The No Till Cropping System and its evolution toward the achievement of the MOSHPPA Model Principles (Modern Sustainable High Productivity and Profit Agricultural Model)

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• Abstract

During the last twenty years and as a result of a quest to improve cropping efficiency, and to counteract soil erosion and deterioration, the Argentinean producers, introduced, improved and extensively adopted the No Till cropping system principles. The No Till approach is inspired in emulate nature as much as possible regarding those plant growth basic mechanism on which the cropping and general farming processes are pillared on. No Till is a cropping system aimed to improve the agro-ecosystem functioning protecting soils against erosion and degradation by means of avoiding soil tillage and keeping the topsoil covered with crop residues -and living plants- as much, and as longer as possible.. Utilizing No Till and the consequent soil and agro-ecosystem "health" improvement as a general framework, the Argentinean cropping system evolved toward the achievement of the MOSHPA model goals: namely a higher level of productivity, profitability and competitiveness within the short term, and a proper level of sustainability within the medium-long run. This goals are very much in coincidence with those pertaining to Conservation Agriculture.The result was a deep transformation of the Argentinean grain production and general farming system. Within the analysis of this farming evolution, the Argentinean agro-biotechnology adoption and the soybean production case are considered to better exemplify the agricultural transformation and evolution process.
Keywords: No Till, tillage avoidance, soil covered, erosion control, stubble, biotechnology, MOSHPA, productivity, competitiveness, sustainability.

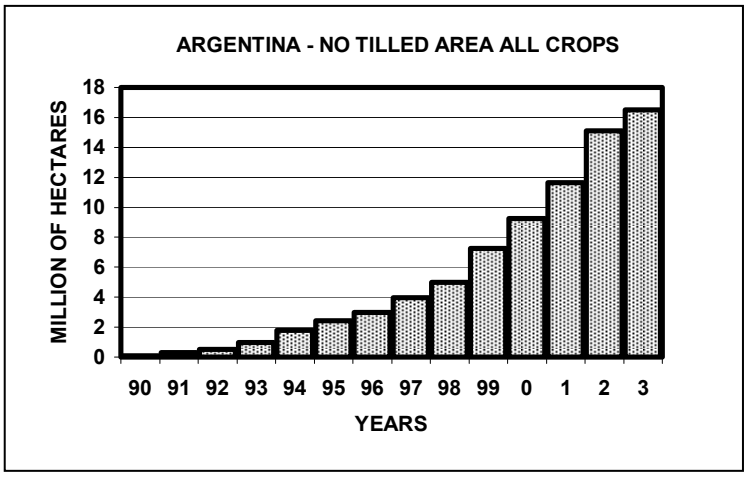
• Introduction

"The world is not globalizing but instead it is already functioning as a global unit". Based on this assumption, and heavily exposed to the international and internal challenges and opportunities, the Argentinean farmers started to work toward the counteraction of the challenges and at the same time attempting to take advantages of the opportunities. The main challenges or pressures were (and are) basically derived from: 1.) a strong economic pressure originated on both an international subsidized competition and a domestic very high and somehow farming sector discriminatory taxation policy; and 2.) an unavoidable necessity to overcome the serious soil -and agro-ecosystem- degradation mainly caused by the erosion derived from the conventional tillage on which the intensification of agriculture was based on the past. The traditional or conventional till practice is to disturb the soil surface by plowing and denude of vegetation from the fallow field, rather than to keep it covered with vegetation or crop residues as is done when no-till is practiced. Plowing the land, from the standpoint of soil structure and its biological environment is "equivalent to an earthquake". Through this operation, the

