Conservation Agriculture and watershed management in Brazil: the Itaipu watershed (Paraná 3)

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Introduction
Agriculture has large impacts on quality of water resources. Conventional intensive farming results frequently in high level of sediments in rivers and causes phosphorus and pesticides pollutions. Conservation agriculture is a way to maintain high productivity at the long term and to protect water resources. Indeed, conservation agriculture improves infiltration, soil adsorption capacity and reduces erosion. In some watersheds in the world, it is a mean to restore water resources quality. The Itaipu dam area constitutes an experience where no-till have reduced soil erosion since the 1990. Now, the challenge is to make evolve the farming systems to conservation agriculture, with permanent soil cover and crop rotations, in order to improve water quality of Itaipu lake.

Materials and Methods
Itaipu is the largest dam in the world in terms of annual generating electricity. It is located on the Paraná river, in the frontier between Paraguay and Brazil (cf. Figure 1). The climate of dam area is sub-tropical without dry season, violent rain storms are frequent with high rainfall intensity (more than 20 mm.day⁻¹). The soils are deep red latosols, with good fertility potential. These conditions allow an intensive farming with three harvests a year: soya (main crop), corn (safrinha, summer end crop), wheat or oats (winter crop).

Itaipu lake receives important flows of sediments and nutrients of agricultural lands what causes the lake eutrophication and a risk of premature filling. To reduce these flows, a management plan has been established in the watershed of eastern edge of Itaipu lake, called Paraná 3 watershed. The plan has been financed for several years by Itaipu Binacional within an integrated program called Cultivando Água Boa which includes different objectives like urban waste water treatment, forest protection on the river and lake banks, environmental education, communities development and conservation agriculture. This plan is applied to the whole Paraná 3 watershed (8 000 km²).

Conservation agriculture is an important mean to reduce erosion and lake pollution. Our research is based on territorial analysis with geographic data base and on qualitative interviews of farmers and watershed managers. We identify the agricultural practices, the motivations, the interests and the difficulties encountered by farmers to progress in conservation agriculture and the effects of public policies on their practices.

Results and Discussion
Since the decade 1990s, the agriculture in the Paraná 3 watershed evolved to a better soil conservation. Contouring is systematically used. The larger part of the watershed is covered
with anti-erosive benches whose realization was financed by the program *Cultivando Água Boa*. The benches retain the superficial runoff generated by intensive rains. The high soil hydraulic conductivity allows a fast infiltration of the water upstream of the bench without damage for the crops. So, most farmers accept the benches, but half maintains them well, the others remove some of them when they consider them too dense for agricultural machinery.

Figure 1 underlines the importance of no-till on the Paraná 3 watershed. No-till with permanent cover is practiced largely more in this watershed than in the remainder of the Paraná State. This situation is explained by the high fertility potential which allows two or three harvests by year and encourages to reduce turnaround time between crops. There are differences in extent of this system between the *municipios* close to the lake, in hilly area, where a quarter to half of farms is still in conventional tillage and the more remote *municipios*, located on the eastern plateau, where conventional tillage is very minority. These differences can be explained mainly by the size of the farms, larger on the plateau where no-till is more practiced.

For the farmers, reducing erosion and runoff is the main reason to adopt no-till. Before no-till adoption, an intensive rainfall was able to destroy the young plants. Other main motivations are to save time, to reduce the fuel consumption and to increase the soil water capacity for a better resistance to the drought. The farmers observe that the crop residues form mulch which protects the soil at the time of the growth of the young seedlings. The mulch and the biological activity reduce the soil compaction and improve the infiltration very clearly.

If no-till constitutes a real progress, the impacts of agriculture on erosion and pollution could be improved by conservation agriculture with a higher organic matter production by a maintenance of crop residues and installation of cover crops. Indeed, soya leaves few residues which mineralize quickly (because the C/N index is low and the climate is hot and wet a large part of the year). A larger mulch production and the cover crops could reduce the herbicides using, as farmers of the area have observed.

Inserted in the activities of the *Cultivando Água Boa* program the Brazilian Federation of No Till Farmers Association – *FEBRAPDP* supported by Itaipu Binacional has developed a participatory assessment of no till system (conservation agriculture – CA) quality deployed in the Paraná River Basin 3. The system is a tool for land management using free open source software for simplified analysis of CA quality. This tool allows the farmer or his technician assistant load the system with your data and the program automatically provides the scoring of his growing plot graphically identified on Google Earth and relating it to the ranking of his micro watershed. Moreover, the system generates a continuous improvement plan to optimize the current score analyzing farmer management actions considering the records obtained in the various indicators suggesting the future actions required.

The adoption of a conservation farming system is based on a deep change of the production system and appropriation of knowledge about natural processes. The success of no-till is based on increasing incomes but the sustainability of soil use requires an integrated approach associating no-till with cover crops and crop rotation.
Figure 1. No-till and conventional tillage in the Paraná 3 watershed (Source: IBGE)

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