

## **Keynote: The Development and Future of Direct Seed Cropping Systems in Argentina**

### **Explaining some of the Economic, Agronomic, Environmental, Social and Sustainability Benefits that Support the Process**

*Roberto A. Peiretti\**

In Argentina, due to strong economics forces mainly derived from a World that quickly globalizes and interacts; the grassland farming developed on alfalfa based pastures alternated with a period of an ultra-conventional “plowing land agriculture”; was quickly pushed out by a pure cash crop agriculture. This phenomenon was/is also happening in other parts of the world.

Looking back half a century and studying the history of the Argentinean development of this process, some very noticeable things were happening. As a kind of summary of it, I tried to graphically represent and somehow summarize it in the next four graphics.

By the fifties, and for the humid and sub-humid "Pampas Region" of Argentina, equivalent to the Corn Belt and some other areas of good soils of the United States, the average land share by the main different agricultural activities were approximately as described in the following Graph. No. 1.

Around the end of the sixties, the grain and oil seed production started pushing away the cattle farming, free grazing grassland farming, that mostly had been developed on alfalfa and some other forage crops pastures.

The main reason for this to be so, was an “economic one” At least in the short-term, cash crops became more and

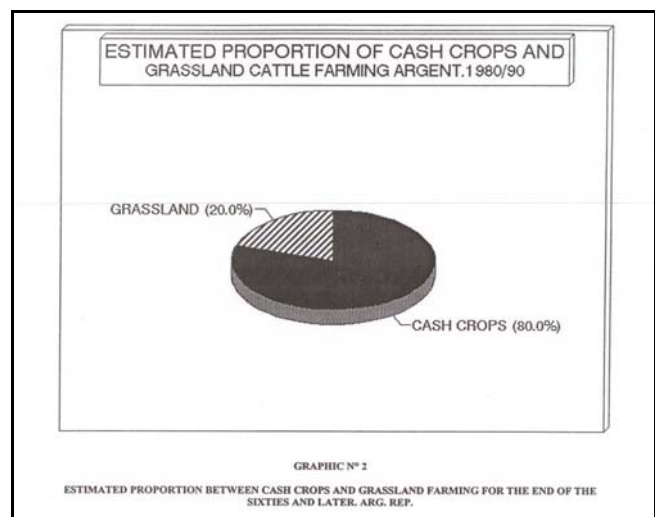
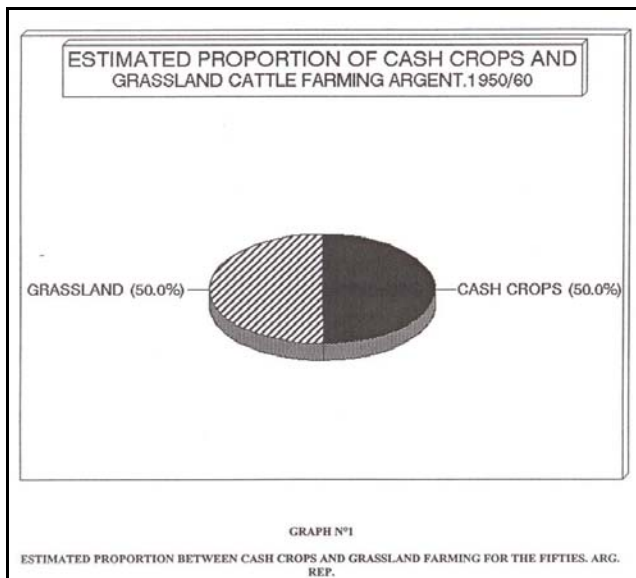
more profitable compared with cattle grassland activities.

The free grazing grassland activities normally include the cow-calf, the fattening, and dairy operations. This phenomenon ended up with a different land share for the two main farm activities, grassland farming and cash crop production.

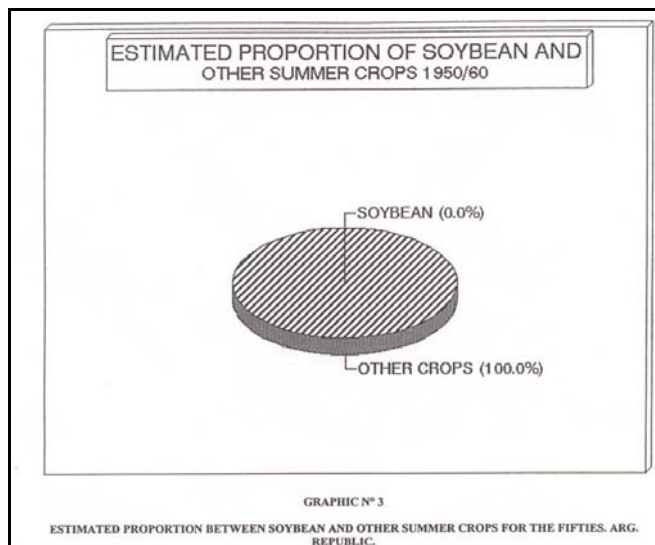
Within the cash-crops, winter wheat, corn and grain sorghum were the crops that occupied the larger acreage. Few years later soybean appeared as a promissory cash-crop and started to increase its acreage growth. Among other crops, it pushed down the acreage of corn and sorghum. At the same time soybean started to be planted as a second crop of the season, mainly after winter wheat. It showed its ability to produce under this situation and then, either as the main or as a second crop (soybean after wheat) of the season; its acreage steadily grew up and became larger.

An old farmers belief rooted or derived from the corn and sorghum crops behavior, shows that the more one moves or cultivates the soils the better the yield to be achieved. Even though they did not had a clear explanation for this phenomenon, this fact behaves as a true hypothesis, unless during those years on which rainfall provides enough water to avoid this production factor, water availability, to become an important yield level limitation.

As a matter on fact from the farmer short-term standpoint



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and for the time when the structural condition of the soils were better than it is today, they were somehow right. With an important number of soil tillage operations, they were shifting potential fertility to actual one. Chemically this is achieved through a relatively violent oxidation process that increases the availability of several plant nutrients among which nitrogen was playing a very important role. We can even consider that they were eventually “burning a great proportion of the organic matter and the fertility” stored during the geological development of the soils and somehow kept there when the soils were occupied by the alfalfa based pasture under grassland activities.

Metaphorically, our high fertility Argentinean Pampas was transformed into a big furnace that uses soil organic matter as the fuel, was utilized as an engine to power the strongly agricultural based relative economic welfare and richness of my country. This process lasted for more than half a century and was basically pushed for the government absence of a sustainability feeling while regulating and legislating the economic and social activity of the society. In a wide sense they push the farmers and the whole society to “make a living” out of the capital in itself instead of more than out of the profitability or the interest of the capital. During the extent of this period in Argentina, rather than consuming and exporting the products of a rational use of our soils, we were consuming and exporting our natural fertility and in some cases the soils in itself. Due to this attitude, our soils were suffering an unacceptable level of soil erosion and deterioration.

During this period, many economic resources were drained from the agricultural activities to the rest of the economic sectors. Successive governments, belonging to different political tendencies, were systematically pressing over the different Pampas Agro-ecosystem from an economic standpoint.

Argentina probably constitutes the only example, within the history of the free economies of the world, of what a government does not have to do at the time of planning the tax policy for the agricultural sector of the economy. Argentinean farmers never had a friendly nor a subsidize attitude from their government and from the economic

standpoint for almost half a century. Further than this, they put a differential very high economic taxation on the agricultural activities “taking off” every year a substantial part of the potential farmers annual profits utilizing them or applying them to the different destinations that they consider adequate according with the different political priorities established for each different period. Most of this policies were somehow not recognizing that after all, what they were doing were to oblige farmers to virtually sale their soil and soil fertility along with their grains, meat and milk. This mainly happens by means of a chemical (nutritional) and a physical (anthropogenic erosion) quite evident deterioration process to which our Agro-ecosystem were strongly pushed by these high economic pressures.

This type of misshape economic relationship between the Argentinean Society and its soils lasted for almost fifty years until after around ten years ago when a more wise and reasonable way to manage this relationships started to be applied.

