SOIL MANAGEMENT QUALIFICATION UNDER NO-TILL SYSTEM IN CENTER-SOUTHERN BRAZIL

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ABSTRACT

No-tillage (NT) system comprises a set of technological processes aimed at exploring farming systems while promoting soil conservation management. Its main principles are: leaving soil undisturbed except for seeding in the drills or rows, the maintenance of permanent soil cover, the diversification of crops by rotation or crop consortium, the adoption of joined harvesting-seeding process to reduce the time gap between operations. Although the NT system was developed to reduce erosion and to promote soil quality, there are several inadequate practices that have been applied in areas where cropping is misnamed as "No-tillage" system, e.g., the use of monoculture, the terraces' misuse or elimination, the absence of contour plowing and others that are incompatible with the conservation principles and that lead to losses in soil and water quality and in local biodiversity. In order to improve the soil management in NT areas, a network research program coordinated by Embrapa Soils and supported by Itaipu Binacional has been studying no-tillage in twelve watersheds of six regions in Center-Southern Brazil since 2014. The network is developing indicators to assess soil management and its environmental effects at property and watershed scales. The program includes: participatory processes of self-evaluation, adjustment and certification by farmers; monitoring farming systems and small watersheds parameters (soil and plant) in twelve locations; long term experiments in six study-sites; and technology transfer in reference areas for training in NT systems. As preliminary results, the selection of monitoring watersheds has been carried out and the communication process has promoted effective participation of farmers in Paranapanema-SP, Londrina-PR, Toledo-PR, Maracaju-MS, Rio Verde-GO and Passo Fundo-RS. In addition, the establishment of local and international institutions network started up actions to improve soil management though no-tillage system.The monitoring approach adopts complementary methods to assess the farming system: IQP which is the No Tillage Participatory Quality Index developed by the Brazilian Federation of No-Till Farms and Irrigation (FEBRAPDP); DRES (Rapid Diagnostic of Soil Structure) to asses management structural quality in areas under NT; and Beta (β) index to classify watershed management based on hydrometeorological data, turbidity time series and sedimentary data set from monitored watersheds.

BACKGROUND

The no-tillage (NT) preconizes soil management without disturbing the soil through tillage while keeping soil cover with undisturbed crop residues and diversified cropping system involving annuals and perennials in rotation, sequence and/or associations. The NT has been adopted rapidly along extensive areas of Center-Southern Brazil due to initial advantages such as the erosion control. Nevertheless, several inadequate practices to tropical and subtropical regions have been applied in farming systems, such as the use of monoculture, the terraces' misuse or elimination, the absence of contour plowing and others that are incompatible with the conservation principles and that lead to losses in soil and water quality and in local biodiversity.

In contrast, we recommend the No-tillage system (NTS) developed in Brazil, which comprises a set of technological processes aimed at maximizing biodiversity, photosynthetic activity, the functions of active roots and soil cover, in order to improve economical production of diversified crops and environmental quality.

In order to study the soil management quality and environmental impacts in No-tillage areas, the project called "Improvement of land management in the Center-Southern Brazil – Research Network SoloVivo" has been carried out in twelve small watersheds.

APPLICATIONS AND IMPLICATIONS FOR CONSERVATION AGRICULTURE

This network is developing indicators to assess soil and water quality management and its environmental effects at small watershed scales. The research includes participatory processes of self-evaluation, adjustment and certification by farmers; monitoring farming systems, and quality parameters for soil, water, crops and management; long term experiments in six study-sites; and formation of reference areas for training in NTS.

The project aims at acknowledging farmers who obtain good yields with soil and water conservation and generate environmental services to society. As preliminary results, the communication process has promoted effective participation of farmers in the selection of small watersheds and in the whole monitoring process. In addition, the establishment of partnership with local and national institutions increased the network and started up actions to improve soil management while seeking the full use of NTS. The monitoring approach adopts complementary methods to assess the farming system: No Tillage Participatory Index (IQP); Rapid Diagnostic of Soil Structure (DRES); the Environmental Performance Indicator (β) and other indicators under development.

DESCRIPTION

The IQP based in Roloff et al. (2011) was developed initially in the surrounding areas of Itaipu reservoir and it is currently under further development and validation in other regions of Center-Southern Brazil. The index is formed by eight indicators of soil management, which have been weighted according to regional farmers agreement in the sub-basin of Western Parana state. The IQP indicators are: rotation intensity; rotation diversity; straw cover persistence; tillage frequency or absence; adequate terracing; conservation practices evaluation; balanced nutrition; farmer commitment (time of no-tillage system). The indicators are evaluated by scores from 0,25 (the worst score) to 1 (the best one). The indicators scores are weighted by factors chosen together with farmers

in order to calculate the index value, i.e., IQP value is the sum of all indicators' values multiplied by its respective weighting factor. This final value should vary from 0 to 10, where the scores 10 to 8,51 mean "very good", scores from 8,5 to 6,51 are "good", from 6,5 to 4,5 they are "regular" and the scores lower than 4,5 mean "low" quality according to Roloff et al.(2011).

According to Ralisch et al (2017), the DRES was developed to assess a visual soil structural quality within the 25cm-depth surface soil layer sampled from small trenches. The soil samples are evaluated according to these main criteria: 1. Degradation features or soil layer structure conservation after initial handling, and 2. Attributed scores based on proportion of different sized aggregates. During the handling, the evaluation comprises the aggregate size, format and disruption; the disruption faces' format, orientation and roughness; root system distribution and aspect; and biological activity evidences. The soil samples should be collected from different plots of the property, according to the land use history, soil classes and soil texture. Due to variations of these characteristics, one to three layers may be identified in the surface soil samples. Scores for structural quality (Qe) should be attributed to each layer, and the scores vary from 1 (totally degraded structure, Figure 1a) to 6 (the best structure condition, Figure 1b).

The sample structural quality (IQEA) is calculated using all layers' scores of one sample (Qe), and the average IQEA of all samples in a plot is called the index of soil structural quality (IQES) for plot area (Ralisch et al., 2017).

The DRES can support decision making of farmers in order to improve soil structural quality and avoid inadequate practices, such as soil scarification that increases the cropping costs and leads to yield losses.

Figure 1. Samples of soil surface layer separated by DRES show **(1a)** a totally degraded structure and **(1b)** the best structure condition with preservation of earthworms.

The SoloVivo network also works in the development of an index to classify the watershed environmental performance (β), according to the proposal of D'Agostini (1999). Based on hydrometeorological data, turbidity time series and sedimentary data set from monitored watersheds, the β index will be used to evaluate the environmental performance from the relationship between the soil management quality and erosive potential.

The objective of developing this index is the proposal of theoretical and methodological approach to subsidize conservation policies and initiatives aimed at improving environmental performance of land use and soil and water management in the watershed.

These methodologies have been developed in the network environment to be applied together with farmers in order to support their decision making on soil management practices of Conservation Agriculture.

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