Deliverable 1.4 - Appendix A3

Conservation agriculture research in Argentina

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1. General Agro-ecological and socioeconomic context of the country.

Main Country Agricultural Features

Argentina is having different agricultural productions across the whole country area located between different latitudes, from the twenties to the fifties at the extreme south. Even so, its main one is located on the central and nearby areas, where a good combination among temperature, rainfall and soil quality is found. This area named "humid and sub-humid" only accounts for around 25 % of the total country area. The rest of it, seventy five percent of the country area, is considered "arid" or "almost arid" areas.
On the central best area, extensive grain and oilseed production along with other productions like meet of all types (beef, pork, poultry, etc.), dairy, fruits, vegetables, etc. are the mayor economic agricultural production for the central area. This area has a temperate climate with an average of eight hundred millimeters (from 600 to 1100) yearly rainfall with the rains mostly falling during the spring-summer-autumn period. Within the best part of the central rolling pampas area, water balance is normally appropriate to develop most of the mayor winter crops as wheat, barley, oats, rye, etc., and summer crops as soybean, corn, sunflower, sorghum, millets, etc. However, and as a general tendency, when we move out of the central area some climatic or soil limitations appears. Moving to east into the center of the Mesopotamic region (basically into the Entre Rios Province), soils become fine clay textured and some agronomic limitations shows up for several crops except for those like rice that normally finds a good agro-ecological condition to be raced on this area. If we move to west, north west or south west of the central region, rainfall normally decreases and soils change from a textural balanced condition (on the core center of pampas area) to a higher silt contain and finally turning to coarser (sandier). Within this so-called "marginal or limited areas" crop racing of all types, become riskier, cost higher and normally only some of them can be successfully raced. The utilization of No Till/CA principles greatly helps to "move these boundaries" and make possible the agricultural activity within these areas. Cattle grazing, mostly cow-calf operations become more frequent on these regions.

Soil Degradation and the solution provided by a new farming System based on No Till.

Nowadays, soil tillage is broadly recognized as the main cause of soil degradation and deterioration of the best agricultural areas of the country included those belonging to this central area. Soil erosion, and a decreased fertility, understood as the general ability to produce of the best farmlands, represents clear evidences of the soil and general agro-ecosystem degradation process that the Argentinean soils had suffered on the past. The soil organic matter (decrease mainly due to tillage) as well as the decrease of the soil nutrient content (due to a rate of extraction larger than that of reposition) also constitutes clear indicators of general fertility loss and agro-ecosystem degradation. Also, on the marginal drier areas, overgrazing of natural pastures contribute to the desertification and salt concentration on topsoil**. (Casas, 1997) (Sola, 1995).** Some indicators to monitor the soil degradation caused by an non-appropriate management has been described b**y (Casas, 2004)**
(Solbrig, 2002), discussed the importance than the agricultural activities had for the development of the Argentinean economy. On the same work, he also pointed and discussed about the environmental impacts of the agricultural activities and suggested a positive correlation between the level of intensification of the agricultural process and the impacts caused on the environment. He also mentioned that new technologies as No Till could mitigate or minimize these environmental impacts. This new technologies are not only friendlier to the environment if not they are able to improve the farmers economic performance. In Argentina, and following this type of principles, the development and adoption of No Till took place as a mean to overcome the serious soils and agro-ecosystem deterioration and to keep and appropriate level of productivity and competitiveness. The Argentinean No Till adoption process is described on Point 3. , and corresponding sub-points.

Especially since the beginning of the nineties, the agricultural boundaries begun to move into some of the marginal areas, so that, nowadays they also significantly collaborate to the total country agricultural production. During this period, a more favorable economic scenario created among other various socio-economic reasons by the reduction of tax pressure as well as the incentive for investment in technology, modern machinery and infrastructure. The investment in machinery during this period significantly grew and was described by some authors, **(Bragachini, 2002**).
Also within this period and following the globalization and market trends, **(Peiretti, 2001 (a)),** the grain, oilseeds production as well as some of the other types of productions, undergone a spectacular growth. In the case of grain and oilseeds, they were approximately doubled within a ten years period. Even new areas were incorporated into production, the total production growth come more than proportionally from a productivity increase than from the area expansion.
From the middle of the eighties and especially from the beginning of the nineties, a new approach to the general agricultural production process and specifically to the way of manage the soils (No till as the new operative tool and framework) was heavily promoted by AAPRESID (Argentinean No Till Farmers Association). Based on some experimental and empirical evidences some authors **(Fogante, 1992)** had summarized some of the benefits derided for the utilization of the No Till principles. Been aware of the dynamism of the process, the Argentinean farmers felt the need to overcame the economic pressures either coming from the domestic as well as from the global scenario. A paradigmatic change related to the way to understand and carry out the agricultural process was perceived as a "must". **(Trucco 2002). A** hollistic approach was suggested and utilized to develop and adopt the new farming approach **(Gadzia, Kirk L.2003).**
The Argentinean farmers understood the evolution of the No Till technology and principles as the development a new framework within which the agricultural process would be carried out. To do so a holistic and systemic approach that simultaneously enhanced the effects of interactions among system components and considered the effect of each system component alone, constituted a kind of true innovative process and leaded to the development the concept that No Till more than represents just a technology ot constitutes a system. A high degree of innovation, the practical adaptation and utilization of already existing knowledge was an important component of the Argentinean No Till evolution and adoption**. (Solbrig, 2000.)**. Also the need to innovate to be able to access to the needed paradigmatic change to evolve our agricultural system was pointed **by (Trucco, 2000)**.

Some Economic Features related to the Agricultural production.

As an average figure, the Argentinean agricultural sector participates with around 12,5 % of the Gross National Product. It supplies the domestic demand and after that it exports a relatively large amount of its production. The agricultural exports accounts for more than 50 % of the total value of the country exportations and constitute one of the main pillar on which the socio-economic development of these areas, and to some extent of the entire country, is based. **(Oliverio y Meninato 2002.)**.So, for the Argentinean economy the maximization of production within a sustainable frame represents a key and central issue and target. Some ideas and suggestion related to how to achieve and keep growing toward these goals were suggested by **(Ordoñez 2003).**

A general Country overview of the "Small-scale/subsistence-oriented agriculture" and "Large-scale/market-oriented mechanized agriculture" issue.

Regarding both, the small scale mostly subsistence oriented agriculture and the large scale mostly market oriented one (including vegetable, fruits and orchards, timber, cattle raising of all type, dairy as well as grain and oilseeds productions), it can be said that the utilization, experience and knowledge regarding CA (basically No Till) is heavily concentrated on the second category and specially on the grain and oilseeds production and to some extent on forage crops production. This is the field where we have the larger experience and can significantly contribute with our knowledge and experience.
A brief introduction to the small/large scale farming issue is included on this point.
Later, while developing each of the main agro-ecological area description, or when going into other specific points of this inventory and report, by default -and unless the opposite is pointed-, the bibliographic references, the empirical observations and their conclusions; etc, will be related (or derived) from large scale

commercial agriculture cases. However, and specifically when related to the study of general principles and No Till general functioning, some of the research reports and its conclusions could be equally valid for both groups; small scale and large scale one.
Also, when specific information exist for an specific country area into which it will be divided on point two and sub-points, it will be included on the corresponding point and sub-point; otherwise the information will be included on some of the general points.