What most of the Argentinean farmers pretend from the government policies is not a subsidizing attitude, they know that world's winds are not blowing in that direction, but only an igualitary treatment from all the tax and economics standpoints with the rest of the society. The Argentinean farmers are ready and actually, they are already doing it, to compete and completely face the free market or free trade rules.

Further than this and hopefully a great number of them are becoming quickly aware about the challenges that the present time, in a world that quickly globalizes, is over imposing to the activity. We know that everyday we should try to be more efficient to be able to keep on business. From this standpoint; a different government attitude to the agricultural activities together with the possibility of being utilizing new systems of production as the no-till one, constitute the key factors to achieve profitability within a frame of competitiveness and sustainability for our activity.

At the beginning of the soybean acreage growth previously described, from the soil tillage farmers' standpoint, this crop was mainly treated as if it were similar to narrow grass summer crops like corn or sorghum. Hence, farmers applied their belief and practical knowledge in regard to the soil tillage strategy.

Now if we look at the whole process from the soil health standpoint or even with a wider view from the Agro-ecosystem Sustainability and Health Standpoint; one thing contributed to make the whole situation even worse. Because soybean needed to be planted two to three months later than corn and one to two months later than sorghum, farmers had a lot of more time to do something either with weeds or with soils and hence they mostly cultivated or tilled them during that period of time. As Mr. Jim Kinsella said, the “Till-Gen”, is cousin and its effect shows up strongly, pushing farmers to till the land when they cannot find something else to do with it.

All these processes ended up with a very bad combination for our soils and agro-ecosystem future productivity. In some way or another, we, the Argentineans, were selling our jewels apparently without noticing or showing a conscious attitude in front of this reality.

At the same time, this process was taking place in a large area of the Argentinean Pampas including the eastern part of Cordoba Province where I live and farm. New technologies to prevent soil depletion were neither adapted nor applied unless with the necessary speed to be able to avoid the troubles that shortly we will be surely going to face with.

During this process we lost a good deal of our soil natural fertility, and hence competitiveness due to the lost of soil nutrients, soil organic matter, soil structure, soil water infiltration and hence water availability for crops, as well as some others desirable soil characteristics.

Besides the phenomenon stated on the previous paragraph; both wind and water soil erosion shortly became a very serious problem that claimed for an immediately and highly effective solution if the production system was going to keep been and improving its profitability, competitiveness, and sustainability.

Estimation for the Argentinean acreage share between the soybean and other summer crops for the eighties is represented on Graph No 4.

At the present, the economic reasons that generate the intensification of agriculture activities keep being more or less the same. So, we are somehow expecting a growth of the acreage cropped with grain and oil seed crops; more than expecting a coming back to grassland farming activities as a mean to produce economically and keep fertile soils.

When I think about the role of no-till system of production within this process, I believe that no-till is called to bring an adequate solution to overcome the problem from both the economic and the soil deterioration standpoint. Furthermore, I personally feel that today no-till is the most adequate system of production to stop soil destruction in the shortest possible period, at least, for most of the agro-ecosystem where agricultural activities are being carried out. My personal experience as a farmer, an agronomist, and an advisor gave me the chance to validate the advantages and benefits derived from the development and usage of the no-till system of production as an adequate solution to this problem.

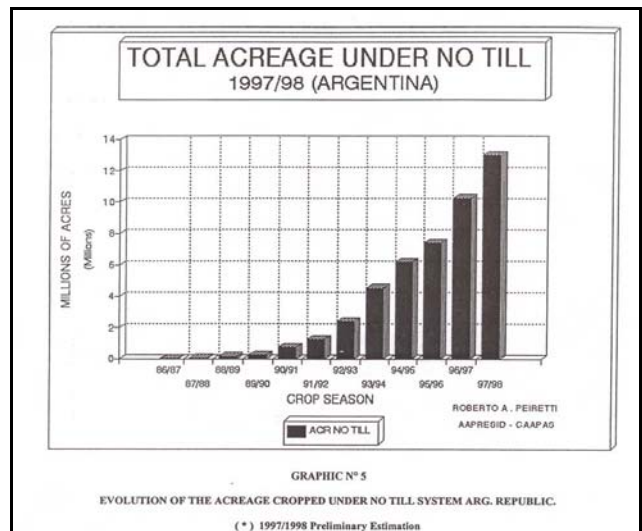
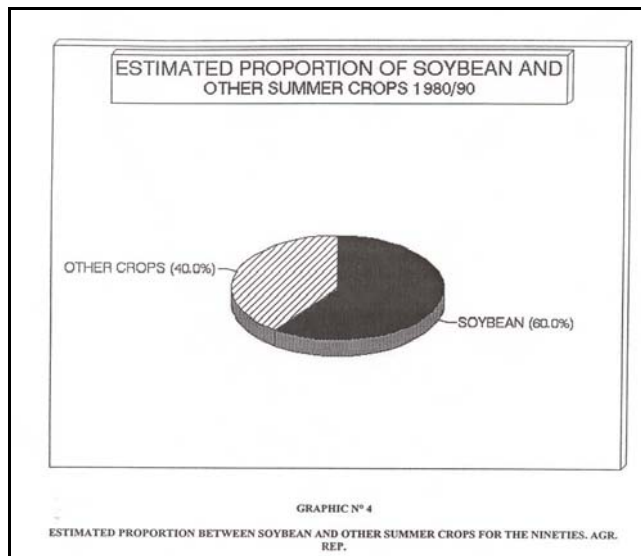
Quite a large number of Argentinean farmers became aware of this reality and started the adoption of the no-till system

of production as a way to overcome the arousing troubles they were starting to face when they try to keep farming lands on an intensive manner. Because of this farmer attitude, and of the activities of AAPRESID and in some extent Official Institutions and Universities, the Argentinean no-tilled acreage had grown at a rather high rate during last years. This phenomenon is shown on Graph No 5.

With some logical variations and approximately at the same time, similar processes were taking place in different American countries. Six years ago, and during one of the International no-till Meetings organized by AAPRESID, representatives of the different countries decided to join efforts and after some deliberations we settle down a new organization which acronym is CAAPAS, The English translation for its Spanish meaning would be: " American Confederation Of Farmers Associations for a Sustainable Agriculture ".

The major purpose of this organization is to enhance the possibilities of interchanging ideas and point of views in regard to the different problems that agricultural activities are facing across the countries members and at the same time to make a diagnosis and suggest alternative proposal of solutions to them.

Until now, CAAPAS had six ordinary and several extraordinary meetings in different member countries of this Institution. Among some other important achievements, we had and space to make a presentation at ECO 92 World Ecological Meeting held in Rio De Janeiro, Brazil 1992. We also attended as speakers and had the chance to strongly interact with farmers and to interview with National and State Ag. Ministers and other Political, Technical and Educational Authorities of different CAAPAS's members and non members Countries; among others like: Argentina, Canada, Colombia, Bolivia, Brazil, Chile, Madagascar, Mexico, New Zealand, Paraguay, Spain, Uruguay, USA Venezuela, and some others. While interacting with the different countries, among many others, we took into consideration a wide range of issues. Among others, some farm economical comparison as well as many different agronomical, technical, farm management and sustainability matters were included on the discussions.





This gave us the chance to make an analysis of the problems and of their possible solutions from a very wide based background. Occasionally because of all this activities, we concluded these meetings with documents that tried to describe the problems as well as a solution proposal. The similarities brought into by the globalization in most of the cases is a noticeably phenomenon.

