

Keynote: Soil Conservation Policies in the State of Parana, Brazil - The Role of Agricultural Research and Development to Attain Sustainability

Osmar Muzilli*

Geographic features

The State of Parana is located in the Southern part of the South American continent. The total area is almost 200 thousand hectares and the population is about 9 million people, 22% of them living in the rural zone. Parana is the geographic center of the most developed region of South America, called MERCOSUL, which encompasses 100 million people in four countries and is the Continent's principal consumer market.

The Tropic of Capricorn cuts the Northern part of the State. In this situation, the climatic conditions in Parana range from Tropical to Sub-tropical and Temperate zones, with temperatures ranging from 300 to 800F. The Sub-tropical and Temperate zones in Parana get frost in the winter season (from June to September). In the Tropical zone, the average rainfall ranges from 1030 mm (summer season) to 315 mm (winter season); in the Sub-tropical zone, it ranges from 1060 mm (summer season) to 504 mm (winter season) and in the Temperate zone it ranges from 948 mm (summer season) to 445 mm (winter season). In all zones, the drought periods usually are no longer than 3 to 4 weeks (IAPAR, 1999).

The State of Parana is also well supplied by hydric resources. A well-distributed river basins network, leads Parana to be a main hydroelectric supply in the country. The construction of the world's largest hydroelectric power station - the Itaipu Dam - in Parana River, led to produce over than 10 million kilowatts of electric energy. Four other dams constructed across the Iguazu River, are also producing energy to supply demands in the center and southern parts of Brazil.

Parana's topography consists of a narrow coastal plain, which is separated from the interior of the State by an abrupt wall - The Serra do Mar mountains. At west side of the mountains, there are 3 successive plateaus. More than half part of the State is above 2000 feet in altitude.

A heavy clay and fertile soil - called "purple earth" - derived from basaltic rocks and covering almost 40% of the Parana's area, made possible, in the span of a century, to reach a diversified and productive agriculture.

Modern Agriculture Expansion

Since the beginning of colonization, which started about 60 years ago, the State of Parana was a main coffee producer. The excellent soil fertility and rainfall distribution in the Tropical zone, led to extensive and productive coffee mono-cropping systems, reaching almost 2 billion trees from 1950 until 1975.

Nevertheless, in 1975 a strong frost killed all coffee plantations, producing several impacts in the agricultural economy of the State. As consequence, an expressive change on land utilization occurred, with a replacement of coffee plantations by mechanized annual crops and pastures in the Tropical zone. At the same time, a 17% of clearing also occurred, due to the agricultural expansion to the Sub-tropical and Temperate zones.

Under these circumstances, from 1970 to 1980 the Parana's agricultural profile has been going through an expressive change, when the mechanized annual crops were intensified. As an example from that time, in the Western region, the land occupation process consisted on clearing large areas, originally covered by natural forests, which were, in the course of almost 10 years, replaced by the mechanized cropping systems based on soybeans-wheat sequence.

In 1998, the agricultural profile in Parana was based mainly on annual crops production (Table 1), such as *Summer season*: soybeans, covering 2.8 million ha and giving around 7.3 million tons of grains; corn, covering almost 2.2 million ha and giving 7.8 million tons of grains. *Winter season*: wheat, covering almost 1.0 million ha and giving 1.6 million tons of grains. Other tropical or annual summer crops - such as dry beans, cassava, sugar cane, coffee and cotton - or annual winter crops - such as oats and barley - are also expressive commodities in the agricultural economy of Parana. Beef cattle are also a traditional and expressive economic activity, being concentrated mainly in the Northwest region where sandy soils predominate.

In the areas where mechanized process predominate, the traditional cropping systems practiced by farmers still include soybean or corn in the summer season, followed by wheat or oats in the winter season.

Impacts of the traditional tillage practices on sustainability

At the initial stage of the mechanized agriculture expansion, the traditional tillage practices for seedbed preparation consisted of burning the wheat crop residues after harvesting followed by an intensive use of heavy disc harrows, thus promoting strong soil surface disaggregation.

The formation of compacted layers below a disaggregated soil surface was a common problem caused by intensive mechanization, restricting root development and crop establishment, reducing the water infiltration capacity and facilitating soil runoff, even in the clay soils derived from basaltic rocks.

* Osmar Muzilli: Biographical sketch at the end. omuzilli@pr.gov.br.