"Small-scale/subsistence-oriented agriculture"

As it generally happens in the whole country, to some extent this type of agriculture is always present at some level. In Argentina, the farmers belonging to this category regularly are dedicated to produce grains, vegetables and fruit crops as well as racing animal of different types, mostly for their own consumption. They represent a small proportional area (to that utilized for agricultural activities on the whole country) and are also of small economic significance when compared with that of the large scale one. There were some special programs oriented to promote the No Till/CA principles among the small scale mostly subsistence oriented farmers. In some cases they were oriented to promote the production f some specificities. They had achieved variable level of impacts according to the areas and cases. Mainly due to the scarcity of easy to access reports related to the information, description and results of these type of programs, and also because they are beyond the possibilities and scope of our report, we will not be including information on this area.
Even so, if they exist and can be detected, they will be mentioned while describing any of the country regions where they take place.
As well, it is to mention that INTA (National Institute of Agricultural Technology) had some special programs oriented to this farmers category mostly on his urban or peri-urban agriculture category mostly oriented to the cultivation of vegetables on small pieces of land.

"Large-scale/market-oriented mechanized agriculture".

This farming category is largely responsible for most of the Argentinean Agricultural production. Their production, rough or processed, are of such economic importance that after heavily collaborate to supply the domestic demand the left over is exported and constitutes at least fifty percent of the annual country exportations value. Within this category is where our largest experience on No Till/CA had been developed and keeps been developed at the present time. Most of our contribution to the KASSA program that is offered on this inventory belongs to this category.

2. A more detailed Country Areas Description
Main Agro-ecological areas of the Country.

From the agricultural standpoint and due to agro-ecological and socioeconomic reasons as well as for practical and production purposes, the country can be divided into the following areas; namely:

2.1. Central Area or Humid Rolling Pampas.
2.2. Central West, South West and North West or Sub-Humid Semi-Arid Pampas.
2.3. North East and North West.
2.4. South East of Buenos Aires Province area.
2.5. Southern or Patagonian area.

A more detailed description of the country regions and their particular characteristics specially regarding to the deterioration process, can be found on the introductory chapter of the book "El Deterioro de las Tierras en la República Argentina**" (Sola, 1995).** As well, on this book a comprehensive discussion of several issues related to both the deterioration and management improvement toward a more sustainable use of soil and water can be found.

2.1. Central Area

The core part of the central area is located between the 30 and 35 degrees of southern latitude and the –60 to –65 western meridians and has a mild climate and a suitable rainfall and water balance for racing rain-feed summer and winter crops.
On this central area (humid and sub-humid pampas) agriculture started more than a century ago. From the Agricultural Production standpoint, this central area is the most important one. On this area is where the development of crop production happened on the past when agriculture and grain production started to be developed around hundred and fifty years ago. It keeps been the most important production area of the country at least for the commodities grain-oilseed and to some extent for animal production of all types. Also fruit in some specific areas and vegetable mostly around big cities are important.
A comprehensive description of the characteristics of the whole country and its eco-regions as well as climate, soils, infrastructure, and economic agricultural production information can be found at **(Schnepf , 2001)**.

2.1.1. Small Scale/Mostly Subsistence Oriented Agriculture

On the north east of the central area of the country, more precisely on the northern part of Entre Rios Province, where soils are generally heavy clay content a mixed private and official pilot program was run aimed to improve the production carried out by small farmers of that area. The program both attempts to improve grain yield for certain important crops for that area as corn is, as well as, to improve forage production on alfalfa-based pastures. Even no formal papers were written on this program some information is available at sdrob@idi.com.ar or at www.aapresid.org.ar

2.1.2. Large Scale/Market Oriented

In Argentina the largest proportion of the agricultural production is currently generated by large scale/market oriented mechanized agricultural operations mostly located on this area. Even so, some other relevant and special productions as wine, some vegetables and fruits, sugarcane, cotton, and several others and in an important proportion are been produced outside this area.
Most of the papers, findings and empirical experience that is inventoried and commented on this work, will be related to this type of farming category and to a great proportion related to this central or near by areas.
Large scale/market oriented mechanized agricultural operations is very strong on this area central area. Indeed, within this area mostly occupied by the so-called “Humid and Sub-Humid Rolling Pampas”, the great majority of the empirical and scientific knowledge related to No Till was generated. Most of the information offered on this report (before and after this point), unless is indicated other region, is originated and related to the so-called central area and for this type of farmers (large scale / market oriented). However, if some relevant knowledge originated in other areas is detected, it will also be considered and included on the inventory within the corresponding point.
Also this area -and for this farmer’s category- is where new technologies normally started to be developed and used to later be widespread or irradiated to other parts of the country. On the past, and for around a century, the most common activity on this area was to rotate pasture and grain-oilseed production based on conventional plough based agriculture. Cattle (mainly but not only beef if not also dairy and other species like pork, lamb etc.) production was largely based on free grazing on artificial planted pastures (mostly based on alfalfa - Medicago sativa -). Regarding the grain and oilseed production, the most important crops were wheat, oats, barley, rye, flax etc. during the wintertime and corn, sorghum, sunflower, millets and others during summer.
During the last thirty to forty years’ grain and oilseed production started to growth and largely replaced pasture grazing for any purpose on this area. Specially the cow-calf operation and also to a large extent the cattle or other animals fattening based on grazing over cultivated pastures was moved to the lower rainfall areas on the west, south west or northern part. Following and international pattern, lately some feed lot for cattle fattening as well as some other intensive animal production as intensive dairy, poultry, pork, etc. were

growing in (or near) the best grain production areas of this central as well as in some special "spots" on the other areas.

No Till development and adoption on this area

Argentinean agriculture was based on conventional (mainly plough tillage) until after the middle of the eighties when No Till started to be adopted. At the beginning of the seventies the first very limited No Till trials were carried out. Even so, and mainly due to severe limitation on the availability of appropriate planters and drillers (as well as of other critically needed inputs as proper herbicides and specific No Till knowledge) it was not until after the middle of the eighties when No Till adoption started its growth first on annual crops and later on cultivated pastures.

Even for the last thirty to forty years and for the best part of this central area straight grain production was gradually replacing the "old traditional grain-oilseed crops / artificial pastures rotation", some authors attempted to keep this rotation but now under No Till. This model was developed and described by authors that worked on it. **(Trossero, 2003).(Alvarez, 2003).**
For some lowlands areas of this central area, No Till principles were also utilized to improve the forage-crop production for cow-calf operation. **(Ossana, 2004).**
Also across all the different agro-ecological areas of the country the No Till system principles, were utilized to improve the quality and carrying capacity of the pasture of both for the best country soils and areas as well as for those marginal quality soils and agro-ecosystem with restricted quality. On this type of agro-ecosystem, as for example on the north-east part of the central area -where a considerable amount of low, flooded and salty land are present-, some authors had developed technologies that based on No Till principles are useful to improve soil functioning and to increase forage production either based on the introduction of non native species or in enhancing the production of natural ones. **(Rey, 1999), (Rey, 2001), (Tamagnini, 2001), (Tomassone, 2003, (a)), y (Tomassone, 2003,(b)).**
Lately, Some AAPRESID publications prepared in coincidence with the organization of some specific meetings, had covered these No Till- Pasture management, beef and other animal production issues on a comprehensive fashion, including a significant number of results and conclusions derived from the work and observations of many authors. Trials, experiences, conclusions derived from the work of both researchers and farmers. Twenty-two authors had reported the results of their experiences as well as their empirical observations and conclusions on **(AAPRESID, 2004(a)).** Among others -not mentioned in this inventory-, AAPRESID had published extra materials covering the same issue as **(AAPRESID 2004 (b))** where fifteen authors had reported.
On the eastern part of the Central area, Entre Rios Province where soils are fine textured (high clay content) and rainfall rather intense during the spring, summer and autumn time, water soil erosion was intense under conventional plough tillage. On these areas, No Till was introduced with a high degree of success**. (Culasso, 2001)**

2.2. Central West

Following a kind of circular pattern and moving west, northwest and southwest around the central area described on point (1), we will find a lower rainfall area into which, the western the drier. Also soils generally become first higher in loam contain and the sandier and even coarser. While moving west they agro-ecosystems become less appropriate for rain-feed agricultural activities. However, within the area and both near the central (Cordoba and San Luis mountain places as well as on the Andes mountain region as the San Juan, Mendoza and some other regions) several microclimates can be found where special crops and agricultural activities can be successfully developed. Within the area, large and extensive plains with natural xerophytes vegetation are found. Normally they are utilized for extensive cattle grazing on caw-calve operation. Also either by rain-feed on the best areas or by irrigation where water is available, important fruit and vegetable production is present. In some special spots also some irrigated grain and oilseeds production can be found. It is worth to mention that most of the country grape production and wine industry is located on

this area specially in San Juan and Mendoza Provinces with some growing importance in some northern provinces as La Rioja, Catamarca, Salta and Jujuy.
This area cannot contribute with much No Till experience, however lately some trials are been developed on it. The comments of these experiences are included on point 2.2.2.