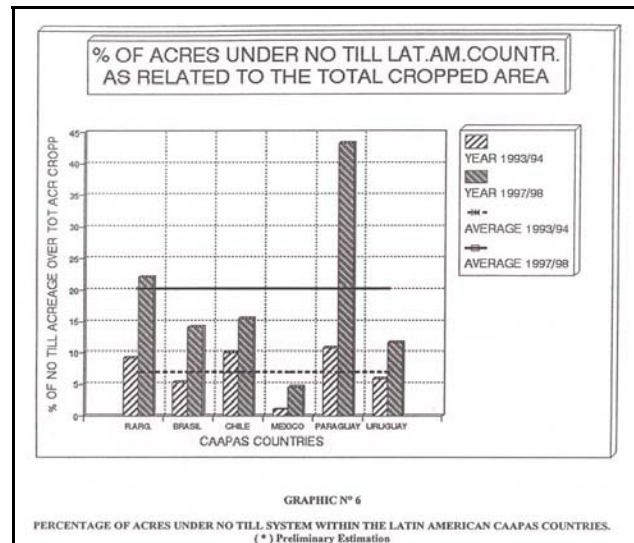
Sustainability is suggested aid considered as a must for any proposal or conclusions derived from CAAPAS activities. We in CAAPAS consider that Sustainability from its more wide sense should be "a must": more than just one option. This point applies not only for farm activities - Agroecosystem relationships if not for the whole and complex relationships between the human being and their Ecosystems that comprises the Global World Environment.

Even though the CAAPAS's farmers goals could be considered as too big or high, our thinking activities and proposals are always trying to be strongly tighten to everyday farm activities reality. We are primarily farmers and then after that we are trying to play some other roles to help the societies of the countries to which we belong. We are fully aware of the necessity of developing a Production System that should fit properly within the nowadays necessities. We know and are strongly convinced that among other characteristics for a new system to be applicable, it should be profitable for the farmer. This eventually will allow being able to compete successfully. All this should be developed within a frame of sustainability and even improvement of the natural resources involved on the process. We should be willing and wise enough-ah to be able to make the necessary efforts to achieve our goals. If we do so we are insuring to be socially and politically accepted and recognized.

Based on the information that the different CAAPAS countries had submitted to me; I built a database from which I constructed the Graph No. 6. Within the CAAPAS's countries memberships, we can clearly see a positive trend for the areas cropped under no-till in the CAAPAS's countries, is to increasing every year. I should mention that due to the lack of Mexican data for the last three years, I used the last ones that this country submitted to CAAPAS; 1995 data.

Even though the figures included in the previous graph, content a certain degree of "estimation errors"; reality should not be significantly far from them. A clear tendency for a generalized no-till System growth can be seen. Eventually it constitutes indirect validations of the fitness of the system to a wide range of agroecological, economical, and to some other kind of realities found across these countries.

I can add that while traveling these countries, I had the chance to personally visit several operative real farm situations and I had personally seen the system working for a wide range of farm situations including different kinds of general Agroecosystem limitations as well as a wide range of situations concerning farm sizes. They ranged from a couple of acres to thousands of them. Within all the situations, and due to the same group of reasons, the system appears to be equally useful, but it should be properly adapted to the local and particularly to the punctual farm situation and reality in order to be able to fully express their



advantages.

When we look for an explanation of the Argentinean no-till adoption pattern probably they went ahead and adopt the system instead of waiting for a great deal of solutions for their production problems, to be coming from the governments or governments technical or even in the academically institutions. This was especially true in the past and until after a few years ago when a tendency to reverse this situation hopefully seemed to be arousing and the official institutions as well as the Universities became increasingly involved with the idea.

When the adoption of new Systems happens without a full and complete scientific understanding and a subsequent practical validation the whole process may be assuming a higher level of risk, but, if the right choices are taken, the beneficial results are going to be achieved earlier. On the other hand, when before reaching an important level of adoption of a new system the process wait until science finish up and gets a "convenient and full level" of scientific explanations and practical validation. The adoption's risk level will be lower but the necessary time, for the adoption to reach a significant level, would be longer than in the former situation.

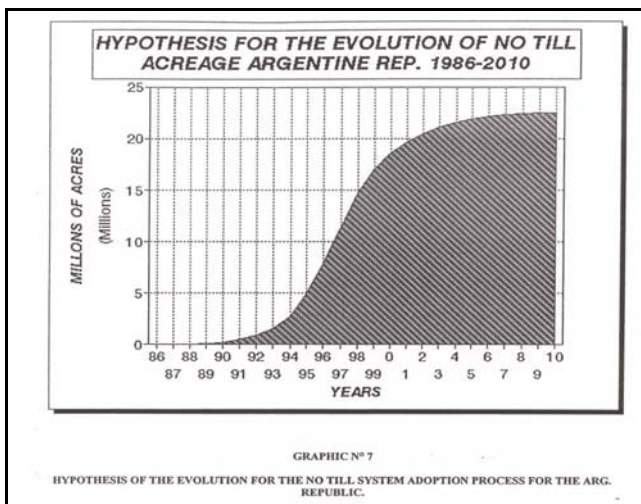
The Argentinean adoption pattern, among others CAAPAS countries ones like Brazil, Paraguay, and so on, mostly followed the first adoption criterion described at the beginning of the previous paragraph. We as farmers and as professional agronomists were able to "see the tendencies" clearly enough to begun the adoption as quickly as possible applying what we considered a reasonable adoption pattern. Been aware of the magnitude of the problem to be solved, this adoption pattern was basically designed from what we tough was an adequate balance between the risk level to be assumed and the quantity and quality of the expected achievable benefits. By this mechanism, we went ahead and while shifting to a new system and "way to produce" or to "interact with" our agroecosystem. We quickly gather all the benefits by taking the full advantages that this new way to look, comprehend and do things were offering to us.

Within the short term among other important benefits, as those I will be explaining later in this paper, we were able to

enlarge our profits and enhance our competitiveness and at the same time stopping the soil erosion and deterioration process. Within the medium and long term, our main goals are centered in reaching Sustainability in the widest sense than we can attribute to the meaning of this word.

**What May Happen in the Future with the Argentinean no-till Adoption Process?**

While looking at the Argentinean no-tilled acreage growing process and trying to figure out how the future could look, we can consider different hypothetical adoption rates. The one represented in the next graph could be considered as a reasonable one and hence as one of the possible adoption pattern for the coming years. On it, for the year 2010, it is considered that the final no tilled acreage would be occupying about half of the estimated agricultural cropped area for that time.

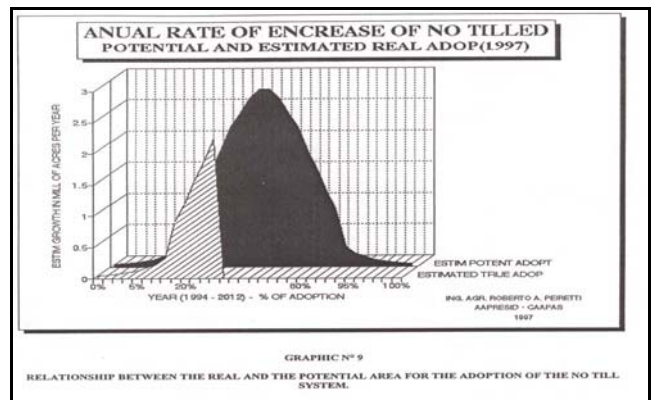
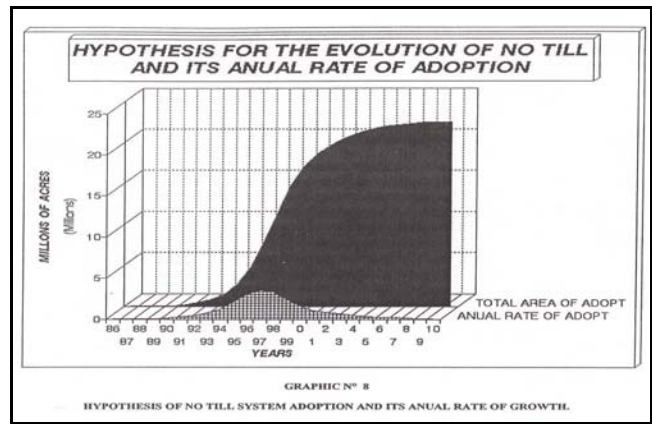


**Hypothesis for the Evolution of no-till**

The “no-till system acreage ceiling share with other production systems” assumes that 50% of the total cropped acreage of the country by the year 2010 will be no-tilled. However, taking into consideration the revolutionary technological tools that biotechnology and genetic engineering are and will be increasingly offering to agriculture, like “herbicide resistant crops”, I strongly suspect that within the coming years, we are going to be seeing a greater adoption pattern of the system. We will also see greater final acreage for the higher ceiling or for the final acreage covered by no-till system.

