

**Nuffield Farming Scholarships Trust Ireland**



# **Conservation Agriculture**

**Learning from the South American Experience**

**John P. Geraghty**

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*The entire body of 'reasoning' about the management  
of the soil has been based upon the axiomatic  
assumption of the correctness of plowing.*

*But plowing is not correct.*

Edward H. Faulkner  
Plowman's Folly(1943)<sup>1</sup>



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<sup>1</sup> Edward Faulkner in his revolutionary best-selling book 'Plowman's Folly' had the honesty and integrity to challenge conventional thinking that cultivating the soil was beneficial. He went through well-thought out reasoning where he clearly showed that all standard wisdom given for plowing[sic] and intensively working the soil was invalid.

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Finally, special thanks are due to Jim and Maureen who always encouraged me to question and oftentimes I'm sure they wished they hadn't.

## **Note on the Author**

John Geraghty graduated with a B.Agr.Sc. degree from University College Dublin in 1992 and went on to complete his M.Agr.Sc. degree in Rural Development in 1995. He has worked in the area of agricultural research, extension, and rural development since that time including periods in Benin, West Africa with the German Technical Co-operation Agency, and Lesotho, southern Africa, with the United Nations World Food Programme. He is an agricultural consultant and a part-time lecturer in sustainable crop production systems with the Waterford Institute of Technology in Ireland. He is General Secretary of Conservation Agriculture Ireland(CAIR) and National Representative to the European Conservation Agriculture Federation(ECAF) and a life member of the World Association of Soil and Water Conservation(WASWAC).

## **Disclaimer**

*The contents of this study are the result of research, personal interviews and observations made by the author while conducting the Nuffield Study Tour of South America during Spring 2004. The contents do not necessarily reflect the views of the Nuffield Farming Scholarships Trust or those of the sponsors of the scheme.*

## **Executive Summary**

Conservation Agriculture (CA) is a system of crop production that involves minimal soil disturbance with no inversion of soil. Permanent soil cover with crop residues or the use of cover crops is desirable. Crop rotations including the use of specialized planters or drills are necessary. The adoption of CA requires the application of new techniques and an increase in a wide range of management skills for the farmer.

The tangible benefits of CA systems are many and varied. At farm level significant cost reductions through greater efficiencies in the use of labour, machinery, time and fuel have all been realised. From an agronomic point of view yields have been maintained and even enhanced with reduced input costs. The system has many positive environmental aspects with reduced CO<sub>2</sub> emissions, less nitrate leaching and reduced phosphate loss due to run-off to waterways. Water infiltration in soils and water holding capacity on land is greatly enhanced. As a result, there is reduced potential for flooding and with less soil erosion there is a significant drop in soil contamination of waterways and build-up of silt in river beds and estuaries. Research has also shown increased biodiversity on farmland where the system is operated.

With all these recorded benefits CA has become a global and expanding practice. Adoption of the system, however, has been much slower in North Western Europe, Africa and Asia when compared with South America. Since the late eighties CA has shown a fifty-fold increase in South America alone from just over half a million hectares in 1987 to over thirty-four million hectares in 2002 - just under half the total area devoted to the system worldwide. The region provides a rich resource for learning about developments in agriculture in a non-subsidised environment where farmers are exposed to world market price fluctuations.

### **Aims of the study tour**

- Investigate the origin and rapid development of CA systems in South America over the last 20 years.
- Identify reasons for adoption of such systems and factors that have influenced their uptake.
- Identify if any of the methods used to promote CA uptake and development could be implemented in north-western Europe.