2.2.1. Small Scale/Mostly Subsistence Oriented Agriculture.

The general scenario is similar to that described for the central area.
Mainly due to the scarcity of No Till programs directed to this type of farmers, as well as to the difficulties to access to the eventual reports, the description and results of these types of programs are beyond the possibilities and scope of our inventory and hence will not be including information related to this issue.

2.2.2. Large Scale/Mostly Market Oriented

Extensive beef cattle production is been developed by this farmer's category and common in this area. In some cases it is developed on improved artificial pastures and also on a rangeland fashion grazing natural forages. No till principles are utilized for the improvement of natural pastures on this area**.(Aguilera, 2001),(Diaz-Zorita, 2001). (Gomez, 2001).**
Also on different regions within this agro-ecological and farmers category, and where the rainfall is not extremely low (normally the eastern part of the area) No Till is gaining area and been utilized mostly to raise summer crops as soybean, sunflower, sorghum, etc. Also where water is available, these crops are been raised under irrigation and No Till principles applied while looking for saving water and for a better agronomic performance. Even so the commonly low price that the Argentinean farmers get mainly due to the absence of subsidies and to a heavy taxation on production, regularly limits the production on this area.

2.3. North West (NOA) and North East (NEA) Regions

These areas are located northern than the 35-degree southern latitude. The Climate varies between subtropical dry to sub-tropical humid. The rainfall ranges between as high as 1800 mm to as low as 500 or even less. Soils vary also from those deep red clay soils to those sandier and coarser. The water balance is very frequently non-appropriate for annual crop racing.

2.3.1 Small Scale/Mostly Subsistence Oriented Agriculture

On these regions of the country some small farmers communities may be more frequent. Even so the general situation regarding the promotion and adoption of No Till/CA principles is more a less similar to that of other regions of the country. Within this NEA (North east Argentinean Region), some INTA (National Institute of Agricultural technology) programs directed to promote No Till principles adoption among small farmers were developed on the Corrientes Province. They were partially successful and to some extent introduced the principles of No Till/CA among those farmers. The strategy was based on stressing the importance and facilitating the access to a proper: crop residue management, the utilization of cover crops, crop rotational strategy and the adaptation of animal draft no till machinery**. (Lieger, D. y Kurtz D. 1998)**

2.3.2. Large-scale/market-oriented mechanized agriculture

The NEA region regularly has a variable and mixed soil quality. To attempt to better allocate the different soils types to the activity that better fits them, a No Tilled combined grain-oilseed production with pasture and rangeland management for meat production (beef in this case) is very common. For a large scale farming category, there is an interesting paper that describes the case and summarizes the advantages of No Till as the framework to enhance the performance of a combined activity typical farming enterprise of this area**.**
(Goujon, 2004).

Besides adopting No Till principles into the already cropped area of these regions, during the last fifteen years approximately one and a half to two millions hectares of mostly degraded forest were cleaned and under No Till incorporated into the agricultural circuit as pasture lands or as grain and oilseed production. Due to some economic and agronomic reasons, cotton had decreased into the area and soybean, sunflower and to some extent wheat, sorghum and corn increased. Also in some cases, natural vegetation is kept and pasture are improved by air-seeding new forages well adapted species like Panicum maximun (Gatton Panic). Also in the area some other strategies oriented to achieve a pasture renovation and improvement by applying glyphosate and top dress seeding (generally air-seeded by plane) was successfully developed and utilized. Some of these experiences were inventoried on section 2.1.2.

2.4. Southern part of Buenos Aires Province

Into this area we can find the most important wheat production area of the country. The soils are good with a balanced texture and good organic matter content. The rainfall is appropriate especially on the central and eastern part of this ecological region. Temperature is somehow lower than in the Northern and central area of the country and solar irradiation is good. Cattle grazing wheat and other winter crops as well as sunflower and potato were always important production for this area. Even so, and due to the introduction of some shorter maturity genotypes, the area cultivated with corn and full season soybean grew during the last fifteen to twenty years. To some extent, and especially during the last five years, No Till principles were adopted on a growing area.

2.4.1. Small Scale/Mostly Subsistence Oriented Agriculture

The general scenario for this farmer's category is similar to the scenario of most of the other country areas. Our inventory will not be covering this point.
Mainly due to the scarcity of No Till programs directed to this farmer's category on this area, the inventory of them is beyond the possibilities and scope of our inventory and report for this area.

2.4.2. Large-scale/market-oriented mechanized agriculture

Large scale/market oriented mechanized agriculture is the absolute predominant farming profile of this area. Even later than in the central area, No till was introduced to the area with a great degree of success. Also on the southwestern part of the area where rainfall is lower and soils sandier and lower in fertility, No Till was also introduced yielding significant benefits**. (Puricelli, y otros, 2001).** Soybean as double cropping after wheat is successfully raised utilizing No Till principles. **(Sanguinetti, 2004)**.

2.5. Patagonian area

On this extensive southern Andes Mountain Region of around 600.000 square kilometers, rainfall is very low (ranging between 100 and 400 millimeters) except for the western part of it constituted by the Andes Mountains where some different ecological regions can be found. On this mountain part, the rainfall is higher and the vegetation entirely different. Timber production is the most representative one as well as some limited valley areas where better pastures and some other specific crops are developed. On the northern part of this Patagonian mountain area into the Rio Negro Province, fruit production is very important for pears, apples and some others. On the non-mountain area, sheep and lamb production were and keeps been the most common one. The general carrying capacity of the area is normally very low and also normally this natural rangeland pastures were overgrazed. The process leaded to an intensification of the soil erosion and degradation with a general deterioration of the agro-ecosystem characteristics. The improvement of the pasture quality was attempted introducing some No Till principles. Even the general agro-ecosystem characteristics are extremely limited some of the No Till principles were adapted and utilized with variable but promising results. In some trials the addition of fertilizer allowed a large increase (more than double) of the total dry matter production. By both top dressing or regular no till drilling, seeds of both natural and introduced forages species were utilized with a variable degree of success. It varies according to the region

and the particular weather and rainfall conditions of the year. In general we can say that the technology is promising to attempt to stop wind erosion and increase the carrying capacity of those agro-ecosystems. More studies are needed to further explore the issue. **(Becker, J.F. 2001).**

3. Conservation Agriculture

Taking into account the Argentinean socioeconomic and technological reality, and while aiming for the No Till/CA knowledge to be inventoried, we will be necessarily paying attention to the empirical and scientific knowledge mostly generated on the central area of the country. On it, the development of No Till started on the past as well as the development of knowledge by pioneers farmers and institution as AAPRESID (Argentinean No Till Farmers Association). Some of the new challenges to which No Till/CA development is faced nowadays, are discussed by **(Romagnoli, 2003).**

