries: palm oil, coffee, rice, *Jatropha,* cotton, tomatoes, beef, etc. LCA results serve to pinpoint and improve the practices and conditions behind greenhouse gas (GHG) emissions.

In Mali and Burkina Faso, researchers supplemented their studies of the prospects for developing *Jatropha curcas* as an energy crop with an environmental assessment based on LCA. Their work showed that in a West African context, the yield response to fertilizers of *Jatropha curcas* appears to be limited, hence the additional GHG emissions resulting from fertilizer applications would not be cancelled out by the improvement in yields.

In Asia and Latin America, a study of the GHG balance for palm oil clearly demonstrated the virtually prohibitive risk of setting up plantings on peat soils. Moreover, GHG savings can be made by planting on degraded soils or grasslands, by capturing the methane emitted during effluent treatment or by optimizing fertilizer applications.

Spreading effluent in an oil palm planting. © C. Bessou/CIRAD

Partners

Field PT Smart, Indonesia
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Projects
SOCLE (ADEME), AGRIBALYSE (ADEME), SPOP (ANR)
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Indonesian LCA Network: http://indonesian-lca-network.org
Asia LCA agrifood network: http://lcaagrifoodasia.org

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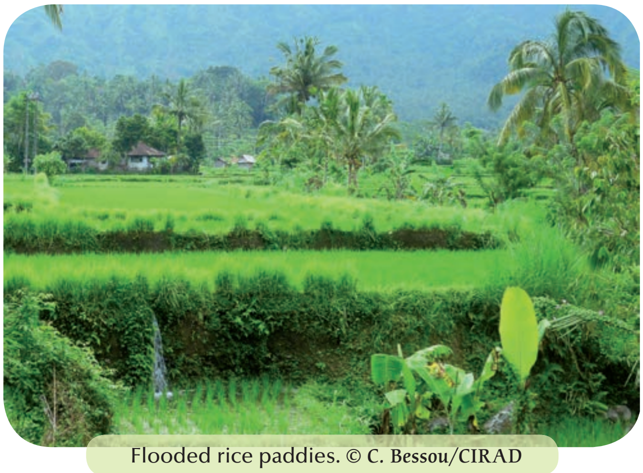
Bessou C. et *al.,* Lifecycle analysis to understand agriculture-climate change linkages. *In:* Torquebiau E. (ed.). *Climate change and agriculture worldwide.* Springer (in press)

See also: http://publications.cirad.fr



Flooded rice paddies. © C. Bessou/CIRAD

In Thailand, an LCA study on rice highlighted the determining role played by the irrigation management method in methane emissions. It is recommended that the fields be allowed to dry out occasionally and urea applications be limited, since they are another source of environmental impact: splitting applications and digging in fertilizers are recommended in order to limit GHG emissions.

Greenhouse tomatoes.
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In France, LCA has been used to compare the impacts of agricultural products depending on their origin. For instance, there is no clear-cut difference between producing eating tomatoes in France and importing them from Morocco: importing them minimizes the impact on climate change, but maximizes the impact on water resources. This demonstrates the importance of considering every impact category so as not to overlook a pollution transfer, but also illustrates the difficulty of certain decisions.

Prospects

CIRAD transfers its knowledge and expertise in terms of LCA to its partners in the South via training and appraisals. Its researchers are also contributing to the drive to promote LCA within national and international scientific communities.
Above and beyond environmental impacts, it is also vital to take account of the social and economic impacts of a given supply chain in order to steer development decisions. CIRAD is also conducting research into these aspects.
Lastly, despite all the questions surrounding the improvement of LCA, it is still one of the most comprehensive, coherent ways of estimating the impacts of human activities on the environment, and particularly on climate change.