Table 1. Agricultural production in Parana. Season 1997/98.
Source: PARANA - SEAB/DERAL, 1998.

Main crops	Area (1,000 Ha)	Production (1000 Tons)
<i>Summer crops:</i>		
Soybeans	2,852	7,295
Corn	2,226	7,832
Dry beans	0,577	0,502
Sugarcane	0,334	28,000
Cassava	0,156	3,300
Coffee (C. arabica)	0,130	0,128
Cotton	0,110	0,174
<i>Winter crops:</i>		
Wheat	0,960	1,605
Oats	0,115	8,120
Barley	0,043	0,087
TOTAL	-	7,723
		50,016

As consequence, soil erosion became a severe problem in most parts of the mechanized areas in Parana. In the short-term, the seeds, herbicides and fertilizers lost by erosion resulted in additional costs to farmers, while in the long-term, the agricultural and environmental sustainability decreased.

Terracing and planting on contour lines were, at that time, the main strategies adopted to control soil erosion caused by heavy rains during the seedbed preparation and in coincidence with the initial growth of the annual crops. The practices were used at farm level, according to the existing technologies summarized in the first soil conservation program - PROICS - supported by the State Government.

The role of research and development (R&D) to support sustainable agriculture

IAPAR - The Agricultural Research Institute of Parana - was established in 1972, as a State Government agency in charge to promote applied research and development on a scientific base to provide support for sustainable agriculture.

Looking for a better soil management strategy, IAPAR became a Brazilian pioneer research institution to develop the no-tillage system, as a key point to ensure sustainable agriculture in Parana. An important part of the strategy to ensure success with no-tillage, was to develop diversified cropping systems, based on corn in rotation with soybeans in the summer period, followed by wheat as cash crop, in rotation with oats or others alternatives as soil cover crop, in the winter.

After 15 years of experiences, the benefits of diversified crop rotations under no-tillage were confirmed by an increase in the average yields of soybeans and corn at lower costs, and improving the profitability of the farming systems due to savings on fertilizers, pesticides, fuel and labor. The no-tillage system was also essential to provide a better protection against raindrop impacts on soil surface, an improvement in the soil aggregation and an equilibrium on soil temperature, giving as consequence a better water infiltration in the soil profile and leading to stable

mechanized cropping systems, even on undulated landscapes more susceptible to the erosion hazards. In the present, the no-tillage system is practiced by almost 90,000 farmers, covering an area around 3,2 million ha in the State of Parana.

IAPAR is also a pioneer in developing soil conservation strategies for the small farmers conditions in the State of Parana. As result of the joint efforts with EMATER - the State government extension service - and some local machinery industries, it was possible for IAPAR to develop and transfer appropriate technologies, based on no-tillage system to be practiced with animal power traction. All these efforts were done in close cooperation with farmers and local extensionists, through long-term on-farm trials, in order to adapt and validate the technology according to the farmer's agroecological and socioeconomic circumstances. Actually, no-tillage system based on animal power traction is adopted by almost 3,000 small farmers in the State of Parana, mainly to save labor in the field operations.

The Watershed Management Program

In the period of 20 years, the efforts done by the research and development programs on soil and water conservation focused on farming systems in Parana, provided the technical support for a Land Management Program at watershed level - the PARANARURAL Program. This Program was supported by the state government from 1987 until 1995, through loans financed by the World Bank.

The PARANARURAL Program consisted to implement projects for soil and water conservation, involving the state rural extension company - EMATER/Pr - and local communities established in agricultural watersheds. A characterization was made about the problems and techniques that compromise land utilization and its conservation, as well as the integrated rural development in the watershed area. After the diagnostic characterization, and based on the facts pointed out, a development plan was established with the local community represented by farmers, politicians and the extension service. Each plan comprised priority measures, such as the increase of soil surface protection by crops and residues, improvement of water infiltration in the soil and better runoff control, and improvement of the production means and general infrastructure, which was necessary to increase income. The plan also maintained the feasibility of the farming systems without, however, compromising the conservation of the soil and water, the quality of the population's life and the environment.