### **Main Observations**

- While initial motivation for uptake of CA systems was mainly for the control of soil erosion throughout the nineties the main reason for uptake was cost reduction
- Farmer groups have had a major influence on the uptake and development of CA systems and regional and national CA organisations with a strong farmer focused ethos have been hugely supportive and influential in providing technical back up, information and practical advice to farmers

- The vast majority of research work on CA is undertaken in collaboration with farmers and the majority of formal research is undertaken on-farm using farmer implements and techniques. Extension and advisory agencies also facilitate farmer to farmer education as much as possible
- Land is never left fallow and constant soil cover with previous crop residue or cover crops is a vital component of all successful CA systems throughout the region
- Crop rotations are vital to improve soil structure, build soil fertility and manage weed development while green manure cover crops are successfully incorporated to optimise benefits of the system throughout South America
- A wide range of seeding equipment is available to farmers with frequent evaluation trials on the suitability of such machinery made available to farmers from independent research institutions
- Equipment required for successful implementation of CA need not be expensive or state of the art once the basic principles of the system are adhered to
- CA is a suitable system for small, medium and large-scale farm enterprises

### **Conclusions**

- The mentality and attitudes of farmers, advisers and researchers involved in developing CA are very different to those traditionally observed; there is a genuine commitment to life long learning and a large amount of humility is required to succeed with the system
- Lack of knowledge and information is the main constraint to adoption of CA at farm level; information has to be relevant, factual and of practical use to farmers
- Weed control has proven particularly difficult for some farmers adopting and managing CA systems; greater understanding on weed species and biology is essential together with ready access to information on herbicide choice and availability
- Greater knowledge about soil properties - physical, biological and chemical - are vital for successful management of CA; different methods for fertilisation of crops and building soil fertility are required for CA
- The importance of constant soil cover, either with residue or cover crops, cannot be over emphasised; farmers are obsessed about and insist on constant soil cover
- Compared with South America there is poor choice and availability of adequate and appropriate drills and planters for CA systems in North Western Europe

### **Recommendations**

- CA technology is a truly sustainable form of agriculture and crop production and should be promoted and developed by agriculture agencies involved in the arable sector
- More specific and focused research based on farmer needs is required e.g. soil structure improvement, soil fertility building, cover crop interactions with cash crops, weed suppression, crop nutrient requirements under CA systems et.c

- Farm based research and farmer to farmer dissemination of experiences is essential to improve the rate of uptake and quality of techniques used
- Agriculture education institutions need to place greater emphasis in relevant courses on sustainable soil husbandry to ensure that adequate knowledge and appreciation for soil management is present in the agriculture services sector
- Appropriate drill technology already exists and every effort should be made to import and/or modify suitable machinery for use in CA systems in North Western Europe
- In view of the positive impact on the environment it would be entirely appropriate for government to offer temporary subsidisation to farmers during the early adoption phase of CA systems as such initiatives are already in place in other EU member states

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## Introduction

In spring 1995, while working with the German Technical Co-operation Agency (GTZ) in Benin, West Africa, I stood at the side of a sloped area of land that had been cleared of small shrubs and trees. Local Beninese women were planting cassava in the clearing. They prodded a cassava cane about two metres long into the ground through the grass vegetation and cut the stem at ground level with a machete leaving behind a stub about 10cm in length just protruding from the ground. Moving forward the process was repeated as the cane became shorter and when too short they continued the line of planting using another cane. I remember watching this process and thinking to myself ‘what a waste of time and energy ... this will never work’.

Four months later I visited the site and the clearing was full of thriving cassava plants. The grass vegetation cover had harnessed water from the rains that had fallen, it had protected the soil so there was no soil erosion even though situated on sloped ground, and the plant cover had prevented the soil from drying out. Through this cover the cane stubs had grown and were producing viable tubers underground and a dense canopy overhead. It did work.

My mindset back then was the product of years of formal agricultural education where there was this unquestioning belief that to grow plants, any plant, it was necessary to cultivate and loosen the soil. It took years of observation, practical experience, and research for me to change this basic assumption.

Mother nature does not disturb soil. The soil is not ploughed, disced, harrowed or pulverised with powered implements to render it suitable for growing plants. In natural forest woodland there are no artificial inputs such as fertilisers, trace elements, herbicides, fungicides, insecticides or plant growth regulators and yet plants grow, flourish and produce their respective fruits. This natural process can be observed year after year on a worldwide basis. Yet today we often simply refute the very lessons that nature provides us with. The irony is that by not adhering to some basic principles of nature, crop production is costing us more money and we are using increasing levels of inputs to achieve satisfactory yields. Is this sustainable production?