Even though, if we accept the hypothesis included in the previous Graph No. 8 as the true one, it makes sense to compute the first mathematical derivative and get the annual increase rate for the whole period considered by it. The referred first math derivative computation is represented in Graph No 9 and it shows us the estimation for the annual acreage increase of no-till system of production in the Argentine Republic for the period of years considered.

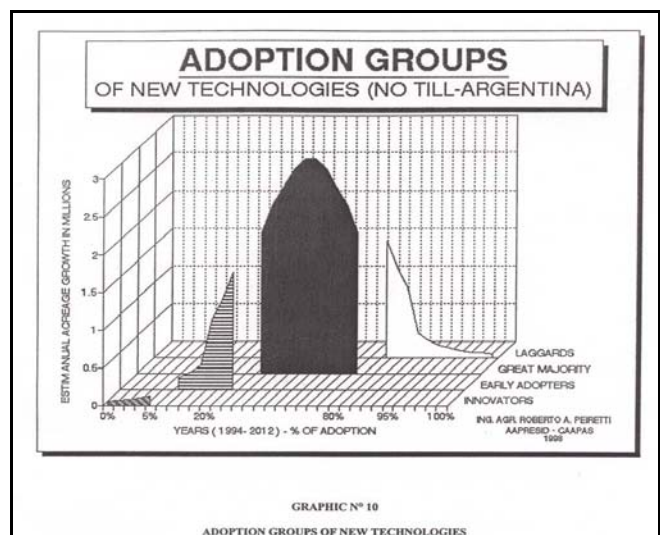
Now, if we make a “close-up” of the annual rate of adoption, we may figure out the relationship between the estimate of the true area of adoption, which is represented by the annual increase for no-till from the beginning until the present time (this figure is derived from the annual increase



of no-till cropped acreage), and the estimated potential area of adoption based on the stated hypothesis of annual increase rate expected to the end of the adoption process. This relationship is shown in the next Graph No 9.

**Annual Rate of Increase of no-tilled**

By studying this adoption process and comparing it with some other technology adoption phenomenon's; we can figure out the different groups into which they could be classified and eventually detect where we actually are in the present time. This classification is showed on Graph No 10.



## **Adoption Groups of New Technologies**

Trying to detect into which adoption group the Argentinean farmers are actually in; we can suspect that we may be entering the great majority group. Because of this, and taking into consideration the new "tools" that Biotechnology is offering us, we may expect an important increase of the annual adoption rate. This fact will surely cause a steady and strong growth of the demand of several kinds of inputs and services to adequately supply the process.

When we take into consideration the adoption status of the others Latin American Countries members of CAAPAS; with the logical differences between countries, we may expect that similar processes will be taking place.

While searching for the reasons that could explain this no-till acreage growth, we may consider the next as important ones able to partially explain the phenomenon:

### **Economic Group of Reasons: Cost Saving System**

Undoubtedly, one of the main groups of reasons is the economic ones. To clearly understand them, we can divide them into two groups a) short term and b) medium or long term economic reasons.

#### Economic benefits within the short term:

By studying this adoption process and comparing it with some other technology adoption phenomenon's; we can figure out the different groups into which they could be classified and eventually detect where we actually are in the present time. This classification is showed on next Graph No 10.

For a given agroecological characteristic and growing season, no-till System is able to increase the amount of usable water offered to the crops. Being aware of this fact and taking into consideration that for the great majority of the cropped agroecosystem, it normally represents the "first limiting production factor"; reality shows us that the system is giving us the possibility of increasing the yield within a crop season and decreasing the variability of it across the years.

For a better understanding, I will define the meaning of the cost terminology that I will be using within this paper. Fixed costs are those derived from the necessary structure for the farm enterprise to operate properly; examples are: land or other type of fixed taxation, farmer living expenses, capital interest; etc. Variable costs are those mainly derived from the necessities emerged from the operative plan like seed cost, fertilizer cost, pesticides cost; fuel costs, etc. Full time employees as well as family members involved in the operation also represent fixed costs.

Some of the economic benefits derived from the utilization of no-till System are: a better and more consistent return for the money invested in variable costs as for example "superior genetic", higher yield target fertilizer strategies, a better fertilizer efficiency use, a better return for the money invested on more effective weed control programs; etc. These advantages usually push us to look for a higher yield target keeping the risk level within an affordable one.

A noticeable reduction of the fixed costs can be achieved and constitutes another very important benefit derived from

the System utilization. This effect is mainly reached throughout a strong reduction of the necessary operative time to raise a crop properly and hence been able to operate a larger acreage with the same structure or on the other hand reducing it to operate the same acreage.

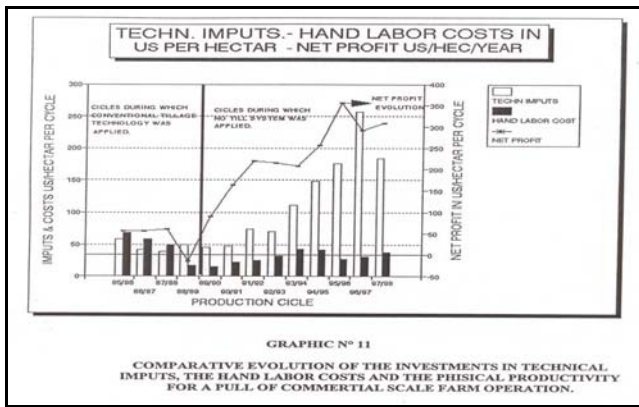
As we can preclude from the phenomena described previously, the No-till System help us to reach an improved economic performance within the short term. The System is very effective in allowing us to achieve a decreased total cost (fixed + variable) for a given level of inputs and yield to be obtained. If we look at the thing from a different standpoint, the system allows us to aim to a higher yield for a given level of inputs to be applied. Also, the fact of getting a higher yield level for a given level of inputs, or combination of them, is leading us to minimize our per unit cost or per bushel cost. Besides this and since we are getting this without increasing the risk level to be assumed, we definitely are improving or shrinking, our risk/return ratio.

This "cost reduction effect" allows us to classify the system as a "cost saving one".

Finally, and even I may be repeating some concepts I would like to try to summarize the short terms beneficial economic effects derived from the adoption of no-till System. A somewhat different way to look at the economic benefits within the short ran could be summarized through the occurrence or to the action of the two main mechanisms related to the enterprise economic growth. The first mechanism allows us to produce more units with the same level of inputs whether we are referring to the variable or to the fixed inputs. While referring to the variable inputs, the increased production or bigger productivity is basically explained for the improved water resource management that the System is offering us. This improved water management is allowing us to achieve a better Performance for the addition of new units of the inputs called variables. When we refer to the fixed inputs, the economic advantage is derived from the possibility of increasing the acreage operated with the same level of fixed cost or operational structure. This will quickly result in a significant Fixed Cost Dilution Effect that ends up with an important reduction of the per unit production cost for a given yield level. In certain cases, for summer crops, the figure for the operative time reduction, measured on the bases of hand-labor hours by acre by crop, it may reach figures as big as from 1.4 hand-labor-hours per acre per crop to 15 minutes on the same unit base.

Most of the phenomena described up to this point are represented in the above Graph No. 11. This shows a situation personally monitored by me, where we can clearly see that when we were adopting no-till as a production system, a big change of the investment share between the technological input costs and the hand-labor costs happened. At the same time, we can appreciate the big progress that was achieved concerning the physical productivity of the system. The information presented in Graph No. 11, constitutes one of the most valuable personal experience that really allowed me to have an adjusted measure of how these phenomena are working in a real production situation.





