Conventional cropping systems based on soil tillage, massive use of industrial inputs (fertilizers, pesticides and energy), and a small number of cultivated species can no longer satisfy food, health and environmental requirements. How can we continue to produce more so as to feed people, while protecting the environment? To ensure ecological intensification, CIRAD makes use of the way in which natural ecosystems, such as forests, in which biological and biochemical cycles are regulated naturally, work. It conducts research aimed at changing farming systems into veritable cultivated ecosystems. In particular, it works to develop ways of protecting and restoring the soil by combining direct seeding with permanent plant covers.

Direct seeding mulch-based cropping systems

Direct seeding mulch-based cropping (DMC) systems are based on three principles: zero soil tillage, permanent soil cover that combines plant species intended to produce biomass and harvest residues, and the constitution of a large biodiversity of cultivated species grown in rotation, association and crop successions. These three principles combine to create a micro-environment for the crop, hence better expression of its potential to resist pests and diseases, and increased productivity (grain, pods, fibre, etc).

Respecting these principles and studying how to apply and master them are the bases of an engineering method that can be applied to ecological intensification. The aim is to design model cropping systems suited to different socioeconomic and biophysical environments, based on more efficient use of natural resources such as solar energy, water, carbon and soil.

CIRAD designs DMC systems as part of its work on agricultural development. It conducts research aimed at understanding the processes at play and building indicators for managing those processes.

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DMC: a tool for a new type of agriculture

CIRAD’s fieldwork sites combine a wide range of biophysical and socioeconomic situations representative of tropical environments. The DMC systems developed in Brazil by CIRAD teams are now being used in Central Africa (Cameroon), North Africa (Tunisia), the Indian Ocean (Madagascar), Asia (Cambodia, Laos, Vietnam, Thailand and China) and the West Indies (Guadeloupe) to:

• regenerate tropical soils degraded by inappropriate farming methods;
• use natural areas for agriculture without compromising their production potential;
• propose cropping systems that use as few chemical inputs as possible, to ensure safe products and avoid polluting water, soils and the air;
• develop a range of alternative rice cropping systems by using DMC and rice varieties developed for DMC, with a high yield potential and that make optimum use of limited water resources;
• detoxifying soils through bioremediation, etc.

DMC systems thus enable the establishment of sustainable farming systems, thanks to more efficient use of natural resources and better integration of agriculture, animal production and perennial crops. If applied on a scale of several villages, they make a relevant contribution in terms of rational development of rural areas. Moreover, if adopted on a larger scale, they can go some way towards providing a response to global issues such as food security and the environment (management of shared natural resources, global warming, biodiversity, etc).

DMC systems and environmental services

Along with its partners, CIRAD works to analyse the ecosystemic functions of DMC systems, notably in relation to soil organic matter dynamics, soil biological activity and pest and disease management.

For instance, the results obtained over the past ten years in Brazil, Madagascar and Laos show an overall trend towards increased carbon stocks in soils cultivated in this way. This sequestration of atmospheric CO₂ can reach as much as 1.5 tonne per hectare per year for rationally fertilized crop rotation systems, producing some 16 tonnes of recyclable primary biomass (cereal and legume mulch and roots) per hectare per year. In France, in Touraine, such systems have resulted in sequestration levels measured in situ of 20 tonnes of carbon per hectare, obtained after 10 years of DMC.

In the long term, extending DMC systems can thus provide considerable environmental services: erosion control, improved water quality, and a reduced greenhouse effect.

Partners

• FOFIFA, National Centre of Applied Research and Rural Development, Madagascar
• Direct Seeding Group, Madagascar
• TAFA NGO, Madagascar
• SODECOTON, Cameroon
• EMBRAPA, Brazilian Agricultural Research Corporation
• Ponta Grossa State University, Brazil
• Ministry of Agriculture, Forestry and Fisheries, Cambodia
• Yunnan Academy of Agricultural Sciences, China
• National Agriculture and Forestry Research Institute, Laos
• Kasetsart University, Thailand
• Northern Mountainous Agriculture and Forestry Science Institute, Vietnam