NO-TILL FOR SUSTAINABLE AGRICULTURE IN BRAZIL

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Abstract

The increase in Brazilian agricultural production in the last decades is largely the result of crop production on soils of very low initial fertility, as is the case of the several regions of the country, e.g. the *Cerrado* West Central Brazil, the natural grasslands in the South and soil impoverished by agricultural use in the South and Southeast regions. Liming and fertilization have been fundamental for yield increases but the insidious process of soil erosion and other forms of degradation wore out and destroyed the soil and reduced productivity. The way to counteract is by no-till or zero-till farming, which impart benefits to the soil in terms of increasing soil organic matter and water holding capacity, thus defeating soil erosion effectively. After having started in 1972 the total no-till area of Brazil is now as high as 23.6 million ha (more than 60% of cultivated land), thus revolutionizing the original concept of agriculture entirely. FAO called no-till 'conservation agriculture', the essence of which is maintaining the soil permanently covered with vegetation, dead or alive, never plowing or tilling the soil and practicing crop rotation including cover crops whenever possible. Because no-till has an outstanding effect that it provides for agricultural production, reduces erosion and the consequent pollution of water bodies, increases the water supply of underground aquifers, increases carbon sequestration and contributes to soil biodiversity and it uses less energy than conventional tillage, the practice essentially contributes to sustainable development. The article ends with a letter submitting to Mrs Gro Harlem Bruntland, the former chair of U.N.'s World Commission on Environment and Development.

INTRODUCTION

The increase in Brazilian agricultural production in the last decades is largely the result of crop production on soils of very low initial fertility, as is the case of the great region of the *Cerrado* West Central Brazil, the natural grasslands in the South and soil impoverished by agricultural use in the South and Southeast regions. Liming and fertilization have been fundamental for yield increases. However, it soon became apparent that the fertility created with chemical inputs would not be enough for a sustainable agriculture, as the insidious process of erosion wore out and destroyed the soil, reducing productivity, often forcing change from agriculture to pasture or even abandonment of the land, with serious social consequences, not only for the producers, but for entire communities.

Thus, much more important than introducing low fertility soils into agriculture was the outstanding development that finally made that important achievement obtained by liming and fertilization permanent, by controlling erosion by the so-called 'direct sowing,' 'minimum tillage,' 'no-till,' or 'zero-till' farming. Based on permanently covered and undisturbed soil, and with crop rotation, no-till farming is defeating erosion. Thus by not plowing, scarifying and cultivating, no-till revolutionized concepts of agriculture that had stood for thousands of years.

Recognized by Brazilian farmers as an outstanding instrument to achieve sustainable agricultural production, producers started to adopt no-till beginning in 1972. Adoption has increased with time and the area under no-till grew exponentially to an estimated 23.6 million hectares (more than 60% of cultivated land) today.

In order to understand what this means for sustainable development of agriculture, it is important to understand the soil ecological roles, how they are affected by erosion and how seeding on top of residues can reverse the degradation process. Photographs in the next page show overall pictures of how no-tillage is seen in the farm and a typical scene of the dissemination of this practice.

THE ECOLOGICAL ROLE OF SOIL

Soil is the most valuable natural resource for agriculture. Situated between the lithosphere and the atmosphere, it supports a great part of the Earth's biosphere.

The difference between soil and other types of non-consolidated matter is the presence in the soil of organisms that produce and degrade organic matter, promoting its transformation. Microorganisms mineralize organic matter from remains of plants and other organisms. In this process, not all organic matter is mineralized. A more resistant part remains as humus, conferring outstanding properties to the soil, such as aggregation, porosity, and water and nutrient retention. This allows the development of plants, which obtain water and mineral nutrients from the soil through their roots.

Soil has a central role in nutrient cycling, especially of carbon and nitrogen, neither of which exists in rocks. They are incorporated in soils from the air, by photosynthesis and CO_2 inclusion in organic compounds and by natural nitrogen fixation processes. As a result of the intimate interaction with the biosphere, soils have more carbon than either the atmosphere or the biosphere.

Good soil cover and no-till maize crop after black oats (as winter cover crop) in Paraguay – Rolf Derpsch

No-till Demonstration at II World Congress of Conservation Agriculture, Iguassu Falls, Brazil – R. Derpsch

On the other hand, soil cultivation results in great losses of organic matter with CO_2 release into the atmosphere, contributing to the greenhouse effect. *Curiously, soils are seldom remembered as one of the main sources of CO_2 release into the atmosphere that contributes to the greenhouse effect.* Important for this discussion is the fact that no-till preserves soil organic matter, reversing the continuous reduction that occurs in conventional tillage. In other words, besides improving the physical conditions of the soil, a very important improvement, no-till is also providing, by the accumulation of organic matter, a sink of atmospheric carbon dioxide, thus an important system of carbon sequestration.