Tillage farming in Ireland and the UK has for centuries been based on the plough. In the early 1970s, largely due to economic pressures, efforts were made to implement direct drilling systems. Straw burning eliminated the residue problem but weed problems soon developed. There were particular problems with grass weeds<sup>2</sup> and there were few herbicide control options for in-crop control. Accession to the then EEC<sup>3</sup> created a situation where cost pressures were reduced. Many farmers abandoned the system and reverted to the plough once more. However, farmers in other continents were subject to fluctuating world market prices and this combined with soil erosion, in particular, meant that they had little option other than find solutions for very same problems that Irish and UK farmers had encountered with direct drilling at that time.

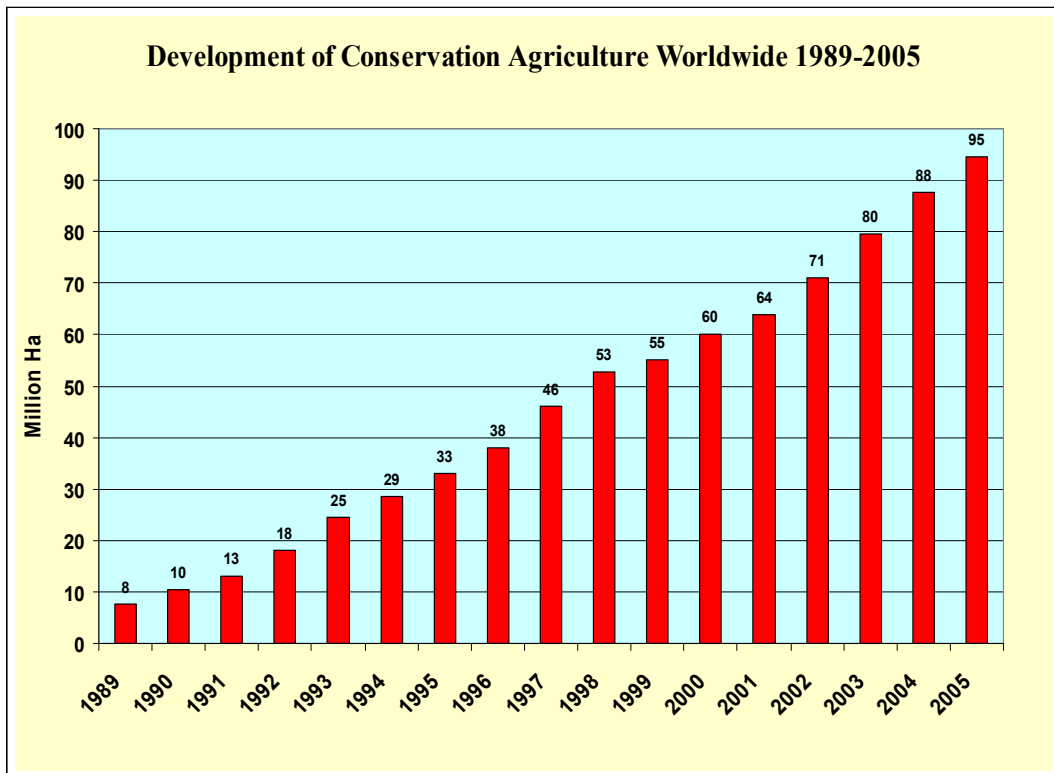
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<sup>2</sup> Sterile brome and meadow grasses in particular

<sup>3</sup> European Economic Community(1973)

These farmers have now developed, and are continuing to develop, conservation agriculture systems. There is no recourse to the plough and the soil is not inverted. Soil disturbance is minimal save for seed placement in the soil. Continuous soil cover is desired through the use of crop residues or cover crops. In order to be successful with the system the constant use of rotations is necessary. Conservation Agriculture (CA) is an international term used to describe these principles. Farmers who establish crops by direct drilling, no-tillage, or zero-tillage, maintain soil mulch cover, while using rotations and cover crops are all practicing CA.

