Cropping systems and organic matter dynamics: direct seeding on plant cover, an agricultural revolution

L. SEGUY[1], S. BOUZINAC[1], A.C. MARONEZZI[2]
1- CIRAD-CA-GEC, a/c Tasso de Castro, BP 504, Agencia Central CEP, 74001-970 Goiânia GO, Brazil
lucien.seguy@cirad.fr
2- AGRO NORTE, Rua Col. Ênio Pipino, n° 993 Setor Industrial Sul, CP 405 CEP 78.550-000 SINOP MT, Brazil

Experimental unit (Brazil).

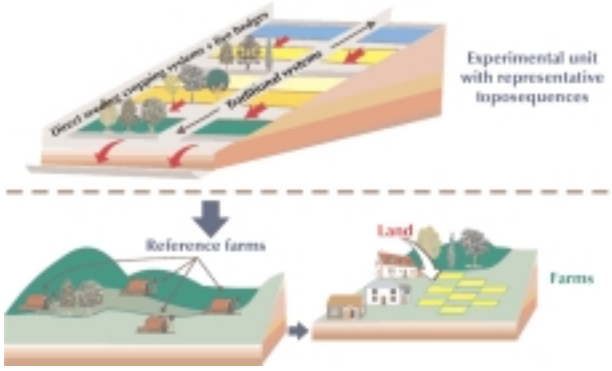
Tillage accelerates organic matter destruction under tropical agriculture conditions. No-till cropping systems involving direct seeding on permanent plant cover enable short-term soil restoration. Cover plant choices are crucial. Soil carbon can thus be boosted to levels generally found in natural ecosystems, even when starting from degraded soils. Direct seeding systems promote net CO_2 storage rather than net production. CIRAD has been working on such systems in Brazil, Asia, Réunion and Madagascar. This poster reports some results obtained in central-western Brazil (hot humid tropical area).

Material and methods

Study design

Cropping systems can be regularly improved via the **"innovation-extension strategy"**, while meeting the requirements of researchers, agricultural professionals and regional institutions (Séguy *et al.,* 1998)[1]. This experimental approach places upstream research in an *in situ* context. The experimental units were managed by researchers and farmers. Volunteer farmers—on their so-called **"reference farms"**—implemented several different cropping systems as-is or tailored them to meet their specific needs. The set of reference farms was representative of the diversity of this region. Cropping systems were set up in matrices on representative toposequences in the experimental units. New systems were developed by gradually including other production factors. Based on matrix construction rules, direct and cumulative effects of cropping system components can be interpreted over a time course. Reference farm matrices are sites of action, innovation and training. They also provide a field-monitoring laboratory for scientists, a cropping system vivarium where tillage techniques, new and highly complex (diversified crops, livestock production, agroforestry) direct seeding systems can be showcased.

Innovation-extension strategy with farmers, researchers and agricultural professionals.

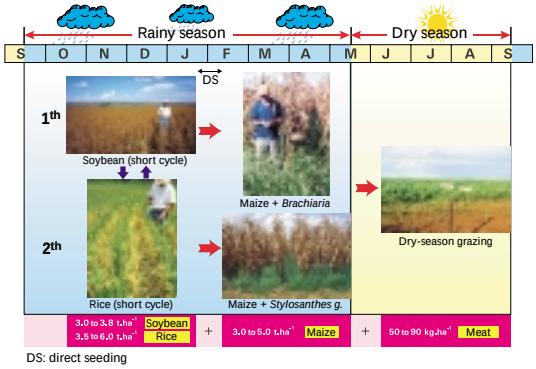


1. SEGUY L., BOUZINAC S., TRENTINI A. CORTES NA., 1998. Brazilian frontier agriculture: I. The agricultural innovation-extension method. II. Managing soil fertility with cropping systems. III. Direct seeding, an organic soil management technique. *Agriculture et développement* Special Issue, Cirad, Montpellier, France, 64 p.