topsoil –in most of the cases and in terms of soil science terminology, the "A" layer, is turned upside down. All existing vegetation is killed by burring it together with previous crop residues. (Peiretti, Roberto A., 2001). Among other negative impacts, soil tillage (based on plough and other tillage tools) denudates soil and pulverize it heavily exposing the resulting "bared topsoil" to the rain and wind forces that act as strong eroding forces. Also, this procedure normally decreases water infiltration capacity, increases water run off and consequent eroding force, increases water contamination, decreases soil organic matter by an enhanced oxidation that finally decreases soil organic matter and liberates carbon to the atmosphere, etc. At the bottom line, the process ends degrading agro-ecosystem and soil quality and fertility understanding it as the basic ability or aptitude to produce. Focusing on the opportunities, it was first clearly recognized that they always were, are, and will be, located on the future but never in the past. The possibility to increase total production and supply both the domestic and the international market was perceived by the Argentinean farmers as an important opportunity. To be able to take advantage of this opportunity, and also to be able to sustain it, it was understood that the simultaneous achievement of a higher level of productivity, profitability and competitiveness on the short run, and a proper level of sustainability -and even improvement- of the natural, economic and human resources involved in the process, constituted a must. The starting point for the new cropping/farming model have to be located on the reversion of the serious soil deterioration originated on the cropping intensification based on conventional tillage that had taken place specially during the second part of last century. No-till, the farming system introduced first in the United States in the 1960, that replaces traditional plowing and general soil tilling, was recognized and seen as the basic tool. The biggest difference separating different cropping/farming systems involves *tilling the land or avoiding tillage.* Under No Till, instead of tilling/ploughing the land, after harvesting a crop, residues are left on the field to protect the soil against erosion and to obtain other benefits. When it comes time to plant the new crop, special machinery cut a very thin groove into which the seed and fertilizer are dropped. This groove is then covered by the same machine. Weeds are controlled through the simultaneous application of herbicides and integrated weed management strategies derived, among others, from rotational principles, soil seed bank managerial strategies, allelophatic effects; etc. Similar criteria are also applied to control insects and diseases. Finally, the adoption of No Till as the general framework, and the strong development and utilization of the MOSHPA Model principles are in coincidence with Conservation Agriculture principles and represented the "simultaneous valid and realistic answer" they found to "properly satisfy" both the short, and the medium and long run necessities or model constrains.

- **The Argentinean No Till Adoption Process**

The first trials started on the seventies; however, it was not until after the end of the eighties, and beginning of the nineties, that the adoption process boomed. The evolution of the adoption process can be seen on next graphic N° 1. From a couple of hundred thousand hectares in 1990; the adoption jumped to more than sixteen millions hectares, which accounts for around 65 % of the Argentinean grain cropped area.



The drillers and planters improvement allowed to properly and efficiently operate under a no tilled and mulch covered soil condition. Among other factors, the irruption of a new generation of better herbicides and the improvement of other managerial strategies are some of the important facts that allowed the No Till adoption process to take place. However, a clear farmer proactive attitude was a key factor and allowed them to realize that the No Till cropping system offered a true possibility to simultaneously evolve to a superior cropping/farming system. This fact, definitely should be considered as one of the main driving forces that shaped the adoption process. The strong domestic and international interactions among farmers promoted by CAAPAS (American Confederation of Organizations for a Sustainable Agriculture) and developed by farmers that belongs to AAPRESID (Argentinean No Till Farmers Association) and to similar institutions created in other countries, represented a valid mechanism to keep improving, adjusting, evolving, and scaling up, the No Till and MOSHPA model principles adoption in America all, and in other parts of the world. (Peiretti, Roberto A., 2003)

- **The New Argentinean Farming Approach**

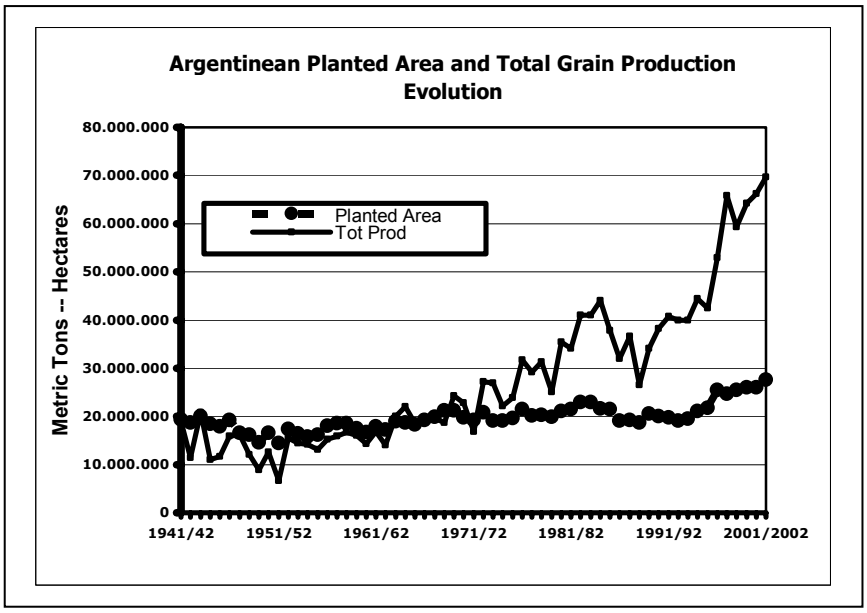
The Argentinean farmers were aiming, and found in No Till, a valid (realistic and applicable) mechanism to improve productivity and profit but at the same time to counteract the evident soil erosion (water and wind born) and degradation process, that was becoming more and more evident and worrisome. (Casas, Roberto R. 1997), (Buschiazzo, D. Aimar, S.B., 1998). From the beginning of the farming transformation process the leader farmers started to look at the soil as "A marvelous lab, and as an entity able to contain and sustain the extraordinary complex phenomenon up to the present time only known in planet earth: LIFE". Also a somehow revalorized and more realistic hierarchical array was established: "First human necessity then the environment; however, a sustainable and even improvement of the "relationship between human been and the environment", ought to strictly be considered and achieved to ensure the sustainability of the human future food provision. Based on these principles, an "evolutionary process" of the farming/cropping system was started. At bottom line the whole idea is pivoting in evolving from a "mining relationship with the environment" to a "more balanced" and sustainable one. However, it always ought to be kept in mind that this goal can only be aimed after matching the unavoidable necessity to increase total production as the only realistic way to properly supply the almost ever increasing human food demand. Also, the total production mainly would have to be obtained trough a productivity increase rather trough a cropping area enlargement. This is absolutely needed as a way to alleviate -or diminish- the necessity to keep expanding the agricultural boundaries and transforming "natural still untouched ecosystems" into agro-ecosystem. Nowadays, most of the "still untouched potential new farming areas" are located on those tropical and sub-tropical forests of the world. Within them, we can find the largest biodiversity reserve on earth, so that, the productivity increase -as a mean to increase total production- turns to be an absolutely strategic approach to keep biodiversity. It constitutes the more "environmentally friendly" way to enlarge total production. (Avery, Dennis T., 1997). Following all this principles, a deep redefinition of the pillars that were going to shape and guide the new Argentinean cropping/farming system functioning, were introduced. A more systemic, interactive and balanced approach was established as the new framework. A revalorization of the interactions in front of the individual system component effects, played an important role on the process. This revalorization, do not only relate to the agronomic, agro-ecological and technical matters if not also to the contractual relationship between land owner, farm manager and other actors involved on the complexity of the grain production and general farming process. Based on this innovative farmer attitude, and on a relevant intervention of