Today in Ireland and the UK many farmers are adopting and practicing minimum-tillage or reduced cultivation systems in whole or in part across their holdings<sup>4</sup>. The soil is shallow cultivated and disturbed post harvest in an effort to promote weed germination and the resultant weeds are then sprayed with herbicide before the cash crop is drilled. Indeed, in some instances, two and three cultivations are used and it could reasonably be argued that these farmers are practicing maximum tillage rather than minimum tillage. It needs to be clearly stated therefore that these systems are not covered by CA.



**Figure 1:** Incremental adoption of CA globally. By 2005 there were 95 million hectares in CA.

Figure 1 shows the incremental adoption of CA worldwide. It is estimated that at present no-tillage is practiced on more than ninety-five million hectares worldwide<sup>5</sup>. Almost forty-seven per cent of the technology is practiced in South America, thirty-nine per cent is practiced in the United States and Canada, nine per cent in Australia and approximately

<sup>4</sup> Only 3 per cent in Ireland and thirty-five per cent of arable land in the UK is devoted to these practices annually (CAIR and SMI, 2004)

<sup>5</sup> A total of 95 million hectares (Derpsch, 2005)

four per cent in the rest of the world, including Europe, Africa and Asia. The UK, Ireland and many other European countries, with the exception of France and Spain, are not recorded for the simple reason that CA, no-tillage or zero-tillage, is not practiced to any great extent.

Despite the fact that the United States has the biggest area under no-tillage, it is interesting to note that in this country no-tillage accounts for only twenty-two per cent of all cropland hectares. While more than ninety per cent of the area under no-tillage in Argentina, Brazil, Bolivia and Paraguay is permanently not being tilled, this is only the case for between ten and twelve per cent of the area in the USA<sup>6</sup>. In Brazil and Argentina no-tillage accounts for approximately sixty per cent and in Paraguay sixty-five per cent of all cropland hectares.

For this reason, any effort to study the development and uptake of CA systems needs to be largely based in the South American region in order to identify what can be learned and implemented to increase the rate of uptake in North-Western Europe. An initial visit to Mexico was necessary before heading further south.

## **Mexico**

### Country, people and agriculture

Mexico is one of the largest of the Latin American states and lies in a geographical unstable part of the world. Many areas are subject to frequent earthquakes and volcanic eruptions. A major earthquake devastated Mexico City in 1985. Covering a land area of 756 thousand square miles the region along the Gulf of Mexico is fringed by swamps, lagoons and sandbars while the Pacific coastline and the southern half of the country in general has a wide variety of landscapes. In between both these coastlines is a massive central plateau. The country's climate varies greatly depending on altitude and region.

Mexico had a succession of highly sophisticated early civilisations, Olmecs, Mayas and Aztecs, between one and three thousand years ago. The better known Aztecs were originally a nomadic people that migrated to the country's great Central Valley where they built their capital, Tenochtitlan, on the site of modern Mexico City. The Aztec empire was largely destroyed by Spanish invaders in the mid 16<sup>th</sup> century and their rule throughout the next century was described as harsh. Independence was not achieved until 1821. Mexico became a republic in 1824. Today the form of government is a federal multiparty republic with two legislative houses.

Half of the population, approximately fifty million, are Mestizos of mixed European and native descent while a further third are Amerindians. Most of the population is Roman Catholic. While there are over fifty different local languages the official spoken language is Spanish.