Soil has another fundamental ecological role, represented by its participation in the water cycle. A stable soil covered with natural vegetation usually supports a great number of plant and animal species and microorganisms that exist in equilibrium. Under natural conditions, the soil is always covered, infiltration rate is high and rainwater penetrates easily. The soil is capable of retaining and storing water for long periods, which enables the survival of plants even during periods of drought. The moisture excess, which takes place when the level of water in the soil reaches field capacity, infiltrates and can reach the underground aquifer. The aquifers provide water to springs that originate streams and rivers. Part of all the water is transformed into vapor, through evaporation and transpiration by plants, returning to the atmosphere, thus closing the water cycle.

EROSION

Plowing has always been an important practice in agriculture, especially for short cycle or annual crops. It was believed that the soil needed to be loosened and aerated to receive seeds and facilitate the seedling roots to penetrate the soil without difficulty. Plowing also eased weed control. Once the crop was established, weeds had to be removed and the crop kept free to avoid competition for water and nutrients. Only the cultivated plants should occupy the area, all other plants that could compete for water and nutrients should be eliminated.

As time went by, this type of soil management was considered inappropriate. Uncovered soil in a slope terrain is a vulnerable soil. Much has been written on the disaggregating power of the water drop, those raindrops falling on the recently plowed soil release the so awaited ‘smell of wet land’, the starting sign of the rainy season. But those same drops also destroy and disperse soil aggregates. And many water drops follow and soon they cannot be recognized anymore as they become part of a rushing stream of water that moves downhill. When there is erosion, the muddy water takes with it the best part of the soil, the finest portion called clay, which contains most of the organic matter and nutrients. Researchers estimate that soil losses caused by heavy rains falling on unprotected soil can reach tens of tons of lost soil per hectare in a single year.

Erosion carries away the best part of the soil resulting in lower productivity of agricultural crops. Erosion can also change the soil surface by digging furrows that hinder the traffic of machines over the land. These furrows acquire, in some soils, great dimensions, forming gullies.

The solids in suspension originated by soil erosion fill rivers, lakes and reservoirs; the silt reduces the space for water in reservoirs or rivers, intensifying the risk of floods. The water content of aquifers is reduced because of lesser water infiltration. The capacity of water reservoirs is reduced and the treatment of muddy water for city supply becomes more difficult and expensive.

NO-TILL FARMING

Research on planting without plowing is not new and such projects have been conducted in the last 50 years. Experimental results were not always positive, and the capability of performing such type of sowing did not advance. But it is important to remember that the modern machinery and herbicides that are so important for no-till technology did not exist at that time. Thus no-till farming was made possible by a combination of factors that, in Brazil, include the outstanding efforts of the pioneering farmers.

No-till, also known as zero-tillage and direct sowing, has been named as 'conservation agriculture' by FAO. The essence of the process is maintaining the soil permanently covered with vegetation, dead or alive, never plowing or tilling the soil and practicing crop rotation including cover crops whenever possible. One important point is that perennial crops are also included under conservation agriculture after weed mowing instead of cultivating.

ENVIRONMENTAL IMPACT OF NO-TILL FARMING

No-till has several positive environmental impacts, such as returning to the soil some of its ecological roles, especially water recycling. The most sought effect, erosion control and its consequences, brings beneficial consequences to the soil that include reduction of soil losses and silting of superficial water bodies. Erosion is minimized by better water infiltration that reduces runoff. This brings about several consequences. Through increased water infiltration and less water loss, floods are less intense and, through greater water supply to the underground aquifers, there is a better water supply during drought periods. In that way, the soil recovers its function that is substantially lost through conventional cultivation: the ecological role of water recycling. Furthermore, no-till promotes the stabilization of the soil surface, reducing dust and its damaging consequences, such as the direct effect on human's health, dirt in the houses, and nematode and pesticide transport through the air.

Another important impact is soil organic matter accumulation, thus reverting the continuous decrease observed in soils under conventional cultivation. This can be explained by non-inversion of the soil by plowing and cultivation, in that way protecting the soil from exposure to the air and organic matter oxidation. As a consequence the soil accumulates more carbon and nitrogen, re-establishing at least part of the original carbon and nitrogen lost in the recycling process.

It is important to remember that the degradation of organic matter under conventional tillage occurs independently of erosion.

Non-inverting the soil favors soil biodiversity, contributing to porosity improvement and proliferation of natural enemies of pests.

SUSTAINABLE DEVELOPMENT

How can we position no-till in relation to the so-called 'sustainable development'? The no-till system has an outstanding effect; it provides for agricultural production, reduces erosion and the consequent pollution of water bodies, increases the water supply of underground aquifers, increases carbon sequestration and contributes to soil biodiversity.