3.1. Principles

No till, constitute the operative tool to achieve the goals of a CA. The No Till principles gives shape to the general framework within which the agricultural process is carried out. No Till/CA has to be understood as the general frame or scenario or system within which all modern technology based on science and in knowledge and not in ideologies, are utilized as a way to achieve the MOSHPA model goals: a "Modern Sustainable High Productive Agricultural Functioning". **(Peiretti, 2004)**. The same author discussed the issue before. **(Peiretti, 2001)**. Also several other authors had considered and discussed the issue**. (Derpsch, 1997), (Romagnoli, 2003).**
This new Farming System represents a truly new way to understand and carry out the agricultural process. To achieve its goals a paradigmatic change is absolutely needed. Among other important changes we must understand that we must review and reshape the way "we relate" with our agro ecosystem components. We should abandon the idea of "mining" the natural resources involved on the agricultural process and evolve to a new one based on a "sustainable and even improvement" relationship with them.
Marelli, 1996, from INTA (National Institute of Agricultural Technology), had reported different kind of positive impacts related to soil conservation, water infiltration and crop yield, derived from the utilization of No Till/Conservation Agriculture Principles.
-Romagnoli, Jorge. 2003. Nuevos Desafíos de la Siembra Directa. En "Rotaciones en Siembra Directa". Revista Técnicas de la Asociación Argentina de Productores en Siembra Directa. Diciembre del 2003. Págs. 5:7. AAPRESID Calle Paraguay 777. Piso 8. Of 4. 2000 Rosario. República Argentina.

3.2. Description of the system and its components

Under the AAPRESID view, the No Till System is understood as the general framework that defined by the contribution of both scientific and empirical knowledge, constitutes a proper scenario to achieve the MOSHPA (Modern Sustainable High Productivity Agriculture) model goals**. (Peiretti, 2004).**
The No Till system is based on several pillars. Among them, the most important ones are:

***Absence of soil tillage**
***Soil covered by crop residues**
***Crop Rotation**
***Balanced "Soil Nutrition" as a mean to achieve the proper crop nutrition**

The absence of soil tillage is one of the main features (and pillar) of the no till system that establish a clear "Edge Line", "border line" or "boundary" that separate this from other conservation farming approaches. This and some other main differences were pointed by **(Peiretti, 2001 (b))** already referenced on this inventory.

The absence of soil tillage and the consecution and maintenance of mulch covering the topsoil and constituted by the crop left over, has a high relevance for a proper No Till system functioning. Both strategies are

responsible for the achievement of several system benefits; from the improvement of water management to higher, less variable and sustainable agro-ecosystem productivity. Besides these benefits, No Till significantly helps to reduce the amount and speed of water run-off diminishing the erosion forces (both for water and wind born soil erosion) and at the same time diminishing the sediments and solutes that are regularly carried on water run-off. Also it creates a much more favorable environment on those first millimeters of the soil profile where a large amount of chemical and microbiological activity takes place. The presence of Glomalin, a stable protein that is a byproduct of a special type of fungi, is largely enhanced by the no till environment (Wright**, 2001).** Also she reported a strong correlation between the soil glomalin content and the soil resistance to erosion by means of a higher stability of soil aggregates.

Under the No Till System Principles, crop rotation is understood as more than a sequence of crops. The issue has a great importance for a proper medium and long tern agro-ecosystem functioning and improvement. Under this scope, a large number of interactions between rotational and several soil and agro-ecosystem functional characteristics were detected. The importance of Crop Rotation to achieve a better level of sanitation for the functioning of the agro-ecosystem under No Till was discussed by **(Carmona, 2003)**. Also on the same paper the author discuss some of the barrier for higher rotation intensity. The value of crop rotations for a proper No Till System functioning was extensively discussed. On **(Peiretti, 1998)**, among others issues as rotation intensity, yields, economic results and others were discussed. The author concluded reinforcing the principle crop rotation definitely represents one of the pillars of the system.
The generally positive impact and synergy between the cover crops and the No Till benefits were analyzed by **(Ruffo, 2003 (a))**. He went deeper with the analysis considering different aspects of the possibilities of this technology for the Argentinean agro-ecosystem characteristics and he concluded that cover crops have a large potential to be incorporated to the crop rotation scheme of the Argentinean pampas agriculture and both improve sustainability and profits. However, the necessity to carry out more research on the issue was pointed by the author. **(Ruffo, 2003 (b))**.

Regarding the "soil nutrition" principle, it should be understood as a more evolved approach to the crop fertilization issue. This principle takes into account a more systemic approach and considers the interactions among soil chemistry, soil biology, soil organic matter and structural properties, nutrient cycling, rather than just the addition of nutrients to a given crop. Some No Till long term studies **(Gudelj, 2002)** had been carried under this approach. On these sixteen years long term study, crop performance and yields, as well as, several soil fertility indicators were monitored and reported. Two different soil managements were studied; combine tillage (a combination of No Till and reduced tillage) and straight No Till. The experiment was located on a typical Argiudol of the humid part of the Central Pampas Area of Argentina. Besides several other conclusion they stated that the yield for the crops was at least equal for the "Straight No Till" treatment when compared with the one that only No Tilled some of the crops of the rotation. The average yields obtained on both treatments were by far higher than the general average crop yield for the commercial crops developed on the same area that only partially utilize the No Till System Principles but not under the systemic approach. The results gave an idea of the great potential that the proper utilization of the No Till System Principles has to increase crop yield.

3.3 Scientific and Practical Result

A considerable large number of scientific and practical results derived from the utilization of the No Till/Conservation Agriculture principles had been reported in Argentina. For a better and easier inventory of these issues, they will be reported following the different thematic areas**. (Sub-Points 3.3.1 to 3.3.6).**
Regarding specific crops information, AAPRESID had published a large number of specific crop magazines reporting the results, findings and conclusions of several experiments and farm trials conducted by the technical AAPRESID staff as well as for AAPRESID members on their own farms Also, these results regularly are extensively discussed during several specific meetings and crops symposia organized and held both along the year and during the AAPRESID main annual conference. On **Annex I, II and III,** attached at the end of this inventory, a list of the AAPRESID actions and activities as well as a list of No Till general and specific crops publications can be found.

3.3.1. The Synergy No Till-Biotechnology

Some authors like **(Young, Alvin, L. 2002)** on a paper and lecture presented as his contribution to the XI AAPRESID Annual Congress, discussed the actual and potential importance of biotechnology to improve agriculture.
Biotechnology was heavily adopted and to some extent a synergic effect was created between this technology and No Till. **(Peiretti, 2004).**
Argentinean farmers had foreseen the importance of the No Till-Biotechnology synergy as a way to keep improving their agricultural production and even founded and finance a Private Biotechnology company named BIOCERES. **(Giaccobe, 2004)**
Also, AAPRESID as a No Till Farmers institution had fully recognized the actual and potential value of this synergy not only from a crop view prospect if not from a much wider scope. **(Trucco, 2005).**
The important GM crop adoption in Argentina is described on **(James, 2004).** By far, Round Up Ready Soybean is the most important one, however, BT corn and cotton and lately Round Up Ready corn are also growing on farmer acceptance and usage.

