

**"From destructive agriculture with soil tillage to sustainable agriculture with direct seeding mulch based systems: 20 years of research of CIRAD and its Brazilian partners in the Cerrados region in Brazil."**

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**Summary:**

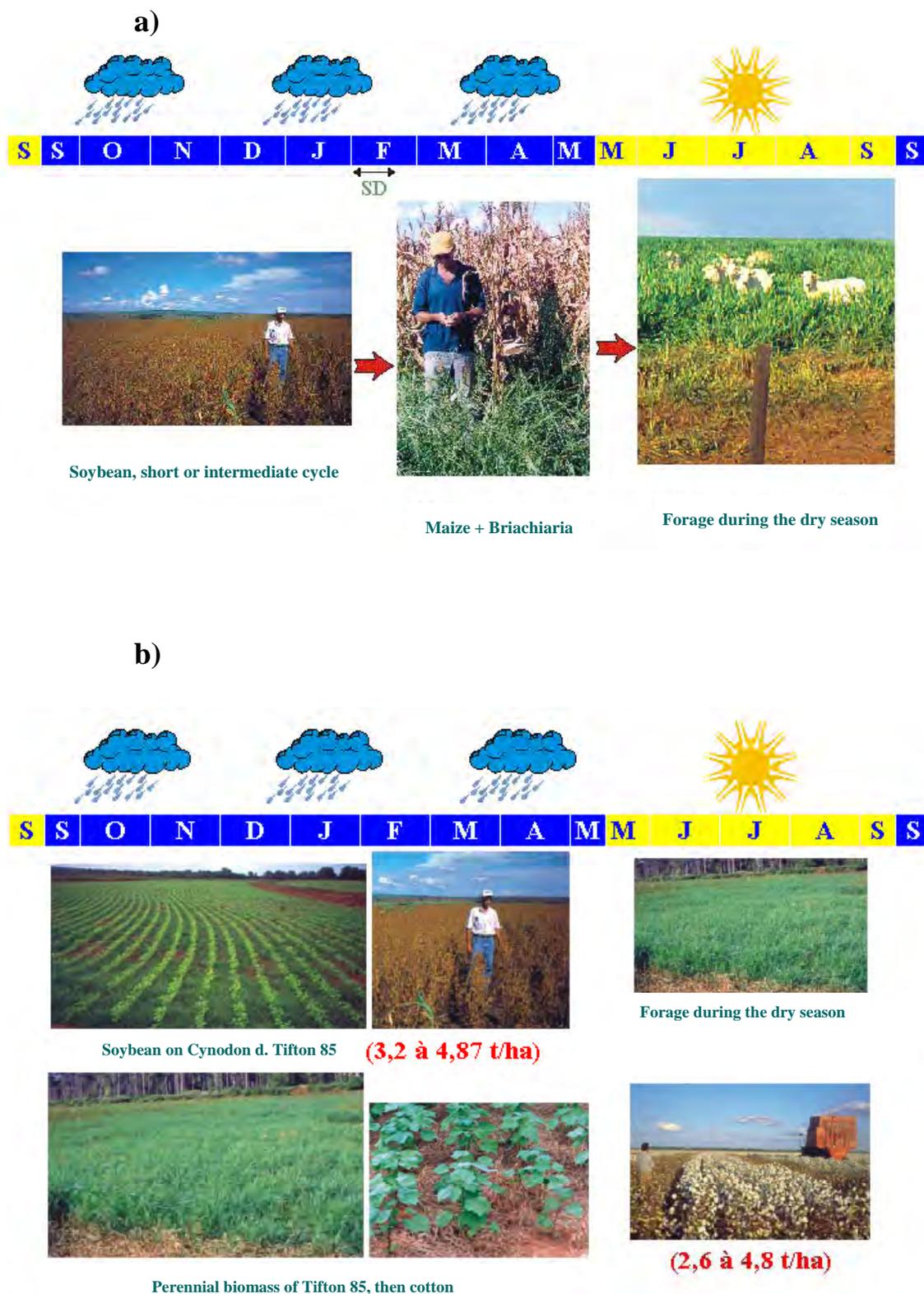
The Cerrados ecosystem from the humid tropics of Brazil is about 200 millions of hectares from what about half could be used to agricultural productions. Actually only 50 millions are effectively used, essentially for pastures (80%). At the beginning of their conversion to agricultural land in the 70's, conventional tillage techniques directly imported from industrialised countries ruined quickly the soil fertility because of erosive processes and excessive mineralisation of the soil organic matter.