Mexico has little good agricultural land and much food has to be imported. Most productive agriculture land is located on the central plateau. Since 1910 much of this land has been

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<sup>6</sup> Conservation Agriculture Information Centre – [www.ctic.purdue.edu](http://www.ctic.purdue.edu)

occupied by small subsistence farmers. Export crops include coffee, sugar cane and cotton, while staples include maize, squash and kidney beans. Beef production on ranches is largely concentrated in the north. Fishing is largely for export, the important species being tuna, anchovies, sardines and shrimps. While forestry covers about a fifth of the country, many of these areas are now threatened with large-scale clearance for agricultural development.

### Conservation Agriculture in Mexico

At the end of 1997 about 490,000 ha were under no-tillage in Mexico, of which up to two-hundred thousand hectares were small landholdings (Derpsch, 2005). But this estimate was based on the number of no-tillage machines sold rather than more reliable information. Other sources indicated that less than 10,000 ha of no-tillage was practiced on small farms in Mexico and Central America (Wall, 1998). This contrasting information is probably due to different definitions of 'small farmers'.

### Mexico and the Irish Connection

The main reason for beginning the Nuffield study tour in Mexico was to visit one of the world's leading researchers and extensionists in conservation agriculture, ironically an Irishman. Patrick Wall was at that time based at the headquarters of CIMMYT<sup>7</sup> on the outskirts of Mexico City. Wall was born, reared and educated in Zimbabwe<sup>8</sup>, Southern Africa. During a rich and varied career in agriculture research and development he has made a significant contribution to the alleviation of poverty among the world's poorest farmers in different countries throughout Africa and South America<sup>9</sup>. This has been achieved through promoting the adoption and development of CA.

Conventional thinking, particularly in Europe, is that CA is only suitable for large scale production. While increased savings due to economies of scale apply it would be misleading to suggest that small scale holdings would not benefit from the adoption of the system. Wall has nearly four decades of experience in this area. Much innovative research work has been conducted with small scale producers throughout South America and more recently in Africa. Manual planting and animal traction technologies have been developed and have contributed to improved production methods and crop yields thereby increasing income on small holdings.

Wall is passionate about the necessity to adopt CA in an effort to boost agriculture productivity and address the many environmental problems that years of intensive soil cultivations have created. His assertion that the European subsidy system has thwarted farm based innovation, enterprise and development is difficult to argue with. The facts are glaringly obvious. There is a general enthusiasm about the future of agriculture throughout South America among both large scale and smallholder producers compared with a sense of negativity and disillusionment among their European counterparts. Wall felt that farm

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<sup>7</sup> International Maize and Wheat Improvement Centre; headquartered in Texcoco, Mexico

<sup>8</sup> formerly Rhodesia

<sup>9</sup> The Bolivian Government has formerly recognised his contribution to sustainable agricultural development

subsidies<sup>10</sup> in the European Union could and should be used for promoting and increasing the rate of adoption of CA. It would be in our own interests to have economically and environmentally sustainable crop production practices in place before subsidies are eventually removed.



*The star wheel seeding coulter can accurately place seed in soil by punching through crop residues*

In Ireland many farmers who have recently adopted minimum tillage have experienced problems with high residue levels affecting subsequent seed placement and crop development. Wall demonstrated a seeding system, developed in Zimbabwe, which dealt with this very issue. The star-wheel is a simple seeding coulter that effectively punches seed through residue into the underlying soil. However, he insisted that monoculture of high residue cereal crops will always give rise to trash management problems. The secret to successful CA implementation is the adoption of different rotations with different residue levels. Weed problems can also be effectively managed with rotation of crops.

Problems in crop production systems are all too easy to identify. In Wall's view the challenge for farmers, technicians and researchers is to come up with practical solutions to these problems. Farmers throughout South America have developed the ability to be solution focused when it comes to CA and herein lies the foundation to their success. Farmers have been open to change and are now willing to share their experiences, both positive and negative, with other farmers at field meetings and open days. Many solutions to technical problems have been identified and promoted in this way.