### Economic benefits within the Medium and Long Run

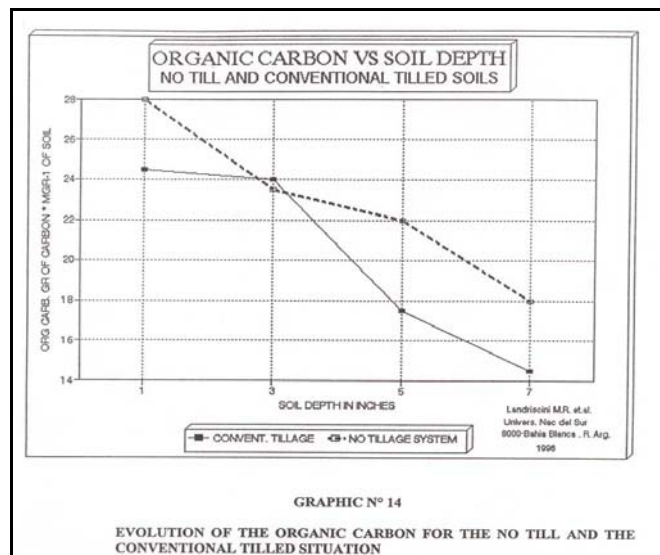
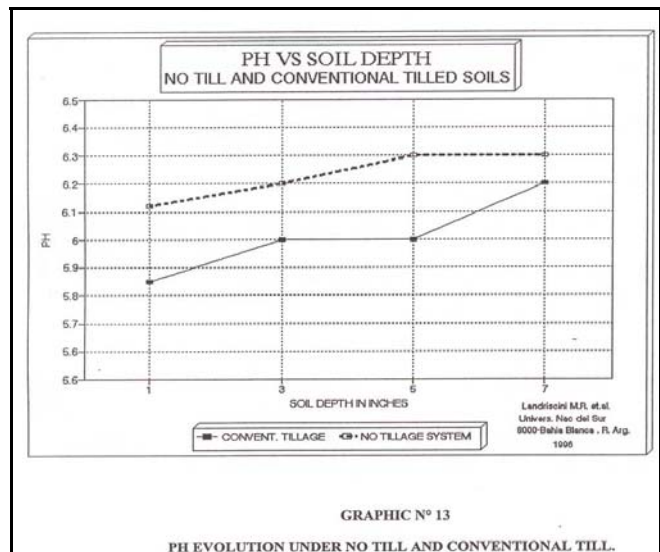
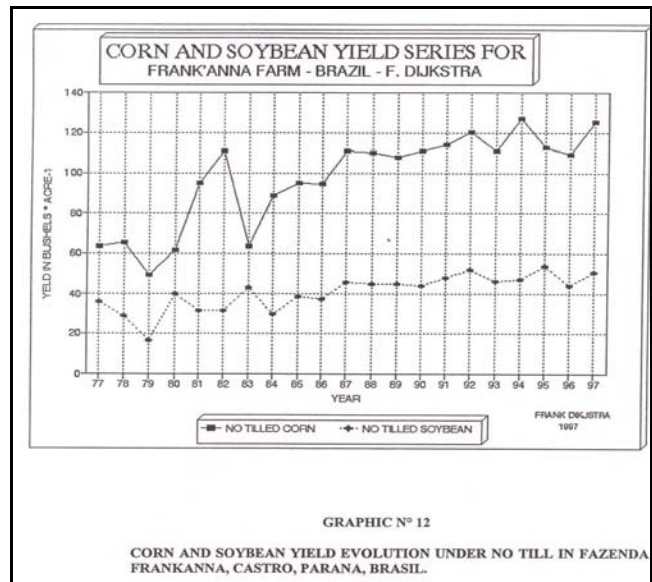
Within the medium and long term, seven years or more, other extra benefits appear. We can see the adequately summarized and represented through a noticeable yield variability reduction and an important yield increase. Totis de Zeljovich et al.; in a study that already lasted for 16 years, (INTA Pergamino R. Argentina) were comparing the evolution of the productivity as well as some chemical and physical characteristics of a soil located on the best part of the Humid Pampas Area near Pergamino Buenos Aires Province. Derived from this long term study and from some others run in Argentina and Brazil, a clear tendency could be detected for the yields to increase while at the same time the internal variability decreased. According to my personal experience and from the experiences of some colleagues, both of these phenomena of increased yield and decreased variability are increased when we move to the sub-humid and even more to the semiarid regions where water shortages are more frequent and intense.

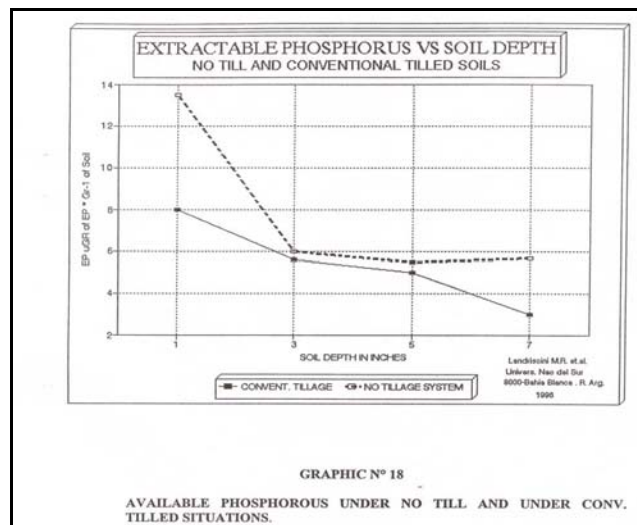
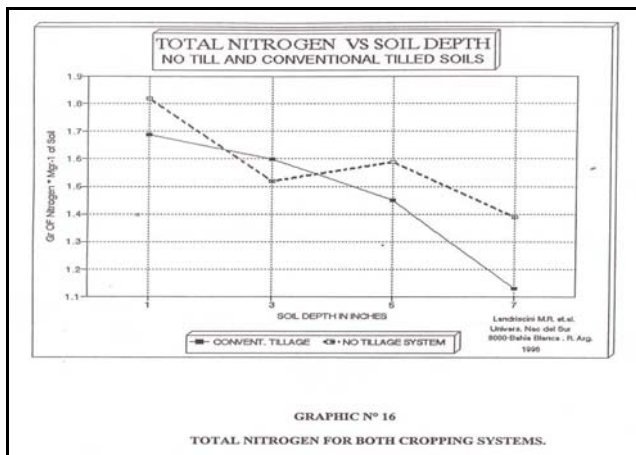
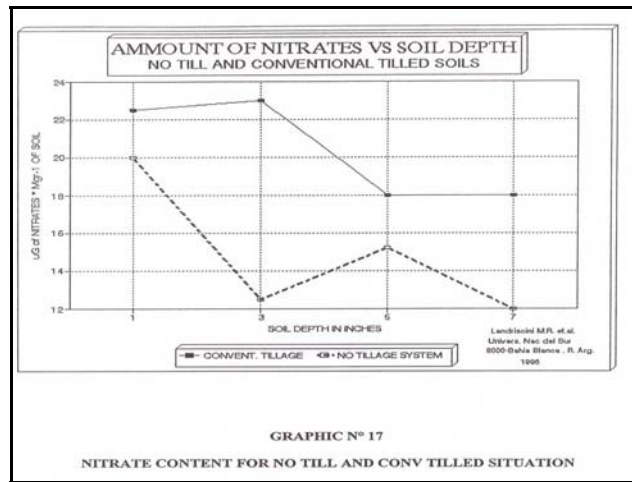
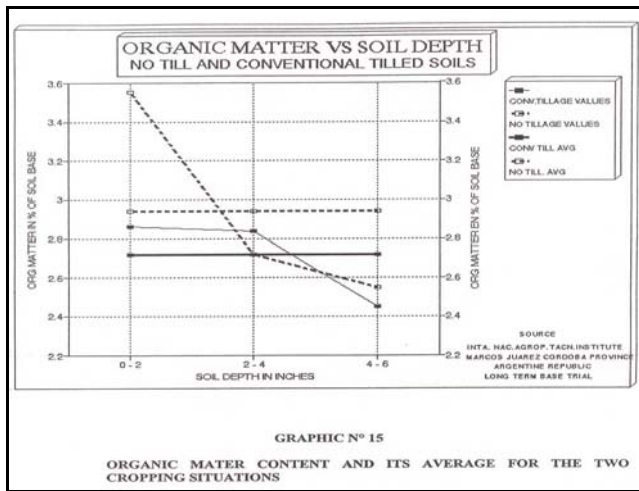
Dr Ramon Rossel and his group, while working at the Universidad Nacional del Sur in Bahia Blanca, Buenos Aires Province, Argentina Republic, were studying the comparative evolution of some chemical and physical parameters derived from the same soil cropped under the “no-till system” and under “conventional tillage”. The experience only lasted for three years. Even though the study only lasted for the relative short period of years, which eventually comprised more a short than a medium or long term, we already can see the positive trend that these key factors assumed when the soil was cropped under no-till.

