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Sustained Soil Management – "No Till" – Agriculture

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1. INTRODUCTION

Brief description of Argentina and its agroindustrial sector

The purpose of this work is to demonstrate what the agricultural production system in Argentina consists of, what we do, how and why we do it.

Argentina, located in the southern tip of the American continent, has wide areas of soils suitable for agricultural production. Out of 279 million hectares, around 40 million are arable, that is to say 12.5%.

The agro industrial sector contributes with 10% to 18% of the total GDP, which ranges from 550 to 600 billion US dollars. It is the main source of foreign exchange accounting for 60% of the total exports and 30% of workforce, direct and indirect employment.

There have been significant changes in production systems through time. They changed from agricultural-livestock systems with rotation and conventional tillage to agricultural systems based on no till with crop rotation.

Livestock was moved to less agriculturally-suitable areas.

Over the past 20 to 25 years, the production of cereals and oilseeds has increased from 40 to 122 million tons.

This increase is due, firstly, to a higher cultivated surface (from 17.5 to 34 million hectares) as the result of the displacement of livestock and the expansion of the agricultural border. This expansion was mainly driven by No Till that allows agriculture in sub-humid or semiarid regions thanks to water economy, a factor we will analyze in detail later on, and also by the use of previously marginal lands because of their susceptibility to wind or water erosion.

Secondly, it is due to a higher production per hectare: genetic breeding and good crop management which allowed to go from an average of 2.4 tons per hectare to 3.7 tons per Ha for the main cereals and oilseeds.

1. What is No Till and how it spread in Argentina

The conventional tillage system is based on the old paradigm of agriculture with a till inverting and crumbling the soil, baring it for seeding. On the other hand, in no till the soil is practically not disturbed and upon harvest, remnants of threshing are spread on the soil. This together with the stubble generate a protecting cover against the impact of rain, wind and sun (Figures 4 and 5).

It began as a conservationist practice in the mid-70s and, in the 90s, it was massively adopted when, due to the knowledge and initiative of producers and technicians, they started to use GMO crops, resistant to herbicides and insects, in no till and good agricultural practices. Producers thus benefit from greater profitability and agriculture recovers competitiveness.

The spread of this system in Argentina was accompanied by the development of machinery which solved the problem of seeding on stubble coverage. Argentine producers joined and encouraged industry and today there are more than fifty Argentine factories manufacturing no till seeders and sprayers (Pognante et al. 2011; Bragachinni et al. 2015).

1. Benefits of no till

The benefits for the soil, water use, productivity and sustainability are the following:

I. Control of wind and water erosion: soil cover, which is kept throughout the year, decreases direct wind action and improves infiltration avoiding soil damage and wind erosion. Better infiltration also reduces water runoff and soil loss to low areas and water courses. Areas with steep slopes must be accompanied with other conservation practices like terracing and contour lines (Colazo and Buschiazzo 2010; Pognante et al. 2011; Gil 2012).

II. Water use efficiency: lower losses by direct evaporation of the soil added to better infiltration determine greater availability of water for crops especially in the first 30 cm of the soil profile. This is beneficial in agricultural production of sub-humid and semi-arid areas, where in long periods of water deficit, greater crop

resistance can be observed. This is contrary to what happens in conventional tillage where there is a higher superficial drying and, in less time, water is no longer available. In several trails, between 25 to 50% higher efficiency of water storage in soil was measured, compared to the conventional system (Figure 7). This implies a better efficiency of water use in grain production and also a production system more adapted to current and future climate variability (Derpsch 2001; Díaz Zorita et al. 2002; Gil 2012).

III. Increase of organic matter and improvement in soil structure: The level of organic matter in soil is considered as one of the main indicators of its quality. In different types of soil, higher organic matter content has been found, after 10-15 years of rotation, in the first centimetres of soil under no till than in conventional tillage (Figure 8), (Blair et al. 2006).

Improvement in the physical structure of the soil is shown in greater porosity and stability of soil aggregates and better root development (Studdert y Echeverria 2002; *Díaz-Zorita et al*. 2004).

IV. Greenhouse gases: From the point of view of the carbon cycle, in no till, carbon dioxide is transferred from the atmosphere to the soil through biomass, becoming an agricultural practice to mitigate the greenhouse effect.

Besides increasing carbon in soil, reduction of emissions has also been proven. Research carried out by the Department of Agronomy at Purdue University in the United States proved that emissions in no till were 57% lower than in conventional tillage (Omonode et al., 2011).