3.3.2. Crop yields and stability of yields

When you start No Tilling on a given agro-ecosystem, some benefits can be achieved from the very beginning, even so, the potentially higher and best results show up after several years of a proper management under No Till. Also to obtain the most out of No Till, a systemic approach to the agro-ecosystem management should be utilized. Along with No Till, an appropriate crop rotation as well as a good soil coverage and soil nutrition strategies etc. constitute some of the key issues to be able to obtain the extra grain yield (and stability of it) that potentially No Till is offering.
For the central area of the Pampas Region as well as for some other regions of the country, an almost generalized trend for a crop yield increase when raced under No Till was reported by several authors**.(Ferrari, 1998). (Quiroga y otros, 1998).** It appears that for any given region and under rain-feed crop condition, the improved water management that No Till allows could be part of the explanation for the yield increase
(Diaz-Zorita, 2002) while comparing different rotations, had reported an increase of crop yields under No Till for the southwest part of Buenos Aires Province where the soils are of relatively high sand content. Also for those rotation that contains the higher proportion of corn and wheat the organic matter content was higher than on those that have lower participation of these crops. The same trend was observed while comparing the No Till treatments against the Chisel Plow one. The organic matter content was higher for the No Till one.
For a thirteen years period under continuous agriculture comparing two basic management No Till and combined till (a mixed management combining reduced till and No Till) for a typical Argiudol of the central pampas areas, the yield evolution as well as the evolution of several soil fertility indicators were reported by **(Ghio, 1999)**. He found a yield benefit for the straight No Till treatment as well as an improvement on some soil fertility indicators. Also he concluded that the system pillars are: No Till, Soil Fertilization and Crop Rotation .Within a No Till environment, other studies were directed to evaluate the interaction between crop yield and stability of it (as the ultimate expression of the agro-ecosystem functioning) with crop rotation**. (Phailé, 2003).** Regarding the crop yield issue, other studies and empirical experiences reported can be found on **point 3.3.3. Soil Characteristics**.
Precision Agriculture, site specific management could potentially be technologies that can further enhance the benefits of No Till. Some of these issues are discussed by **(Borletto, 2001).** Other authors had considered the potential usefulness of this modern last generation technologies to improve the general agricultural operation as well as the management under No Till. **(Bragachini, 2000)** y **(Bragachini, 1999)**. **(Belloso, 1999)** had reinforced the idea of the actual and potential importance of the technology to generate detailed records and knowledge of the soil functioning at the farm level.

3.3.3. Soil characteristics

Changes in soil characteristics under No Till vary across the agro ecosystem and type of soil we are studying. Even so, some general positive trends can be detected when No Till principles are applied. Some of the most

relevant changes seems to happen on the upper layer of the soil profile, however, the general soil functioning from a fertility standpoint -understood on its broad sense as the general soil ability to produce-, is regularly improved. Several authors had reported experimental results -as well as empirical- results derived from trials and also from observations and measurements at the farm level. Several positive changes on the physical properties of soils of the Central West part of Argentina (Haplustols from La Pampa Province) had been reported by **(Quiroga y otros, 1998.).**

(Marelli, 1996) from INTA (National Institute of Agricultural technology) reported different kind of No Till positive impacts related to soil conservation, water infiltration and crop yield.

After ten years of cultivating a high clay content soils (Argiudol vértico) of Entre Rios Province under the No Till principles, improvements for several soil characteristics were reported for **(Chesta, 2001).**

Some interesting conclusions were drawn by **(Fontanetto, 2002(a))** analyzing the evolution of several soils parameter on a seven years No Till and different crop rotation experiment. No Till and an appropriate level of nitrogen fertilization leaded to a soil organic matter increase especially of its younger fraction of the organic matter. Also, the amount of crop residues, the organic matter content and the water capturing and conductivity soil capacity were increased when grasses increased its participation on the crop rotation. Also continuous No Till increased the total soil porosity. The same author obtained similar conclusion in other ten years long study. On this second study he also evaluated different soils physical and chemical parameters as well as crop yields for to different rotations wheat/soybean and wheat/soybean followed by corn. He concluded that continuous agriculture might decrease the chemical properties of the soil. To be able to carry out continuous agriculture with an appropriate level of agronomic sustainability, we should carefully manage the agro-ecosystem and include crops that give back larger amounts of crop residues. From the physical soil properties standpoint, No Till was the best choice. The inclusion of corn on the rotation allowed increasing the water use efficiency. The best yields were obtained with the combination of wheat/soybean corn rotation and No Till. Also he concluded that following the utilization of No Till principles along with some other good agro-ecosystem management practices it is possible to carry out a continuous agriculture. **(Fontanetto, 2002(b)).**

Some soil chemical and physical changes derived from No Tilling two different soil types representative of the Central and Central East area of Argentina, were analyzed by **(Michelena, 2000)**. The two types of soils were compared between them and also with other similar soils cultivated under conventional till (generally plough based) management. A significant increase in most fertility indicators were found when they were No Tilled for a period ranging between nine to eleven years. Some of the reported results for the No Till benefits were: a.) a significant organic matter and total nitrogen increase (which implies carbon increase and carbon fixation). No much changes on soil PH. Regarding the

physical properties evolution under No Till, the bulk density was similar for both types of soils. The resistance to be penetrated (a physical structural measure that within certain limits, under No Till generally does not seems to correlate with Yield Potential and general Fertility as it does for conventional plough tillage), was also studied and the values reported. The values encountered do not represent any troublesome situation and the yield and general productivity evolution of both farms followed a clear positive trend (Personal communication with the two farm owners and managers). Regarding the soil water infiltration, the value reported indicates a significant improvement. For a rain simulator simulating a heavy rain intensity(60 millimeters per hour during one hour), in the case of Ramirez (Entre Rios) soil (Argiudol vértico), the infiltration was 100 % while for Arequito Santa Fe soil (Argiuldol típico), was 83%. Considering that under conventional tillage the most common values for this parameter and for the area would be around 40 to 50% or even less in many cases, the values found under No Till condition for both farms mean a soil in good shape from the efficiency of rainfall water capturing soil capacity. This increased soil ability to capture rainwater implies a very positive and important benefit derived from No Till. The effect has big positive impact on the water availability for crops increasing the yield and decreasing yield variability among years. It represents a phenomenon that has a similar practical impact that if we could increase the rainfall of a given area. Since the soil water capturing capacity is enlarged, the irrigation total efficiency is increased and hence a true possibility of reducing the irrigation need when under irrigated condition appears. Also in the paper it was reported that soil losses by mean of water erosion were drastically cut on both cases. In Ramirez Entre Rios, was equal to zero after applying a sixty millimeters rain in an hour. For the Arequito, Santa Fe soil, the soil loss value was only 0,15 metric ton//ha, which is extremely low while compared with the values for the

average losses obtained on the area. As an example some measurements derived from other studies on the Carcarañá Basin that surrounded the Arequito´s farm area, and while under conventional tillage, values for soil losses by means of erosion are as high as 50 Tn per hectare year and even higher. Similar figures were found for conventional tillage in some Entre Rios farm area when cultivated under conventional tillage. The author of the paper concludes: 1.) No till improved several soil properties in both soils when compared with conventional tillage (even the comparison with conventional was not the main study target he draw a conclusion in this respect). He also stated that the improvement was especially noticeable in regard to the Organic matter and soil structure evolution. 2.) The soil from Ramirez (Entre Rios), showed a higher organic matter and total nitrogen content, better structure and a higher infiltration when compared to the one from Arequito (Santa Fe). 3.) These differences in structure and infiltration between the two soils may be due to a higher organic matter and clay content of the Ramirez (Entre Rios) soil, lower loam content and a better structural condition of the same soil. The findings reported on this paper exemplify the No Till potential to generate positive environmental impacts.

On (**Michelena, 2001)** the same author extended the study for another year. Several measurements were made and also similar trends for the results were obtained while compared with those just reported on **(Michelena ,2000)**.

Other authors **(Fogante, 1999),** for a general country view considered the No Till adoption. Based on some empirical and other types of evidences he analyzed several actual and potential benefits related to soil fertility and productivity improvement.