Some of the results of these studies are shown in the next graphs. It is neither my intention nor the purpose of this paper to deeply analyze these figures. However, I consider that they comprise good examples for the explanations of the better soil functioning that allows us to improve the physical and economical enterprise performance in the medium and long term.

The soil pH evolution showed on the above Graph No 13, allows us to see better values for no-tilled situation. The increased amount of organic matter that no-till System allows us to incorporate to the soil and its Buffer Capacity may probably be responsible for this phenomenon.

On the next two graphs, No. 14 and 15, we can see that both the organic carbon and the organic matter were increased for no-tilled situation.





In Graph No. 15, we can appreciate the difference between no-till and the conventional-till situations after three years. Within this graph, the average organic matter content for both situations is also represented. We can see that the accumulation takes place with higher intensity on the first one to two inches of soil.

When we go deeper into the soil we are getting further from that surface accumulation of crop stover deposited there. Within this first two inches of topsoil, several new things start to happen when we leave the crop leftover to be deposited there without significant soil disturbance.

When we look at the total nitrogen, we find a close correlation between the organic carbon, the organic matter, and this total nitrogen. This phenomenon is shown on Graph No. 16.

On Graph No. 17, we can see that the nitrate content is lower under the no-till situation. To some extent, and due to a somehow lower temperature for the soil covered with crop stover, this situation can be expected for no-tilled situation. This factor or phenomenon should be appropriately managed and we already developed the technology to overcome this apparent inconvenience. The technological strategy developed to overcome this phenomenon aims more to different application timing rather than to a higher level of nitrogen application. We already have enough evidences that

it works and works properly.

For most of the agroecosystem than we have on the main Argentinean Production Area, the Humid Pampas, the climate is mild, we do not even have snow, so this process is not so strong and we feel that along the year no-tilled soils are offering us even more nitrogen than those under continuous conventional tillage.

In Argentina, there are many works in progress that are trying to increase or enlarge our knowledge concerning these aspects of the nitrogen management under the no-till system.

In regard to the phosphorous comparative behavior under both cropping systems, the results are shown on Graph No. 18. In addition, it could clearly be seen that no-till offers a more favorable condition than that derived from conventional tillage. These results contain a high degree of coincidence with those found by Brazilian researchers.

Carlos Crovetto in his Chilean Farm named "Fundo Chequen" observed similar trends and some additional findings specially related to the functioning of the soil microbiology. He was no-tilling for a long time and his practical results as well as his soil measurements are of a noticeable coincidence with those included on this paper.

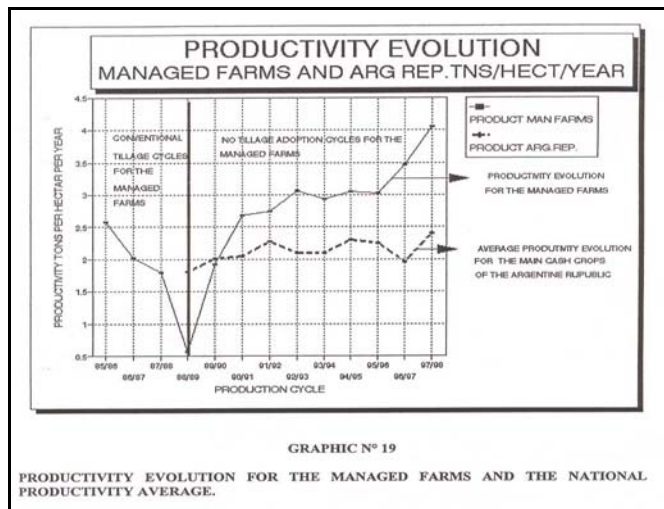
All this chemical and physical positive trends, when adequately utilized within the farm operative system,



normally ends up with improvements of the productivity and usually the economics results.

My personal experience confirms and enhances this reasoning and, unless for all the Agroecosystem evolutions that I had the opportunity to closely monitor, the more the years under no-till, the healthier and more productive is the agroecosystem. Erosion and soil deterioration symptoms completely disappeared. Instead we can see evidences of a soil that is increasing its fertility on its more wide sense.

This fact is shown in the next graph in which I include the productivity growth for a close managed productive situation. In the same graph, I also include, for comparative purposes, the average productivity of Argentina. In this way, we can compare a 100% no-tilled situation for the last three years (it started with 5% ten years ago and reached 100 % for the last three years), against a national average of a much lower no-till System usage (between 1 and 20% of the acreage for the same period).



### Productivity Evolution Water Saving System: A second very important Adoption Reason

The system is very efficient from the water management standpoint. It constitutes other very important technical advantage that no-till system is offering to us. In central areas of the sub-humid Pampas of Argentina, when adequate amounts of crop residue are kept covering the topsoil; an average of four inches “extra” usable water was annually accumulated within the soil profile. This water was measured as the extra water gathered by the no-till system while compared with conventional tillage. (personal communication, Agr. Eng. Nufiez Vasquez who works at INTA Manfredi; Manfredi, Cordoba Province, Arg. Rep. 1995). According to some other measurements made on this study, it appears to be that credits for this better water management and consequent extra water should be given to two main facts. First, an increased water intake capacity for the no-till soils, represented on Graph No. 20, and second, for a low rate of evaporation from the soil after the water was taken in. A soil well covered will enhance this second benefit, represented on Graph No. 21.

This extra water availability helps us to improve crop

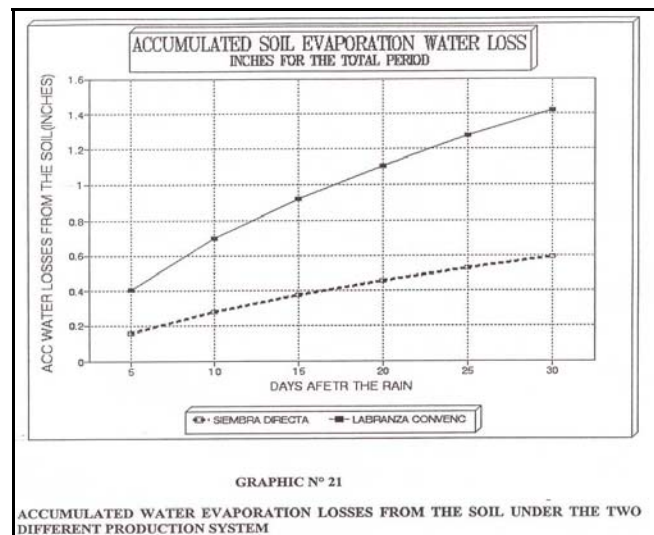
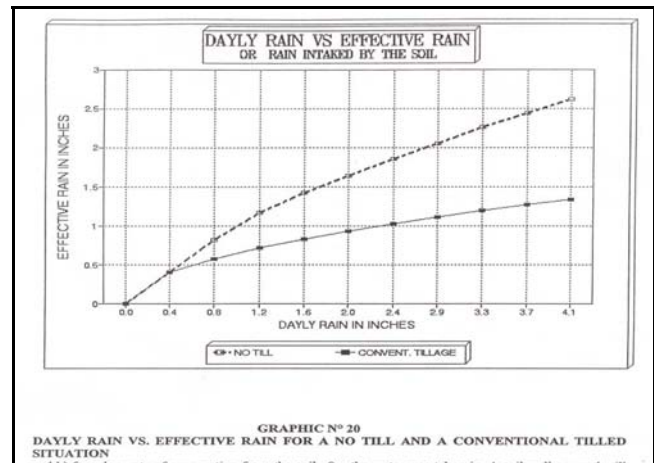
performance in two ways:

- Helping the crop sort a shortage of water availability or Water Stress Period occurring when the soil humidity is approaching the PWP (Permanent Wilting Point). I had personally experienced situations where this water help that was provided by no-till system was able to keep the crop alive while its partner under the conventional-till died.