To answer rapidly and efficiently to this failure, the CIRAD and its different partners developed new direct seeding mulch based cropping systems (DMC). These DMC systems which tend to mimic the natural forest ecosystem, have been improved little by little on agronomical, ecological, technical and economical aspects. The role of cover-crops, introduced in addition to the principal commercial crop, is fundamental to produce enough biomass for protecting the soil the whole year, to recycle nutrients when necessary avoiding irreversible leaching and many other functions improving efficiency of these DMC systems (see Séguy *et al.* in this congress).

New DMC systems are based on diversification and optimal use of biodiversity, avoiding monoculture. Different rotations of the commercial crop can be used in function of technical and economical interest of the farmers. Different annual successions of commercial crop-cover crop have been tested with sometimes three relayed crops per year. Different scenarios are possible for strictly agriculture or grazing-agriculture integration. Actually a large panoply of DMC is now available for the humid tropics regions (figure 1).

In the Cerrados context, these new DMC systems jointly with specific plant breeding programs (directly linked to the DMC systems), contribute to increase the productivity of all the principal commercial crops of the region. Yields of soybean passed from around 2 t/ha in conventional management in 1986 to 4.5 t/ha in 2000 in similar controlled conditions. Actually, it has been shown that good productivity of 3.5 to 4 t/ha of soybean can be obtained in DMC systems with half doses of chemical fertilizers used before in conventional systems. For the same period, rice yields increased from around 2 t/ha to 8 t/ha in rainfed conditions. Finally for cotton, new DMC allowed to maintain good productivity (around 3 to 4 t/ha) with much less chemical inputs and then less costs.

**Figure 1:** Different types of DMC systems for the Cerrados Region, a) with different crops in relay (dead cover during the commercial crop), b) with associated crops (alive cover during the commercial crop)



In all the cases, the productivity of the whole system increased significantly from 6 to 8 t/ha/year of total biomass produced by a single, not very productive, commercial crop up to 30 t/ha/year of total biomass with the most efficient DMC systems. This strong entry of organic biomass to the system modifies soil characteristic and functioning on the long term. Biological activity of the soil is generally improved returning quickly nutrients to the growing plants by mineralising previous crop residues. However, because of the high biomass produced, part of it will increase de SOM compartment mainly on the top layer of the profile. Quality and quantity of this new SOM will depend obviously of the DMC systems and the species involved in their crop rotations. Systems based essentially on very productive gramineas such as *Eleusine coracana*, *Brachiaria* sp or *Panicum maximum* as cover-crops, has induced very rapid increase in SOM.

Unfortunately, this pioneer region is still quite isolated and transport costs hardly penalised local farmers. Thus, economical constraints limit diversification possibilities for the commercial crops. Because of being a widely exported production, Soybean is the most stable and interesting production, that's why in some regions as the south of the Goias state, more than 80% of the surface of commercial crop are planted with soybean. On the contrary for maize and for rice (even been the cereal most consumed locally), price are fluctuant with no guaranty. That's why maize is often cultivated as a second cycle after soybean when climatic condition allow it. Rice is still cultivated on new deforested areas, using natural fertility with minimum inputs, even if new DMC systems allowed good economical results when well managed. The cotton, is often cultivated as a monoculture to valorise specific machinery and structural investments. Nevertheless, with decreasing international prices and stagnant productivity, conventional systems are not viable, new DMC systems are interesting in rotation with other crop as soybean.

Anyway, from this general economical and environmental adversity a new generation of very competent farmers is born, ready with these new DMC system to face the international markets free of subsidies.