3.3.4. Weed management

Due to relevant changes on the basic agro-ecosystem variables, weed population, both in size and composition, is different while comparing the "No Till Environment" with the "Conventional Till" one. Some different management strategies have to be applied when under No Till. **(Papa, 1998).** Also under No Till and with the repeated utilization of certain herbicides. The same author reported some changes on the weed population. **(Papa, 2003).** An increased impact of grassy weeds over broadleaf weeds under No Till, was reported by **(Puricelli, 2003).** The phenomenon is clearly seen at the farm level.
Integrated Weed Management Strategies are successfully working on some cases and constitute a very promising area of study. Allelopatic effects can be successfully utilized while managing the crop on a No Till environment.
To achieve an efficient use of herbicides, some especial considerations should be taken into account. As we normally have more available water into the soil profile, to some extent the application windows for post emergence herbicides is wider than under conventional. Also when utilizing soil residual herbicides we have to take into account the interference that for certain active principles may represents the crop residues on the topsoil. This can vary from very low as 15% to very high as 85 %. **(Moreno, 1998)**.
The Round Up Ready technology was introduced on Argentina on soybean during 1996. At the beginning some authors had reported doubts regarding its efficiency, however reality proved that the new technology was extremely helpful and very efficient to properly manage weeds while racing the crop. The technology has a high degree of acceptance and in a few years more than 90 % of the areas cropped with soybean was utilizing it. Because its peculiarities, the case of Argentinean Round Up Ready soybean adoption can be considered as a milestone and a paradigmatic change on the technology adoption by the Argentinean farming sector. The adoption pattern and the synergy with No Tilled Soybean can be seen on **(Peiretti, 2004)**. Lately, the same technology was approved for corn, Round Up Ready corn. The first farm trials started during the 2004 cropping season.

3.3.5. Pests/diseases management

A proper management of pests and diseases is a must to allow the achievement of the yield potential.

The Integrated Pest Management principles properly work within the "Created No Till Crop Environment". Empirical observations **(personal experience validated by some other colleagues)**, as well as some experimental observations, show that very frequently under the No Till environment it seems to be easier to

achieve a more balanced scenario between the pest and their parasite or predators so the need for the use of insecticides could be reduced. **(Aragon, 1998).** The same author **(Aragon, 2002)** developed a very comprehensive, detailed and well illustrated management guide for the insects that mostly impact crops while managed under No Till and at the beginning of the growing season. Other authors had studied and reported strategies to use the integrated pest management strategies. Among others, the establishment of thresholds for intervention, natural biological control, cultural control, and the use of both chemical and biological insecticides, was considered. **(Mazzaro, 1994).**

A systemic and holistic approach to enhance the benefits of No Till and management of pests under the principles of Integrated Pest Management is absolutely needed. (**Trumper, 2002)** published a paper analyzing this issue.

Regarding biotech technology, BT corn and cotton are officially approved and currently used by Argentinean farmers. While compared with non-BT on both crops a significant reduction of insecticide use was achieved. (Personal Experience). In corn the technology also help to reduce the amount of damaged grains and also to increase per hectare grain yield. The BT technology in corn is becoming more popular, widely accepted, and utilized by more farmers every year. To some extent similar results are valid for cotton.

Special considerations should be taken to properly manage plant diseases under the No Till environment. The behavior of some plant diseases change while managing the agro-ecosystem under No Till**. (Formento, 2002**). She pointed the occurrence of significant micro-environmental changes and a consequent modification of the plant-pathogen relationship. She also pointed the importance of applying integrated management strategies and a holistic approach to minimize the disease impacts and get all the important and multiple benefits that No Till is offering.

The analysis and some recommendations to better understand and diminish the impact of some soybean diseases when this crop is raced under No Till were reported by **(Ivancovich, 2001)**. Also when considering wheat raced under No Till an interesting study was reported by **(Annone, 2001).** The importance of crop rotation to diminish the impact of plant diseases under No Till was analyzed by **(Carmona, 2003).**

3.3.6. Efficiency of water use - Irrigation

While compared conventional tillage with No Till, different studies had detected and to some extent explained the better water management performance that can be achieved. **(Dardanelli, 1998), (Andriani, 2002).** Among other benefits, a much larger capacity to capture the rainfall into the soil profile was reported. Among other important economic benefits it implies a relevant environmental benefits as reduction or water born soil erosion, reduction of water run off and contamination of the “basin path”, and other related benefits.
Regarding an improved water management **(Gil, 2001)** had described the main changes that happen when a soil is managed under No Till. Also, **(Gil, 1999)**, while taking into account that only twenty five percent of the total country area can be considered as humid or sub-humid, analyzed and stressed the importance of the improved water management that is achievable by No Till. (**Gil, 2003)** reinforced these findings and added some extra benefits derived from No Till and a proper crop rotation modeled toward the match of water demand and consumption with water availability to either overcome water excesses and deficits and get the most and more stable agro-ecosystem productivity.
Martelloto, 1999, reported information derived from a three years No Till-Sprinkler Irrigation experiment that was carried out on the central part of Cordoba province within the so called sub-humid (seven hundred and fifty average millimeters rainfall). It showed very high yields for the different crops that were raced under the irrigation condition and also emphasized the benefits derived from the synergy between No Till and sprinkler irrigation. The higher the yields the greater the amount f crop residues that cover the soil and enhance the No Till derived benefits .He also pointed, that a good strategy for water management should be based on the need to maximize the efficiency of use of rain water (under No Till) and only after that we may start considering irrigation. The high, and consistent yield reported, constitutes a clear evidence of the potential benefits of this technological approach.

3.4. Socio-economic impacts

(Peiretti, 2000), had reinforced the need to achieve a proper level of sustainability for the farming operation. Also he had analyzed some of the "linkages" between sustainability with competitiveness and profitableness. He reinforced the idea that the No Till system creates a favorable "production environment" to simultaneously achieve these goals.
Previously the same author analyzed several functional characteristics and potential benefits of all types from the environmental to the farm economic and operational point of view. This recognition of the No Till benefits by many farmers heavily contributed to the adoption of the system**. (Peiretti, 1994), and (Peiretti, 1996)**
The noticeable rate of No Till adoption than the Argentinean agricultural sector had shown, (it will be later discussed on specific point 3.6), somehow constitutes a proof of the short term mostly economic benefits achieved by No Till farmers operating under a high taxation environment and without subsidies. On **(Peiretti, 2000)** and on **(Peiretti, 2001(a)),** these issues had been discussed and also some specific economic and organizational impacts analyzed. Also the need to achieve a proper level of sustainability for the farming operation and the" linkages" between sustainability with competitiveness and profitableness were taken into consideration. He reinforced the idea that the No Till system creates a favorable "production environment" to achieve these goals.
Some practical examples of how the No Till system was utilized as the pillar for a farming enterprise to be able to counteract the pressures derived from an ever-changing scenario was presented by an AAPRESID member **(Watson, 1994).**

3.5. Environmental impacts

No Till had several positive and relevant impacts from the environmental standpoint. They are of high relevance and should be further developed considering the absolute need to achieve a larger food production while minimizing, avoiding or even restoring the damages to the environment.
Adamoli, 1999, had discussed different issues related to the relationship between Ecology and No Till. On the development of an interesting and conceptual paper among other things he stated that we should be conservationist with the species but the one we should prioritize is the human been, then the plants and animals. While analyzing the relationship between No Till and ecology. No Till has already demonstrated to be environmentally friendly and could significantly help to minimize the impacts of converting "natural ecosystems" into new agro-ecosystems.

3.5.1. Carbon stratification and sequestration.

Some research work monitored the organic matter evolution under No Till at a "farm field condition" (**Casas, 2002)**. On this and other local research work, some promising results were found regarding a positive correlation between years under No Till and soil organic matter content. The same author reported a similar carbon fixing trend but in this case pointing the importance of crop rotation to enhance the process. **(Casas, 2003).**

The advantage that No Till represents regarding the soil carbon management was reported and analyzed by **(Andriulo, 2002)**. On this paper several measurements derived from different trials and experimental works were reported.