agronomist and other related professionals, an intensive and deep utilization of the whole spectrum of knowledge were brought into the new farming model. A somehow entirely new cropping and farming system was developed and intensively applied. The "wide scope", "open minded and proactive farmer attitude", allowed a wide spectrum of human knowledge (from agro-ecology to biotechnology, from ancestral knowledge to latest scientific findings) to be accepted, incorporated and utilized. Science, and to some extent pragmatism and empirical knowledge, were widely accepted but ideological and related principles fully neglected. A clear shift from the farmer typical figure (operating their own land with their own machinery mostly based on traditional knowledge), to a sort of entrepreneurial array that in most cases operates rented land and contracts and have custom made services of all types (from the drilling/planting operation to the harvesting and grain hauling ones), constituted an important tool for the Argentinean farming sector transformation and evolution. Within this different farming sector array, the best of each system actor, and factor, were enhanced and offered an opportunity of be fully expressed. This change yielded significant benefits from all standpoints. The transformation was very deep so that, nowadays, around sixty five to seventy percent of the grains produced in Argentina are been obtained mostly under No Till with a much higher efficiency by non-land tenants (farmers that operates rented land) that use rented (custom made) machinery and other services of all types.(Ordoñez Hector, 2003. Personal Communication). This "evolved attitude" characterized the cropping and farming system transformation. It yielded significant benefits that even with different intensity reached all the farm size and type of farming operation spectrum; from those large scale market oriented ones to the small scale mostly subsistence operations. Also, it is worth to be mentioned that leader domestic machinery factories working together with leader farmers, made a big effort and a significant contribution designing, developing and supplying a new generation of very efficient drillers and planters specially adapted to work under No Till and soil covered condition, which at the bottom line is also a key factor to be able to adopt and properly apply the No Till principles. All this transformation allowed to achieve a significant increase in productivity, economic competitiveness and sustainability to the Argentinean grain production and general farming sector functioning. (Peiretti, Roberto A., 2001).

- **About other benefits**

Under a properly implemented No Till farming/cropping operation, most of the agro-ecosystem key functioning factors are significantly improved. (Beck, Dwayne L., et.al., 1998). Both wind and water soil erosion can be almost totally controlled by the No Till approach. Mainly due to a great reduction of the water run off and water born soil erosion, the silt and nutrient contamination of creeks, rivers, water reservoirs etc, are significantly reduced and controlled when the adoption happens at a regional level and is accompanied of other actions. (Papendick R.I., 1995). Water management is also an issue largely improved. The soil water capturing and saving capacity are significantly enhanced. For a given crop, rainfall and evapo-transpiration condition, several "extra millimeters of soil available water" are added. Under No Till, and for a given rainfall and evapo-transpiration condition, according to some central Argentinean area measurements, sixty millimeters of soil available water for the crop were added. (Dardanelly J., 1998) .It was also measured a significant reduction of the amount of millimeters needed to produce a given amount of grain. At the bottom line, it means an increase of the water use efficiency by the crop. This and other related phenomena allow the cropping system to achieve a higher buffering capacity in from of the very common water stress that regularly happens under rain-feed crop condition. Related to the soil organic matter issue -specially when located on temperate climate- an increase of it is commonly found under No Till cropping operated agro-ecosystems. (Lal, R., 1998(a) and (b)). This phenomenon correlates with a soil C fixation and positively interacts and enhance many biochemical and chemical phenomena that have to be with a "better and healthier" soil and agro-ecosystem functioning. Also, the utilization of a proper crop rotation, and the principle of