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<sup>10</sup> guaranteed until 2013



*Patrick Wall explains the layout of no-tillage trials at CIMMYT Headquarters, Texcoco, Mexico*

While many large-scale farmers have been very successful in reducing costs and increasing productivity through adoption of CA, Wall remains committed to working with resource poor, small scale producers in developing countries in Africa, Asia and South America. Maybe it is the Irish missionary zeal in his genetic makeup, but it is quite humbling to realise that you are in the presence of a truly great human being.

## Brazil

### Country, people and agriculture

Brazil covers almost half the continent of South America and borders every country in the region with the exception of Ecuador and Chile. Just to emphasise the enormity of the land area during the study period an agriculture researcher included a slide in a presentation where thirty-two European countries were superimposed within the borders of Brazil. The country may be divided into numerous upland and lowland areas dominated by the Amazon River Basin in the north and the Brazilian Highland Plateau in the south. The Amazon river network with over one thousand tributaries is the largest river basin in the world covering nearly three million square miles. The climate varies little within the Amazon region being hot and humid with high rainfall while most of the rest of the country has a warm, moist climate with adequate rainfall levels. There is one semi-arid region in the north east.

Little is known about Brazil in pre-colonial times. The native inhabitants were Tupi-Guaraní Indians whose settlements were well scattered. The European discovery of the country is credited to Pedro Alvares Cabral in 1500. Portuguese interest was minimal at first until a native timber yielded a valuable red dye called brasil, from which the country takes its name. Portuguese interests increased throughout the next three centuries. Brazil was declared a coequal of Portugal in 1815<sup>11</sup> and independence from Portugal was finally achieved in 1822. Much of the 20<sup>th</sup> century was unstable with frequent coups and military styled governments. President Cardoso<sup>12</sup> is credited with reducing inflation, economic reform and reducing the military's political influence during the 1990s. Today the country is a constitutional republic with two legislative houses. Present day concerns include uneven economic development, destruction of the rainforest and agrarian reform.

Brazil has a population of 178 million, the largest of any Latin American state. Its several different ethnic groups have intermixed progressively since colonial times, Portuguese with Indians and Africans. While the population has quadrupled since the 1940s, the country's population density remains low. Major urban centres in the east are now home to three quarters of the total population. Almost half the population is under twenty years of age. Most Brazilians speak a Portuguese that has been somewhat enriched by African influence. Nearly all Brazilians profess the Roman Catholic religion giving the country the largest Catholic population in the world.

Agriculture accounts for one-tenth of the country's gross domestic product and one-fifth of the labour force. Approximately seven per cent of the land area is considered arable whereas over half the country is forested. Cereals, mainly maize, corn, rice and wheat are the principal crops occupying one third of available arable land. Brazil is the world's leading producer of coffee, sugarcane, soybean<sup>13</sup>, papayas, oranges and cassava. Other crops include bananas, cocoa beans, tangerines and mandarin oranges and avocados. Livestock production is very important and Brazil's cattle and pig stocks are among the

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<sup>11</sup> Portuguese Prince Dom John initiated these reforms