Moving up the yield crop ceiling on those areas of production where a non-adequate supply of usable water commonly becomes the first yield-limiting factor. This phenomenon also usually happens for the crops raced under rain feed conditions on the sub-humid and/or semiarid regions of the USA (Personal Communication, David L. Shertz, USDA-NRCS).

This extra water availability, also allow us to push the agricultural boundaries and gaining new areas where either the crops didn't find enough soil humidity to properly develop or due to the same reason, yields were too erratic and hence represented a non-adequate risk level to be taken.

- Derived from a combined effect of the phenomenon described previously; and as it was said, we may find a noticeable decrease for the inter-annual yield variability



specially when we compare the yield series for different crops raised for several years under no-till and Conventional Till System of Production. This fact would be especially true and valuable for the sub-humid and or semiarid Agroecosystem.

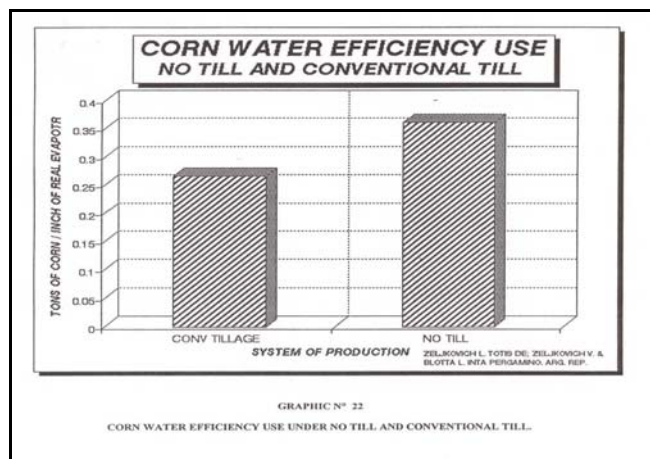
L. Toots of Zeljkovich; Zeljkovich V and Blotta Luis, worked in a long-term trial previously mentioned in this paper. They had carried out this trial at Pergamino Experimental Station of INTA (National Institute of Agropecuary Technology), located at the humid area of the Buenos Aires Province, Argentina. Republic, between 1983 and the present time. Among other important things as the yield evolution and variability, they measured the water efficiency use by corn comparing the performance while raced under no-till and conventional-tillage. They had data that showed a highly significant better water efficiency use for no-till corn than that obtained for conventional-till corn. The figures were 14.5 kg of gain produced by each millimeter of real evapotranspiration (RET) under no-till (equivalent to 0.368 ton of grain per each inch of RET water), while they only obtained 10.6 kg of gain by each millimeter of RET (equivalent to 0.269 tons of grain per each inch of RET water) for conventional tilled (plowed land). This data are represented on Graph No. 22.

Graph No. 22 shows a 37% increase of the water efficiency use as measured by the mean kilograms of grain obtained by each millimeter of water that was evapotranspired by the crop. The equivalent figures while expressed in tons of grain by each inch of water of real evapotranspiration are: 0.362 ton inch<sup>-1</sup> for no-till and 0.266 ton inch<sup>-1</sup> for conventional tillage (Table 1).

As a way to summarize the beneficial “water saving effects” that no-till system is offering to us; I would like to include and offer to the reader my most personal valuable experience in regard to the practical validation of the close

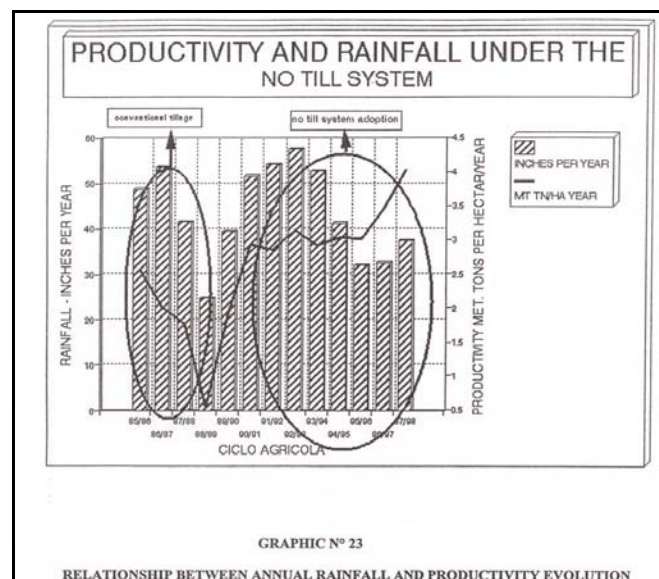
correlation between no-till adoption and the improved water management. Since we can increase the soil water intake and later on diminish the evaporation losses, when we approach the water stress limits, permanent wilting point (PWP), we can clearly see the differences while comparing with the conventional alternative. This phenomenon can be clearly seen in Graph No. 23. Again, it was constructed with information derived from my personal records collected from real operation situations for those farms managed by myself that I mentioned early in this work.

For a better understanding of the phenomenon presented in Graph No, 23, I should add that the adoption of the no-till system began during the 1989/1990 production cycle. It started with 5% of the total acreage and in three to four years ended with 100% of the acreage managed under no-till. If we look at the graph carefully, we can see that during the cycles in which no-till did not occupy a significant acreage, the productivity closely follow the rainfall pattern. When the adoption of the system was important, after 1993/1994 production year, the “system buffering capacity” shows up and allow us to overcome the troubles derived from a lower rainfall year. In this case and due to the system ability to gather more water into the soil profile, when the drought period showed up we had some “extra very valuables inches of water” down there ready for the crop to use them. Because of these, we can see that even during the last three cycles, we had a lower rainfall; crop productivity was able to keep growing up. This situation was not the same at the beginning of the series when no-till was not applied as the production system. As it was said, by this time when the rainfall was lower the productivity fell down. This graph was constructed with information derived from those farms personally managed by myself. To me the information of this graph is of great importance as a real and practical validation of those favorable soil water relationships that can be experimentally measured while studying the properties of no-till system in relation to the improvement of the soil physical characteristics.



**Table 1.**

Product System	R.E.T. (inches)	Yield (T/Ha)	Water Eff. Use (T of grain/in RET)
Conventional Tillage	19.04	5.08	0.266
no-till	19.28	6.97	0.362

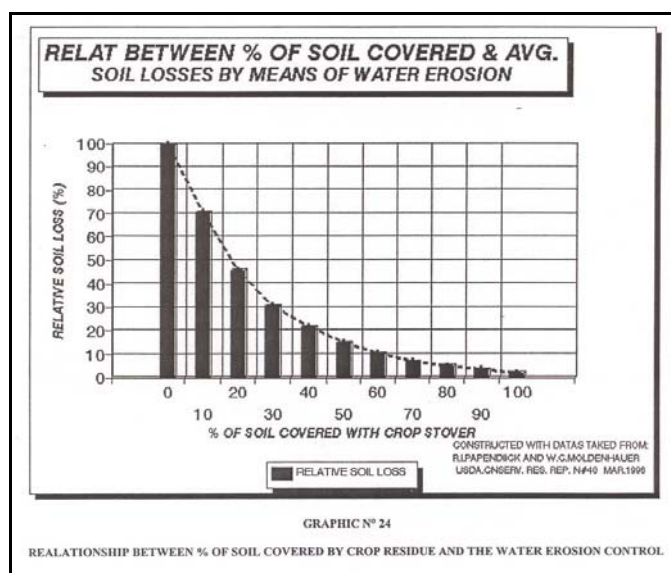


## Soil Saving System

Another important reason for adoption is that when no-till system of production is adequately applied; it normally comprises an excellent way to control water and wind soil anthropogenic erosion and hence allow the adopters to give sustainability to their production systems.

In many cases, and especially when we are cropping HEL (High Erodible Lands), for each ton of grain produced we are losing 10 or more tons of soil by means of the erosion processes. From any standpoint we look at this phenomenon it does not appear to be neither an “environmentally or socially affordable” nor an “economic price” to be paid.

