les dossiers
d'AGROPOLIS INTERNATIONAL

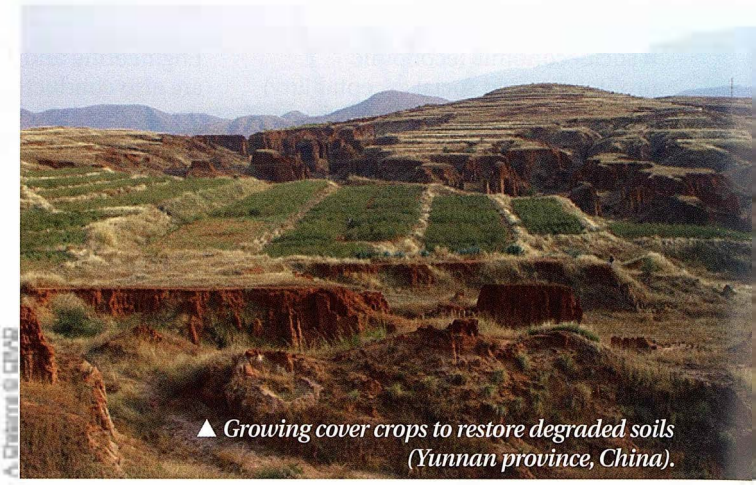
Expertise of the scientific community

Agronomy
Crops and cropping systems

Number 12

Direct seeding mulch-based cropping systems (DMC) and carbon sequestration

Soils contain more carbon than terrestrial vegetation and the atmosphere combined. They hence represent a critical carbon sink that is closely dependent on land-use patterns. Agricultural practices contribute to the depletion of organic carbon resources. At the plot level, the decline in carbon stocks is attributed to three processes: 1) oxidation due to the loss of soil cohesion, thus exposing carbon to temperature and humidity variations, 2) transfers such as leaching and translocation of dissolved organic carbon or particulate organic carbon, and 3) water and wind erosion. It is thus essential to increase soil organic carbon levels so as to ensure sustainable agricultural management.



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▲ *Growing cover crops to restore degraded soils (Yunnan province, China).*

DMC with high annual carbon inputs can rectify degraded agricultural soils, restore their fertility and promote overall diversity (production, soil macro- and micro-fauna). In humid tropical conditions, regeneration of the organic matter and physical and biological properties of soils can be as substantial and rapid as losses due to continuous intensive tillage. Between 10 and 15 t/ha/year of dry matter residue must be input into the system, depending on the extent of chemical fertilization, to maintain a stable carbon balance. The best DMC produce between 15 and 28 t/ha/year of dry biomass, thus enhancing organic matter regeneration, improving the physical (aggregation, infiltration), chemical (cation exchange capacity, nutrient recycling, buffering capacity) and biological (macrofauna and microbial population diversity) features. These systems, which are founded on high annual biomass production and actively increasing functional diversity (even in the dry season), have carbon sequestration capacities ranging from 1.7 to 3.0 t/ha/year in humid tropical regions.

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Recycling organic matter and waste through agricultural practices

The internal research unit (UPR) *Environmental Risks of Recycling* (CIRAD) develops solutions for recycling organic matter and waste using agricultural practices while controlling the agroenvironmental risks and making effective use of the cleansing potential of soil and plants. It addresses this issue by investing in research topics ranging from studies on biophysical organic matter and waste transfer and processing systems to the modelling and the integrated management of organic matter stocks and flows from the plot to the territory.

The UPR is based at several sites, with the main ones being in Montpellier (France) and Réunion. Studies are also conducted at other sites under collaboration agreements: (i) Aix-en-Provence (France) with the *Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement* (two researchers), (ii) Rennes (France) with UMR Sol, *Agro et hydrosystème Spatialisation* (INRA, one researcher) and (iii) Hanoi (Vietnam) with the National Institute of Animal Husbandry (one researcher).

The UPR is organized along two main lines of scientific research:
- Line 1. Management of above-ground and territorial residual organic waste (from workshop to territorial scales)
- Line 2. Studies on residual waste-soil-crop interactions (from molecular to plot scales)

It is also supported by analytical and experimental platforms at each of the main sites.

The research topic 'Modelling and analysis of mass flows on a territorial scale' (Line 1) is focused on developing models to simulate agricultural production systems in which recycling has been used and to assess them in terms of sustainable development objectives, while taking two organization levels into account: farms (individual management) and organized groups of farms (collective management). The research topic 'Interaction dynamics between residual organic waste, soil and crops' (Line 2) is aimed at studying the dynamics of interactions of trace metals and nitrates with cropping systems and different types of soil on three different scales: regional, experimental plots and laboratory (rhizosphere and molecular).

In Réunion, the UPR is closely collaborating with local authorities and above all with the *Région de La Réunion*. In Montpellier, it has forged innovative partnerships with private companies, especially Phalippou Frayssinet, the leading organic fertilizer manufacturer in France.

Funding is mainly provided by the public sector and additional French national resources (*Agence nationale de la recherche*, ministries other than the *Ministère de l'Enseignement supérieur et de la Recherche, Ministère de l'Outre-mer, Agence de l'Environnement et de la Maîtrise de l'Énergie*). Funding associated with the unit's research activities in Réunion is provided by the European Community and local authorities. Funding from the private sector and consulting missions also contributes to the unit's financial balance. ■