Comparison of cropping systems

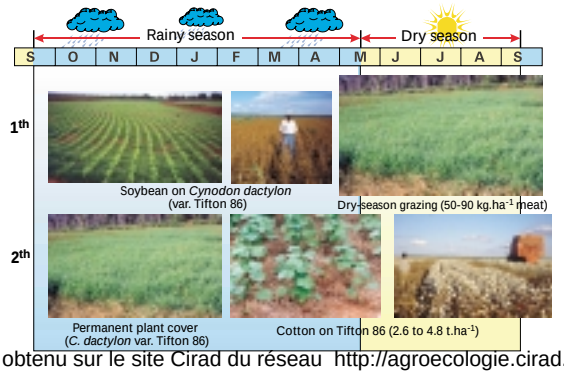
In the "Cerrados" of Brazil, CIRAD has set up three types of cropping systems based on different permanent plant covers. Systems with dead cover (mulch) involve crop residue and a high biomass producing support crop—it is wilted with nonselective herbicides prior to direct seeding the crop. Systems with permanent live cover involve perennial forage species as cover crop, and the above-ground parts are wilted but the underground vegetative reproductive organs are conserved—after harvest, the live cover recolonizes the field and can thus be grazed. Mixed systems involve annual sequences with a main crop and a subsequent crop requiring minimal inputs (producing grain for harvest and high biomass), associated with a forage species. Crops are harvested in the rainy season and the forage crop can be grazed by livestock during the dry season.

Direct seeding on permanent mulch and plant cover: mixed system with annual sequences with a main crop and a subsequent crop, associated with a forage species (two exemples from Brazil).



DS: direct seeding

Direct seeding on permanent plant cover: grain production and temporary dry-season grazings (two exemples from Brazil).



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Results and discussion

Carbon and cation dynamics

After 6 years of analysis, in the three cases, 0.2-1.4 Mg C/ha/year was lost under conventional farming conditions in the [0-10 cm] and [10-20 cm] soil horizons. With direct seeding on plant cover, soil carbon levels increased from 0.83 to 2.4 Mg C/ha/year, depending on the site, cropping system and cover species. Similar patterns were noted in cation and carbon exchange capacities. Direct seeding systems were found to enhance fertilizer retention to a level proportional to that of carbon, while reducing leaching.

The most efficient systems enable continuous high aerial and root biomass production, with a high C/N ratio and lignin content, extensively developed root systems that reach deep soil horizons, so plants can tap deep humidity resources and recycle nutrients, even in the dry season, thus enhancing organic matter accumulation. Roots most resistant to mineralization have thick microaggregate sheaths that protect the organic matter, e.g. *Eleusine coracana* and *Brachiaria* sp.: carbon is recycled especially in the [0-5 cm] horizon, but also in the [0-10 cm] and even [10-20 cm] horizons, with the grasses *Eleusine* sp. and *Brachiaria* sp. intercropped with sorghum or millet and used for temporary grazing.

Cotton, direct seeding in a mulch of *Brachiaria brizantha*, 20 days after seeding (Maeda, Brazil).

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Soybean: direct seeding in thick mulch of sorghum straw.

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Brachiaria brizantha roots (as plant cover and forage).

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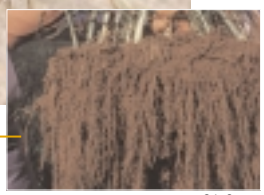

Eleusine sp. roots(as plant cover and forage).

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Uses of live forage covers (Brazil)

Eleusine sp. harvest.

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Grazing.

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Eleusine sp. forage.

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Soybean in a sorghum straw mulch (Brazil).

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Soybean in *Brachiaria* straw mulch (Brazil).

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Cropping system performance

In humid tropical areas of Brazil, annual aerial dry matter production rose from 4-8 t/ha in 1986 to 25-28 t/ha in 2000.

Soybean yields increased from 1 700 to 4 600 kg/ha between 1986 and 2000. Rainfed rice yields rising from 1 800 to 8 000 kg/ha between 1986 and 2000.

Direct seeding strategies can help stabilize incomes in these regions of highly fluctuating economies: depending on the risk level, production costs range from $US300 to $US 600/ha to as high as $US 1 300/ha for cotton crops. Net margins range from $US 100 to $US 500/ha, depending on the producer price. Fuel consumption, tractor and seeder fleets are cut by half. In central-western Brazil, the use of direct seeding systems halted erosion, increased cotton yields by 10-30%, enabled crop diversification, and control of *Cyperus rotondus* weeds.

Cotton harvest after direct seeding (Maeda, Brazil).

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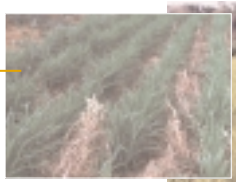
Cotton crops: direct seeding in mulch (Maeda, Brazil).

Rainfed rice in *Eleusine* mulch (Brazil).



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High technology cultivars of rainfed rice, Brazil (direct seeding in a permanent plant cover).

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