Most farmers began to make efforts to adopt no-till System as a means to solve their erosion problems once they realized how “easy” it was allowing them to maximize the amount of crop stover that could be kept on top of the soil. In addition, with four tons of stover they can reach a soil coverage of 60 %, and that with this percentage they can be avoiding as much as 90 % soil water erosion. This kind of benefits can be clearly seen on Graph No. 24.



## Availability of Improved Technologies That Make the Adoption Less Risky and “More Easy”

Herbicides and other technological tools that allow using less costly and very effective weed control programs constitute an example of this phenomenon. New Biotechnological Tools like Crop Resistance to Very Effective and Cheap Herbicides undoubtedly is giving an extraordinary adequate solution to one of the major problems that should be adequately solved for anyone to be successful in raising crops under no-till System, “To Properly Control Weeds”.

Another example of the kind of factors that help to push the adoption are the availability of better fertilizer and the improved technology to apply them, the availability of better commercial “tradable” genetic, (also lately enhanced by biotechnology and genetic engineering), especially adapted to some of the requirements of no-till system. One example of this could be the better tolerance to cooler soils that have

been incorporated to certain corn hybrids developed during the last few years. The incorporation of resistance to disease, insects, and specific herbicides comprise another example of this line of action. Lately the finding of tolerance to the aluminum toxicity and the possibility of combining this genetic trait with some other relevant ones through biotechnology processes could be of great importance to allow the adoption of these new systems of production such as no-till within those “fragile” tropical and subtropical agroecosystems.

## Availability of Improved Planters and Drillers

The specially no-till designed planters and driller should be given some credits for a less risky shifting from one system to the other. Some of the new pieces of equipment have a very good performance, and eventually are able to efficiently and properly operate almost under any reasonable planting or drilling condition. This is very important issue because to get the most out of no-till System, when we adopt it we have to be able to abandon the constraint of having to get a “good seedbed preparation” to be able to deposit the seed in intimate contact with the soil. Either the planter or the driller should be able to do it for us almost whenever and wherever we decide to plant or drill again within reasonable limits.

## Good Farmers’ Common Sense

Credits should be also given to the common sense of a good farmer to detect the economic and other types of conveniences of this system of production. In most of our countries, the adoption process grown from the farmers to the government and educational and research institutions. This was so, because the farmers were the first in realizing and became aware of the necessity and the tremendous advantages of changing the way to produce. They match this necessity changing conventional system of production by no-till system.

Even though this description does not pretend to include all the valid reasons that push no-till adoption process; it surely includes many of the important ones.

The next facts comprise common concerns especially at the beginning of the adoption process when farmers are not completely convinced of the advantages of the systems and normally are looking for some valid reasons or troubles to quit the adoption and come back to the conventional situation. The following situations normally Do Not Constitute serious or real troubles unless for the most common CAAPAS Countries Farmers realities.

Even though in some cases and in the medium term some slight increases in soil bulk density appears, no significant yield problems were detected as derived from these situations. Other clear phenomenon that happens is the stratification of the nutrients with distinctive characteristics. Under no till, stratification within the first two to four inches of the topsoil seems to happen. While under conventional tillage instead of concentrating them on the surface, a tendency “to dilute” them within the first seven to eight inches of the topsoil appears as a “visible one”. Lower soil temperatures doesn’t seem to be a problem for the Argentinean conditions neither for the Chilean, Bolivian,



Paraguayan, Uruguayan, and Brazilian conditions. However, if it appears in some special situation it looks like than also could be solved by properly managing the position of the crop stover. An appropriate crop rotation strategy in many cases resulted in a right answer to this possible inconvenience. In our country, we are using no-till system from the very north in the Salta and Misiones provinces, to the southern part in Tierra del Fuego. Even though it requires that no-till be adapted to the particular characteristics of each agroecosystem, the system is working properly and offering to the adopters the chance to take the multiple advantages offered by it. As a rule, it could be said that there is not any recipe to properly adopt the system. Further than this, the use of a wide and wise based criterion is strongly needed to be able to properly adopt it. If we do so, we will be in a good position to take all the advantages that it is offering.

On the other hand, if we look for reasons that probably constitutes real adoption troubles that do not allow a faster and generalized adoption and quicker growth of the acreage cropped under no-till System, among others, we may find the following:

### **Absence of Adequate Government Policies and Valid Strategies to Strongly push the Adoption Process**

Taking into consideration the last 30 to 50 years, I personally feel that we, in Argentina, did not have adequate government policies applied to the agricultural economic activities specially if we look at it from a sustainability standpoint. We had a rather high tax pressure and an absence of enough effective lines of action tending to promote the agricultural activities from the economic standpoint; orienting and pushing the process, at the same time, only to sustainable agricultural production systems.

### **A Shortage of Research and Technical Efforts**

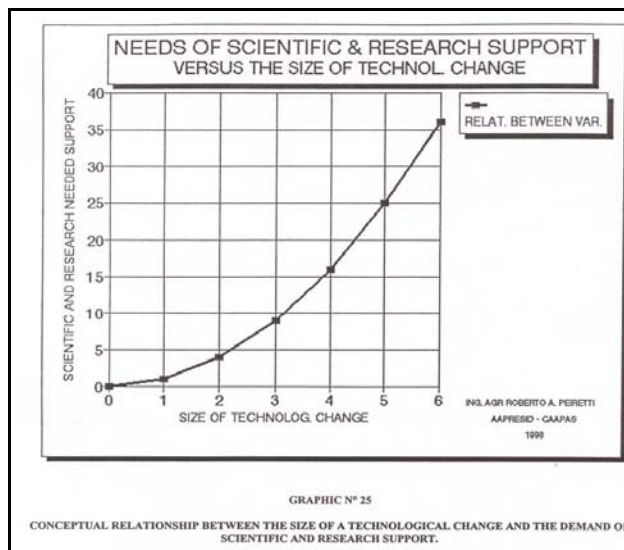
Not enough research and technical efforts have been applied to the development of technologies and systems that stopped and/or prevent the soil deterioration process by the government official experimental stations and university plans (Graph No. 25). We should never forget that the greater the technological change we are trying to promote, the bigger the necessity for research support that we need to be successful.

An absence of adequate official campaigns trying to help farmers to became aware of the necessity of adopting new technology and systems to take care of soil, allowing with this the development of sustainable agricultural production system on the widest sense. By achieving this goal, we are going to be able to keep the comparative advantages that we already have and eventually to transform them in competitive advantages.

Even though government, universities, and private institutions have carried out some actions during the past, many things should still be done and the efforts be doubled in this respect.

The institutions I represent, AAPRESID (Argentinean Association of no-till Farmers) and CAAPAS (Latin American Confederation of Sustainable Agriculture Farmers

Associations), are trying to work as much as they can in this way. Neither of them are government-supported institutions. They are supported only by the efforts of their own memberships.



## **CONCLUSION**

As a conclusion of this paper, I will add some concepts trying to summarize and wrapping up the main ideas that I tried to explain while developing it.

Before ending this paper, I would like to include some word regarding the most recent findings concerning no-till system ability to act as a carbon sequestration system. These systems, recently discovered and recognized as a property of it, will surely add credits for the Governments, educational, and financial institutions to help to the future development and adoption of it. The systems are seen as a valid way to collaborate to mitigate the carbon dioxide emissions as well as a mean to achieve the other benefits that the adoption of the system is offering from the environmental and socially standpoint. As an example, it should also be given credits as a valid way to diminish the water contamination by means of a very important and immediate reduction of the soil water erosion.

I hope that nowadays, due to different reasons, no till systems is quickly wide spreading and growing and therefore arousing as a way to temperate the serious soil deterioration process that many areas of our countries and of the whole world are suffering.

While writing this revised and newest edition of this summary, I feel very happy of being able to inform that U.S.A. through the CTIC (Conservation Technologies Information Center) had become a member of CAAPAS.

As a foundational member of this Institution, I feel very proud of being able to see that the seed we planted several years ago is growing approaching our goals. From the very beginning, CAAPAS was pushing for the adoption of sustainable systems of production as a mean of keeping the ability of our agroecosystems to remain highly productive so they can keep offering the food that humanity is needing today and is going to be needing in the future.

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