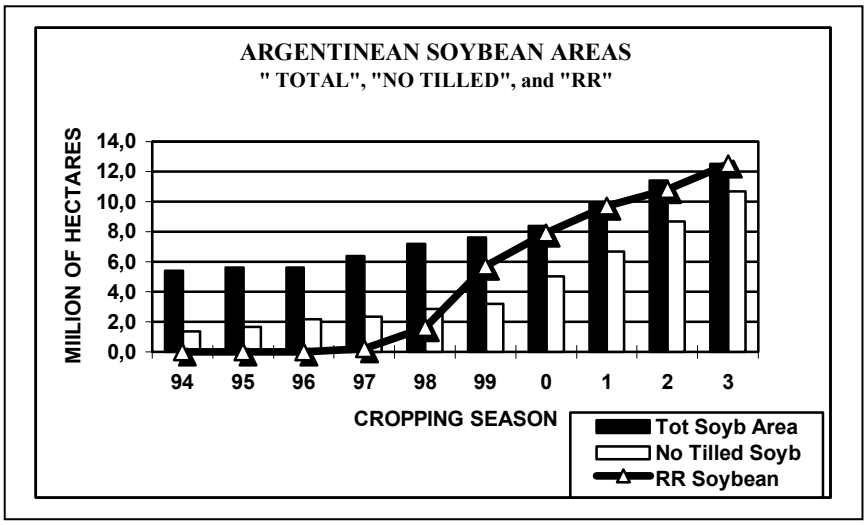
"feeding the soil rather than fertilizing a crop", greatly enhanced several beneficial biological processes. Some allelophatic effects utilized to control weeds, as well as some symbiotic interactions, as legume-rhizobium for nitrogen fixation and others; constitutes only a few examples of this type of benefic related effects. All these phenomena together with the "structural changes" and with the better economic domestic environment that prevailed in Argentina during the nineties, yielded a significant increase of the total production in a sustainable manner. Focusing on next graphic that includes the area cropped and the evolution of total Argentinean grain production between 1941/42 and 2001/02; we can see how much the total production grew especially during the last fifteen years in coincidence with cropping/farming system transformation.



Even so new areas were incorporated into the cropping system, the biggest part of the explanation for the total production increase can be found in a relevant productivity increase. The productivity increase (paired with a significant reduction in production costs of all type), allowed a profitability and competitiveness improvement, but now obtained within a sustainable frame.

- **No Till, Biotechnology and the Argentinean Soybean Case**

Agro-biotechnology that was introduced in Argentina in 1996, as RR soybean also played an important role in the process. After 1996, other biotechnological events as Bt corn, Bt cotton, and others, were also introduced and followed a steady farmer acceptance and adoption.



A positive correlation between "No Till" and "biotechnology", in this case with soybean, can be clearly detected by the analysis of upper graphic N° 3; and a kind of synergy between both strongly suspected. This synergy speeded up the adoption rate, and yielded economic and environmental benefits. The control of insects, weeds, and diseases by a combination of pesticides and biological means as biotechnology, rotations and other related strategies represents and offer us a clear example of a favorable trend that at the bottom line allows to reduce costs, and to generate farm products obtained trough a much more environmentally friendlier farming process. Furthermore, they are obtained not paying a penalty in terms of productivity (as other approaches like the organic one implies), if not with an increased productivity

- **Conclusions**

A few years ago, Dr. Norman Borlaug, the agronomist's father of the Green Revolution and Novel Peace Price Laureate 1970, stated: "One of the most serious challenges that humanity will be faced with during XXI century, will be to develop the capacity to produce enough food but conserving the environment at the same time". Most of the actions and phenomena associated with the Argentinean grain/farming production evolution are oriented to offer a "valid and realistic" answer to this challenge. Even it should not be considered as a final stage because surely it will keep evolving on the future; it clearly constitutes a proper reaction of the Argentinean farmers to both the challenges imposed and the opportunities offered by the globalization process. Until after other attempts can prove in reality to be superior to the one described in this paper, it could be consider as a successful attempt and could be followed by other farmers of different regions of the world to further improve the world grain and farming production system.

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