However, this is not enough, since the sustainable development concept should be considered not only within the no-till area, but also assessed with a perspective of the effects that

farm management and preservation of non-agricultural farmland have on the environment and on human beings. Therefore, one should also analyze how the producers that have no-till can be seen within the concepts of sustainable development. First, however, we must define what is understood by sustainable development.

The Brundtland Commission of the United Nations 1987 report, *Our Common Future*, defined sustainable development as one that *"meets the needs of the present without compromising the ability of future generations to meet their own needs."* Another important landmark is Agenda 21, approved by the United Nations Conference on Environment and Development in Rio de Janeiro, 1992, the so-called ECO-92. Agenda 21 is a consolidation of several reports, treaties, protocols and other documents elaborated during decades by the U.N., starting in 1948 with the Universal Declaration of Human Rights. It is a very comprehensive document, with information, guidelines and recommendations, and it can be considered as an action plan in order to implement sustainable development, which should combine economic results, environment preservation and social interest.

NO-TILL FOR SUSTAINABLE DEVELOPMENT

In that way, the no-till producer that seeks sustainable development should attend to other requirements, which are flora and fauna preservation, reduction of energy and of the use of resources that are not renewable, reduction of environmental contamination, etc. One of the critical points is land use that preserves streams and springs, protecting them from agricultural areas by forest or other native vegetation.

No-till uses less energy than conventional tillage because it eliminates soil tilling operations. This contributes to sustainable development.

By minimizing erosion and losses of fertilizers and nutrients through the erosion process, no-tillage contributes to a substantial reduction in fertilizer use that contributes to a sustainable development

Fertilizers are essential products for agriculture and are used regularly in no-till planting systems. Two aspects should be considered: the use of non-renewable natural resources and environmental pollution. In the case of non-renewable natural resources, the main ones are phosphates, obtained from distant mines that may eventually be depleted; and nitrogen fertilizers, produced mostly from natural gas, which is also a non-renewable natural resource. What is not usually noted is the great savings that soybean, the most important crop in no-till areas of Brazil, brings into the agricultural economy, since it fixes nitrogen directly from the air. The amount of nitrogen introduced by soybeans in the Brazilian production systems is twice the amount of all nitrogen contained in mineral fertilizers used in agriculture. Savings are double. First, due to the natural gas that is not used for producing nitrogen fertilizers. Second, due to lower soybean production cost because of the fixing of nitrogen, soybean production brings a direct social benefit to the population because poultry and pork prices are reduced, as well as the extensive use of vegetable protein in several food types. It is obvious that soybean is not specific for no-till, but it is this system that guarantees both the production sustainability and the subsequent double cropping, in that way increasing profits and avoiding serious problems of soil degradation that occur under conventional tillage.

The main pollution problems in agriculture are nitrate in underground water, and nitrate and phosphate in surface waters. No-till farming is not expected to contribute to these problems within the large areas of deep soils. Such problems may occur in areas of high productivity corn

and in regions of intensive production of dairy cattle and swine, where waste is applied at high rates to shallow soils.

To avoid this and in order to fit into the sustainable development concept, mineral or organic fertilizers should not be applied above required quantities, to avoid losses in the environment and pollution.

Plant protection is another complicated problem due to the risk that pesticides present to those who apply them and to the environment, besides the possibility of agricultural products contamination. The way to sustainability, in this case, is to avoid calendar applications and to implement measures that reduce pests at their origin, such as crop rotation, protection of natural enemy habitats, diagnosis of problems, decisions on pest control using integrated pest management (IPM), preference for less toxic products and correct application to avoid drift and contamination of forest areas and superficial water streams and lakes. All these practices, although not belonging specifically to no-till, are nevertheless required and must be used for sustainable systems.

SUSTAINABLE DEVELOPMENT AS AN INSTITUTIONAL IMAGE

Since the 1990s, many companies have sought to show a commitment to the environment, adopting environmental standards and certification, as is the case of ISO 14000. Although at first the intent was to create a favorable image of the companies for their customers, shareholders and the general public, in many cases the measures improved the economic performance of the companies, which certainly constitutes a very interesting incentive. Everything points to the direction that, also in agriculture, the use of 'good agricultural practices' will reflect not only on the image of the producers, but also on the positive financial results of the production systems.

An example of how certain initiatives can be implemented is given for the great water reservoir of Itaipu, the largest hydroelectric plant of the world that had been suffering great silting up due to erosion of the surrounding agricultural areas. The responsible company, Itaipu Binacional, in partnership with EMATER/PR (Technical Assistance and Rural Extension Service of Paraná) and the Federação do Plantio Direto (Direct Sowing Federation), created a project to reduce the silt load deposited in the reservoir with outstanding results, such that no-till is now part of the institutional image of Itaipu Binacional.