A major task assumed by IAPAR in the context of PARANARURAL, was to design, implement and monitor pilot projects in some selected watersheds, as well as provide training courses to the extensionists, focused on farming systems research and development for representative areas of the State of Parana. According to this approach, after a diagnostic characterization, the pre-selected techniques were tested and validate in private farms, in a cooperative work with the extensionists and farmers, by monitoring changes in edaphic parameters, agricultural production and labor needs. The date enable the local extensionists and farmers to evaluate the efficiency of the

proposed alternatives and, after validation by the farmer's community, these techniques were disseminated throughout the watershed and surrounding region.

In a period of 8 years, the PARANARURAL Program covered a total area of 6.9 million ha and benefit some 280,000 farmer's families in the State of Parana, being recognized by FAO as one of the best efforts towards agricultural sustainability focused on soil and water management in the Tropical and Sub-tropical areas in Brazil.

BIBLIOGRAPHY

- Derpsch, R.; Roth, C.H.; Sidiras, N.; Köepke, O. O controle da erosão no Paraná, Brasil: Sistemas de cobertura do solo, plantio direto e preparo conservacionista do solo. GTZ, Republica Federal da Alemanha, 1991. 268 p., ilustr. (Portuguese version edited by IAPAR).
- IAPAR - Instituto Agronômico do Paraná. Plantio direto no Estado do Paraná, Londrina (PR), 1981. Circ. IAPAR, 23. 244 p., ilustr. (Published in Portuguese).
- IAPAR - Instituto Agronômico do Paraná. Plantio Direto - O caminho para uma agricultura sustentável. Palestras do I Congr. Bras. de Plantio Direto para uma Agricultura Sustentável, 1996 (Ponta Grossa, PR). R. T. G. Peixoto, - D. K. Ahrens, M. J. Samaha (ed.). Ponta Grossa, PR, 1997. 275 p. ilustr. (Published in Portuguese).
- IAPAR - Instituto Agronômico do Paraná. Plantio Direto - Pequena propriedade sustentável. Londrina (PR), 1998. 255 p. ilustr. (IAPAR, Circular 10). (Published in Portuguese).
- IAPAR - Instituto Agronômico do Paraná. Dados climatológicos. Londrina, Paraná, 1999. (personal communication).
- Muzilli, O. Plano Integrado para o Manejo e Conservação do Solo em Microbacia Hidrográfica-piloto- A experiência do Paraná na região, do Arenito Caiuá. In: F.C. Castro & O. Muzilli (ed). Manejo Integrado de Solos em Microbacias Hidrográficas. Congr. Bras. e Encontro Nac. de Pesquisa sobre Conservação do Solo, 8, Anais ...

1990, Londrina (Pr). SBCS-IAPAR, 1996. P. 97-119. (Published in Portuguese).

PARANÁ, Secretaria da Agricultura e do Abastecimento - SEAB. Manual Técnico do Sub-Programa Manejo e Conservação do Solo - PARANARURAL. Curitiba, 1989. 306 p. ilustr. (Published in Portuguese).

PARANA - Secretaria da Agricultura e do Abastecimento, Departamento de Economia Rural - SEAB/DERAL. Produção agrícola no Estado do Paraná, safra 1997/1998. Curitiba, Paraná Brasil.

*Biographical sketch

OSMAR MUZILLI is M. Sc. in Agronomy and Soil Scientist, having post-graduation training on research and development focused on farming systems. From 1968 to 1974, he realized his professional activities as Assistant Professor at the Federal University of Parana, Brazil and as researcher staff member of the Soil Resources Project from CERENA - The Natural Resources State Commission - held by the Federal University of Parana in cooperation with the Parana's State Government. Since 1975, he was contracted as a researcher staff member of the Soil Science Area by IAPAR - the Agricultural Research Institute held by Parana's State Government. In the course of the time, his main research activities were related to cropping fertilization process, zero tillage cropping systems and farming systems focused on soil management at watershed level. From 1983 to 1988, was Research Coordinator and then formal President-Director of IAPAR. From 1992 to 1997, provided advisory and consultancies in some South American tropical areas, such as the Brazilian savannah's zone, the Bolivian lowland areas and the Venezuelan savannah's belt, on soil management and farming systems development projects, sponsored by the World Bank, the IICA and the UNDP. Actually is a member of the Technical-Scientific Directory from IAPAR, being in charge to manage a zero-tillage development project in the bordering agricultural areas from the Itaipu dam, sponsored by Itaipu Binacional in cooperation with IAPAR.