V. Greater biological diversity: stability in temperature, soil moisture and structure create ideal conditions for microbial and fungal activity, nematodes and soil worms, and arthropods in general (Paul 2007; Gil 1999).

VI. Less energy: around 70% less fuel is consumed, and up to 50% of tractor power is saved (lightweight and fewer trips) (Gil, 2012).

VII. Time opportunity: solid soil and more surface moisture allow sowing, spraying and harvesting in longer windows of time. However, lower soil temperature sometimes conspires against the advancement of sowing dates.

VIII. Yield stability: important attribute for sustainability which has been proven in different edaphic environments, different crops and over many years. Actually, it is the result of greater water use efficiency and improvement in Organic Matter and soil structure.

1. Requirements for the proper functioning of this production system

Since no till is a technique within a Production system and Sustainable management, almost none of abovementioned benefits are obtained, nor can sustainability be achieved in the long term, if the principles of *Good Agricultural Practices* are not met.

- Crop rotation (grass should be included)
- Full and continuous soil cover (sometimes achieved by double-cropping or even cover crops)
- Replacement and balance of nutrients
- Systems approach to pest and weed management.

2. Emerging problems in the production system of Argentina

In parallel to the benefits listed before, there are some emerging problems to be solved. Among these are the following:

- The occurrence of resistant weeds
- Subsurface compaction due to the passing of machinery
- Excessive use of herbicides and insecticides
- Contamination, mainly in peri-urban areas
- Natural tendency of producers to abandon rotation and sow a more profitable crop.

1. Constraints in the use of no till

A brief list of reasons for the delay in adopting and anticipating the inconveniences that may exist at the beginning of this path:

- Unawareness and change resistance
- Lack of appropriate machinery and skilled operators

- Adverse economic conditions that do not allow for adequate crop rotation (e.g. a price relationship that discourages or overstimulates certain crops)

- Prejudices and myths about biotechnology and the use of GMOs

- Inherited situations due to poor soil management (e.g. compaction) which must be corrected before starting with No Till.

2. Development, innovation and Social sustainability

It is necessary to promote development instruments such as integration and associativism among producers' communities, industrialization of primary production in origin, add value, transform production, generate genuine jobs. This will allow a wide range of investment possibilities in different regions of the country, and above all the settling down and work of men and women in their region.

It is also necessary to continuously adopt technologies such as:

- Precision agriculture
- New germplasm and GMO crops
- New criteria in fertilization
- Innovation in machinery and new management practices
- Include a greater use of plant eco-physiology and ecology concepts, etc.

3. Regulatory framework and public-private interaction

In 1991 Argentina created the National Advisory Commission on Agricultural Biotechnology – CONABIA – which regulates the activities related to genetically modified organisms (GMOs) for agricultural use. This commission generated a regulatory framework which was been recognized internationally by FAO in 2014 as a reference centre for biosafety and GMOs worldwide. Full use of biotechnology in an extensive production framework has mainly occurred with soybean, corn and cotton events (CONABIA, 2016).

Commitment and institutional support are key to changing the paradigms and adopting new technologies. Argentina has a public institution which will be 60 years old in the next days, INTA, a research and extension institute which carries out research and promotes the use of technologies for the whole range of Argentine producers. Institution which today I represent as vice-president.

Also private non-profit institutions, made up of agricultural producers who have been able to promote the entrepreneurial spirit and their integral views, and are active participants in these processes of change and adoption of new technologies. Among them we can mention the Argentine Association of Regional Consortiums for Agricultural Experimentation (AACREA) and the Argentine Association for Direct Sowing Producers (AAPRESID).

4. Conclusions

Historically, agriculture is equivalent to tillage, and soil plowing. Moreover, currently, around 90% of the total world surface under agricultural production is still under this system. No till is a practice with long-term benefits which could be adopted in other parts of the world.

The synergy of the no till system with biotechnology and good management practices allows significant progress in large-scale food production, contributing to maintain the inter-annual stability of agricultural food production, consistent with sustainable development goals and the preservation of natural resources.

In the future, mankind and nature face the challenge of increasing food production by optimizing the use of resources, preserving soil and water, and offering at the same time a mitigation alternative and adaptation to climate change. In order to achieve the objectives of producing required food and reducing environmental impact, the future manifestation of our creative and innovative capacity must be to adapt, transfer and develop technologies that result in greater production, better use of resources and inputs, and lower environmental impact (Andrade, 2016).

This is why we consider that perfecting and disseminating this production system is not only a professional duty but also an important moral responsibility.

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