(Puricelli, 2002) had monitored the evolution of certain soil chemical properties of a mollisol located on the southern part of the Buenos Aires Province. Even the study was run on soils that just begun to be cultivated under No Till, after fifty months some positive trends were detected for organic carbon and phosphorous content. The validity of this information would have only to be restricted to a short no till period because No Till treatment started at the same time the study begun. However, on the same paper the authors revised the information derived from different No Till long term trials, between nine and twenty eight years, carried out

in different parts of the world and found a generalized positive correlation trend between No Till and some important soils properties as organic carbon content and total nitrogen.

3.5.2. Nitrogen and nutrient cycling.

Even sometimes is mentioned that for crops raced under No Till a higher nitrogen application rate is needed, the issue is neither empirical nor scientifically well documented. Furthermore, and derived from empirical observations on farm level trials as much as ten tons per hectare of corn can be produced by a crop without the addition on nitrogen when raced on a paddock that had been no tilled for the last fifteen years. The soil is a typical Argiudol of the central humid Pampas area. **(Peiretti, 2005)**. Nine thousand and eight hundred kilograms of corn grain could be obtained without irrigation and without the addition of any fertilizer. Even so when the soil nutrition was properly managed by adding the proper amount of nutrients into the system almost fourteen thousand and four hundred kilograms of grain were obtained on the same trial. On this very reactive No Till environment and depending on the rate of added the average efficiency of use for the added nitrogen reached more than 25 Kg of grain per each Kg of nitrogen added for the 125 Kg per hectare N rate. However while moving from the 85 to the 125 units of N applied the response was of almost 50 kg of grain per each Kg of nitrogen added. To some extent this data shows us the high capacity of this No Tilled Soil to provide nitrogen, as well as the high reactivity of the No Tilled agro ecosystem to react in front of some nitrogen utilization. Even on the "0" fertilizer test plot no fertilizer of any type was applied for the last three years and still a good yield was achieved, the results do not indicate a sustainable balanced situation from the soil nutrition standpoint. If we want to achieve soil nutritional sustainability, every cropping season we need to add to the system at least the same amount of nutrients that we are picking up out of the field with the grains.

Argentinean agriculture used negligible quantities of fertilizers until the beginning of the nineties. Since them the usage grew up considerably from around an average of ten kilograms per hectare year of commercial fertilizer to around eighty kilograms at the present time. Even the increase in the utilization of fertilizers was noticeable; we still did not reach an extraction/replacement-balanced situation. Every year we keep extracting more nutrients that we replace into the soil, which indeed constitutes a non-sustainable scenario. The evolution of fertilizer usage on Argentina can be checked on **(Schnepf , 2001)**.

Some new reports analyzing and describing some new findings regarding the nutrient cycling under No Till were made by **(García, 2004).** On it among other conclusions he clearly establish that under the No Till environment, the yield potential is higher and hence the nutrient supply should be adjusted to it. Also the nitrogen dynamic is different under No Till so it must be taken into account at the time of designing a proper nitrogen fertilization strategy.

Same interesting nutritional studies for a No Till crop rotation were carried out within a net of AAPRESID trials. The fourteen experimental sites represent the most important production areas of the country. The evolution of the soil content for the different nutrients and related parameters, were studied. Also the yield response for the different fertilizer application rates was considered. The conclusions shows that for both maximum yield and for a sustainable soil nutrition management fertilizers should be used a higher rate than the actual**. (Bianchini, 2002).**

Different fertilization strategies considering the residual fertilizers under No Till were analyzed by **(Quintero, 2004)**. Also several issues related to nutrient management and sustainability of the agricultural system was considered by **(Salvagiotti, 2004).**

Also some studies oriented to develop proper fertilization strategies for specific areas of the country were carried out**. (Quiroga, 2004)**, for the sub-humid and semiarid region, **(Fortunatto, 2004**) for the North Central area and **(Pailhé, 2004)** for the south east of Buenos Aires province.

3.5.3. Erosion mitigation (CNPT, UFG)

Among several other benefits, the System is highly efficient to control both water and wind born soil erosion. Regarding the wind born erosion **(Buschiazzo, 1998)** had monitored and reported very promising results. Regarding the erosion mitigation and some other important environmental and economical positive impacts had been described by **(Marelli, 2001).**

3.5.4. Energy Use

Some authors reported a lower energetic need to race crops under No Till condition on the past, (Baumer, 1998) . At the present time, and after adjusting several technical managerial strategies for fertilization and other issues as well as allowing the No Till to express all its improvement regarding the agro-ecosystem functioning, it is highly expectable that if we measure the energy consumption and efficiency not by hectare if not by ton of grain produced, we will very probably find a No Till advantage when compared with conventional. Even so, further studies will be needed on this important issue.

3.5.5. Biodiversity

The relationship between No Till and Biodiversity can be focused at different levels. This inventory and comments will be basically focused on the relationship with soil microbiology as one of the expressions of biodiversity.
Several years ago, when we still had a relatively low number of hectares under No Till on the country, some authors recognized the positive interaction between a more friendly soils and general agro-ecosystem management and soil microbiology for our agro ecosystems**. (Molina, 1994)**
A positive relationship between No Till and the increase of microorganism in two types of soils one of the central area of Argentina (a well balanced soil) and other for the central west (a sandy soil) were found by **(Sagardoy, 2002).** Other author **(Montero, 2000),** studied the evolution of some microbiological parameters on soils cultivated under No Till, reported a general trend to a higher enzymatic activity and also a positive correlation between the soil organic matter content and the microbial biomass the presence of certain fungi and the action of certain enzymes as "ureasa" and "cathalasa".
The necessity to better understand and become aware about the multiple interactions between the microbiological load and its dynamic activity with soil functioning and agro-ecosystem productivity, can lead us to take even greater advantages of the No Till created environment. **(Clapperton, 2003(a))** and **(Montero, 2003).** Also in **(Clapperton, 2003 (b))** the author analyzes the great importance of microbiological soil activity to recycle and supply most of the plant nutrients.
Other authors studying the evolution of the macro fauna and No Till found both some positive correlations in certain cases and clearly established the need to carry out new studies to deepen the knowledge on this important area. **(Saluso, A 2002.**

3.5.6 Pollutants (organic/inorganic) in soil and water

Even there are clear empirical evidences of a lower siltation of creeks, streams and rivers located on basins where No Till is extensively used and erosion drastically cut, no specific studies that relates No Till and water contamination were found for Argentina. Also regarding other type of water organic and inorganic contaminants, and since under the No Till environment we are achieving a better and more balanced agro-ecosystem functioning into which Integrated pest and disease management strategies as well as soil nutrition and nutrient cycling are been successfully utilized a reduction of contamination when compared whit conventional tillage agriculture can be suspected. Further studies and research work are needed on this area.