More recently, the social component has been adopted as well, especially on customer demands. In the case of agriculture, demands for fulfilling the principles of sustainable development come from importers that want quality products produced with environmental respect and social responsibility. This is already happening for meat, fruit, coffee and other products in Brazil. The no-till system will possibly follow this path, since it has already guaranteed continuity and improvement of the productive process by preserving soil and water. As a complement, from the social point of view, adherence is expected to labor conventions that in Brazil are already in existing laws.

While Europe and the United States incorporated sustainable development into agriculture in the 1990s, the theme has been adopted in Brazil in recent years, *but greater progress should be obtained with increasing consciousness from all sides, showing that producers and consumers are two sides of the same coin.* On the other hand, society must be better informed of the outstanding effort that agriculture is making to provide the population with cheap food while protecting the environment. And very few people know the importance that no-till has to recover

both the naturally poor soils as well as the degraded pasture areas, bringing them back into production, thus avoiding the opening of new areas.

Brazil has great accomplishments in agriculture and it seeks through no-till farming for agriculture on most of the cultivated area to be conducted in a sustainable way. Thus no-till is the central component of sustainable agriculture, and a *sine qua non* condition for responsible agriculture. It is a part of a success story that points to a better future, an accomplishment that Brazilians willingly share with other tropical areas, thus contributing to a more sustainable and happier world.

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Following is the letter to Mrs. Gro Harlem Brundtland, former Prime Minister of Norway, former chair of the U.N.'s World Commission of Environment and Development (the Brundtland Commission) and former Director General of the World Health Organization, on the occasion of her visit to São Paulo, Brazil

C.E. 098/05 São Paulo, November 9, 2005

To Drª Gro Harlem Brundtland

Dear Mrs Brundtland

The Brazilian No-Till on Crop Residue Federation (FEBRAPDP) is a private non-profit organization, founded in 1992, in order to aggregate people interested in developing a sustainable agriculture based on no-tillage. Since the beginning our actions have been proactive on this purpose. Our founding President, Mr. Manoel Henrique Pereira, was a pioneer farmer of the no-tillage system in the Campos Gerais Region in Paraná State. Also known as Nono Pereira, he participated in Rio-92 conference where he presented the new no-till system, with the sure knowledge that no-till agriculture would bring us closer to the concepts of the sustainable development.

The no-till system started with the strong aim to control soil erosion, a big problem the farmers had to face. From then on, farmers, together with, official research and extension services and private companies worked together in order to solve such problem, developing the no-till

technology adapted to tropical regions. Today this technology has been extended by FAO and the World Bank to other countries where the sustainable production of food is necessary. These initiatives have been justified mainly because this technology is the most efficient strategy relating to the concepts of sustainable development, as established in a report by the Commission led by you in the late 1980s and subsequently endorsed in the Agenda 21 announced by ECO 92 in Rio de Janeiro.

Evidence of this fact can be seen in the notebook published by FAO in 2002 where they list winning strategies supported by the discussions on Sustainable Agriculture and Rural Development at WSSD in Johannesburg. The EPAGRI experience in Santa Catarina State-Brazil is published on page 25 of the notebook. This official research extension institute is associated to the FEBRAPDP and the success of its initiatives is due to the no-tillage system. Nowadays, most FAO publications suggest that sustainable soil management strategies aimed at Conservation Agriculture recommend minimum soil disturbance, keeping the crop residues on soil surface and the adoption of crop rotation – all being the principles of the no-till system.

The adoption of the no-tillage system in South America has occurred in the last 20 years. It has been an outstanding event resulting in the sustainable development of important commodities in the exporting agribusiness of countries like Brazil and Argentina, independent of any government subsidies.

At this moment, when the advances and the difficulties faced by the nations that signed the Agenda 21 are under discussion, on the opportunity of your visit to Brazil, we would like to offer you, in partnership with Agrisus Foundation for the Sustainable Agriculture, a document reporting the several winning strategies that compose the no-till system. We would like to draw your attention and your overall interest to the sustainable oriented policies so that our efforts and our achievements can be acknowledged throughout the different agriculture areas of the world as an example of what can be done to achieve sound sustainable farm production.

We also would like to inform you that the pioneers of no-tillage in South America have been nominated for the World Food Prize of the WFP Foundation. The agronomist Dr. Norman Borlaug, Nobel Prize laureate of 1970, who has often visited Brazil and Argentina, has stated that the no-till system is a successful strategy towards a sustainable development.

We remain at your disposal for any joint effort that will spread the concepts of sustainable Development based on the no-till system.

Sincerely,

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