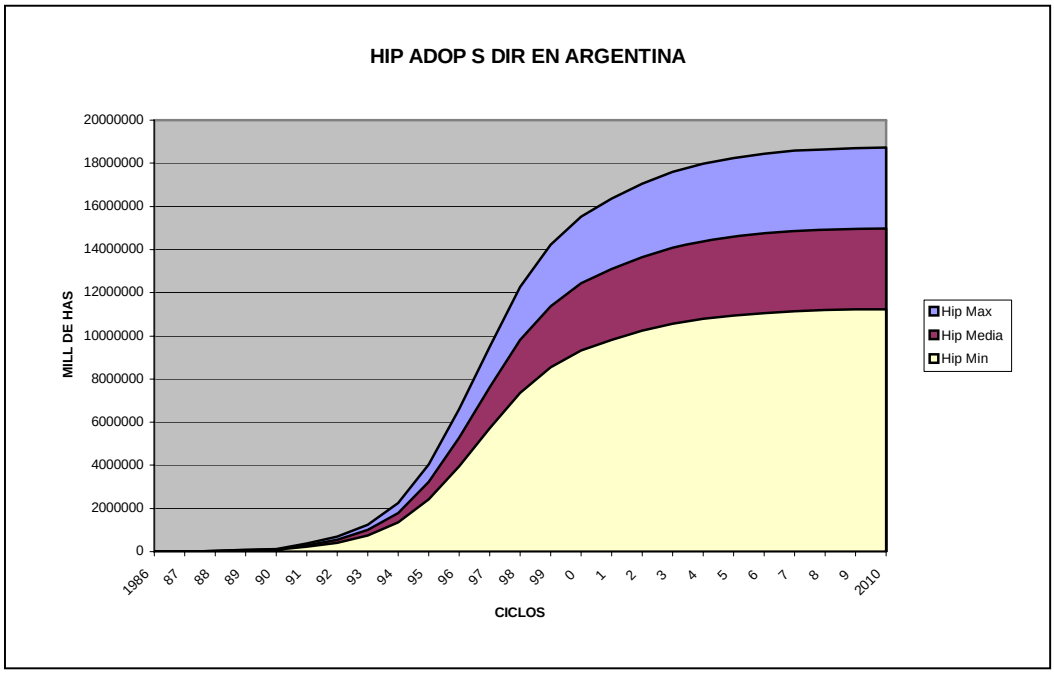
3.6. Adoption

General Considerations

According to some authors, to be able to be successful at promoting No Till adoption several "myths" should be destroyed. **(Derpsch, 2003).** According to the author, farmers, technicians, scientist's, extensionists´**, and** the general public should be instructed about the absence of a need of tilling the soil to produce. It is absolutely needed to promote a change on the traditional and general view of the whole issue. He also pointed that the greater No Till development can be found in Latin America and that it is time for Europe, Africa and Asia to start following the same way.

The Argentinean No Till Adoption Process. Adoption levels.

At the beginning of the Argentinean No Till adoption process an unpublished paper presented on a No Till papers contest organized by the Rosario Board of Trade **(Peiretti, 1995)** had proposed different future No Till adoption scenarios for the future evolution of the Argentinean No Till adoption process. The paper also includes the analysis and prospect of some micro and macro economic impacts. The author, based on the analysis of previous adoption processes for some other agricultural technologies and systems, as well as based on a comprehensive consideration and personal knowledge of the advantages and benefits that No Till was already offering, he proposed three hypothesis for the future evolution of No Till in Argentina. After nine years, reality had proven the predictions were valid. The actual Argentinean No Till adoption is in coincidence with some of the higher adoption predicted values. With the proper adaptation and consideration of other socioeconomic and agro-ecological scenarios, this kind of analysis based on past experience and feed with the data and peculiarities of a particular reality, could be of some help to attempt to predict the future No Till adoption evolution for some other cases. The main Chart of the paper containing the Three Hypothesis considered is included next.



Nowadays around 65 % of the total country farmed area is been cropped on this fashion and a great proportion of that can be found on the central areas.

Adoption Constraints and related issues

The Argentinean No Till adoption process started during the seventies with some small-scale trials within this central area. Later during the eighties the adoption started to grow. **AAPRESID** (Argentinean No Till Farmers Association) was founded during this period. Since them the No Till area never stop growing and been irradiated to the other areas reaching nowadays more than sixteen millions that account for around sixty percent of the area cropped on the entire country. A brief description of the process and the pillars on which it was based can be found at **(Peiretti, 2004).**

No Till/CA and an entire new farming model based on the principles of the MOSHPA Model (Modern Sustainable High Productivity Agriculture**), (Pirate, 2003)** was developed and strongly adopted within that period. In Argentina,

The foundation of CAAPAS eleven years ago, (American Confederation of Farmers Organizations for a Sustainable Agriculture), also help to reinforce the No Till adoption process in Argentina as well as in the other country members of the institution. The characteristics of the organization, its mission, vision and general actions and view in regard to the MOSHPA were described on **(Peiretti, 2004).**

In Argentina, definitely the adoption of this new farming system was mostly a farmers leaded process and to the opinion of several authors it constituted a true technological revolution. **(Ekboir, 2003)**. Those farmers belonging to the large-scale market oriented category play a key role on the process. During the last thirty to forty years, the activity, organizational scheme, farming system etc. utilized by Argentinean farmers of this category, had undergone a deep transformation during the last thirty to forty years. The process was highlighted by the strong adoption of No Till/CA principles and also by biotechnology. Also, deep transformation reached the operative organizational area. Nowadays around sixty five percent of the total grain and oilseed production is coming from a "new type farmers" that produce on rented land and contracting for different services of all type to race and harvest the crops. **(Ordoñez, 2002)**. The "custom made modality" developed to fulfill the necessities of the different stages of the farming process, strongly accompanies the Argentinean farming structural reshape. **(Lorenzatti, 2004)**. Many kind of professional services started to be offered and incorporated into the agricultural process **(Igarzábal, 2004), (Barberis, 2004)**. Also, a proportion, much larger than before, of the farming operations, started been managed by professional agronomists or agricultural related ones. The "new role" demanded from agronomist's actions was suggested and analyzed by **Fogante, 1996**. The result was a significant increase on the amount of knowledge and technology applied to the whole farming process that in term gave birth to the simultaneous achievement of a greater level of productivity, total production, profitability within a frame characterized by a higher level of sustainability than before.

To promote the adoption of No Till principles, the detection and support of leader proactive farmers was a key factor for success. Farmers to farmer's knowledge transmission were an extremely valuable strategy. At the beginning of the Argentinean No Till adoption process the actions of these types of farmers were of high importance **(Rosso, 1992).** Under the farmer view, one of the very active AAPRESID member analyzed some of the why's for the need to evolve to a different farming system was considered by **(Rosso, 2001).** AAPRESID as farmers founded and managed institution, had plied a key role on the process and a farmer's proactive and innovative attitude was also of high relevance. **(Trucco, 2001).**

Also a considerable (and growing) amount of professional people, -agronomist's and other related professionals- got involved into the process of developing, adapting and adopting the No Till principles on agriculture. Some testimonies of these attitude and favorable change were offered by **(Rúveda, 2001),** and **(Vázques, 2001).**

Even the adoption of No Till in Argentinean begun on the Central Area region very quickly started to be spread to other regions of the country. Following this trend, some leader AAPRESID farmers **(Arzeno, 1993**)

recognized and described the advantages and potential No Till benefits for the North West Region of Argentina where a “new agricultural pole” was been developed.

Machinery Constraint

A completely new generation of drillers and planters specially designed to properly operate under the No Tiled Soil condition definitely is a key issue for success at adopting the No Till principles. Some AAPRESID authors **(Romagnoli, 1999)**, had described some new approach and design for the needed planter, drillers and also some key features needed on the combines to properly manage the crop residues. (**Rosso, 1993)**, a very active farmer and AAPRESID member, did the same. He carefully analyzed the drilling, planting and harvesting need for a proper and successful No Till principles adoption.
Also, the industry following the farmers suggestions, invested a considerable amount of time and efforts of all types at developing prototypes of a conceptually entire different drillers and planters. They finally developed and supplied the demand with an appropriate entire new generation, conceptually different drillers and planters. This was also a key issue for the No Till adoption success. The process is partially described by **(Maroni, 1996).**
Also an AAPRERSID member had written a book on which a large number of issues related to the planters and drillers needed characteristics for a proper performance on the No Tilled soils had been developed. **(Baumer, 1999).**

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