<sup>12</sup> Elected in 1994 and re-elected in 1998

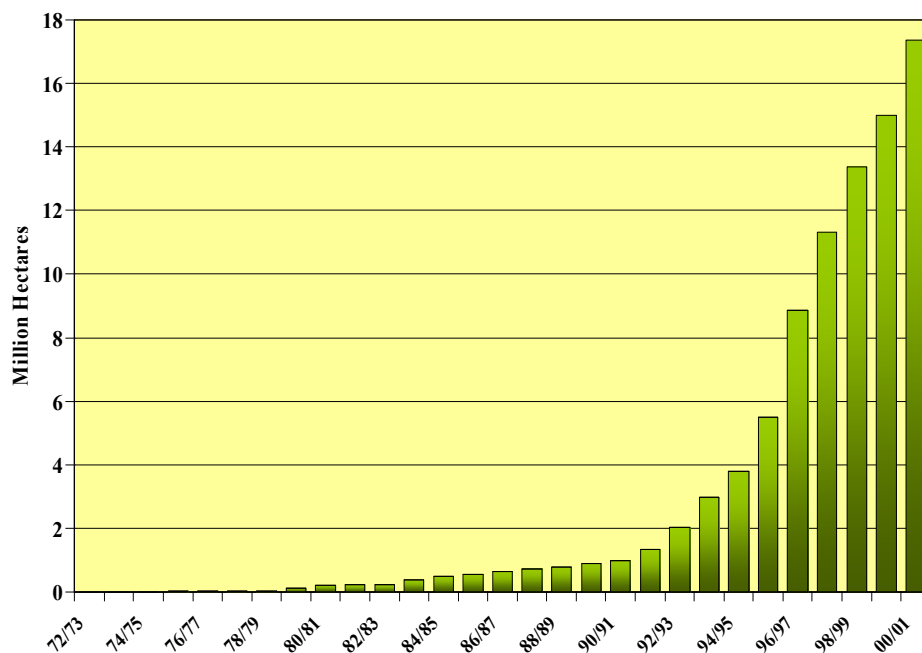
<sup>13</sup> Soybean has increased in importance in recent years due to favourable world market prices

largest in the world causing significant competition for export markets, especially with other beef producing nations, throughout the world.

### Conservation Agriculture in Brazil

Early adoption of CA systems became a necessity for some farmers in the early seventies when they observed that the conventional plough-based system led to excessive soil erosion on their farms. Some pioneer farmers brought new ideas and technology from the United Kingdom and North America in these early years. There was limited choice of equipment and there were but two herbicides, paraquat and 2,4-D, available for weed control so many problems developed.

Formal research began in Parana State in 1976 in collaboration with ICI. In response to practical needs of farmers interested in adopting the system farmer groups and clubs were established. The Earthworm Club was formed in 1979 in the Ponta Grossa State and in 1982 the Friends of the Land Club movement started in Rio Grande do Sul State. These clubs brought early adopters of CA systems together to discuss experiences and identify solutions to problems that were happening on farm. They were crucial in sharing information, experiences and new techniques and are now very popular on a nationwide basis.



Source: EMATER RS, EPAGRI-SC, EMATER-PR, CATI-SP, FUNDAÇÃO MS, APDC(CERRADO)

**Figure 2:** Shows the rapid development of CA in Brazil particularly in the late nineties

National No-Tillage Conferences were held since the early eighties where latest research findings and methods used by pioneer farmers were presented. The commercial sector produced new drills and herbicides that controlled problematic weeds making CA systems easier to manage. With these new developments the rate of uptake increased substantially. Over the years farmers have continued to improve and develop the system. Machinery

companies have modified machines based on farmer experience and formal research and educational initiatives have responded directly to farmer's information needs.

Green manure cover crops were used by all farmers interviewed and the benefits identified included soil texture improvement, increased organic matter, nitrogen fixation and also disease, pest and weed control. In Paraná State alone four million hectares of cover crops are grown annually. Many farmers and researchers now believe the full potential of no-tillage is just being realized and cover crops will have a dramatic effect in developing weed and pest control techniques together with enhancing subsequent crop performance and yields.

### Brazil and the English connection

An English man, John Landers, has made a huge contribution to CA development in Brazil by documenting much of the benefits enjoyed by farmers, the organisations involved in CA promotion, the methods used and the progress achieved at regional and national level. Based near the outskirts of Brasilia he believes that no-tillage or zero-tillage as it is termed locally, is a story of farmer-led technological evolution and integration. It was farmers and interested technicians who consistently resolved all the problems that threatened the system's sustainability in the humid sub-tropics and humid wet-dry tropics of Brazil.

Landers feels that no-tillage was attractive to farmers for a number of practical reasons; lower production costs, more planting days, simpler operation to manage, greater drought tolerance, reduced investment, reduced replacement costs for farm machinery and generally higher yields. The farmers themselves have been extremely active in promoting the new technology. The main areas where CA was adopted in Brazil had occurred due to farmer initiative with their own resources.



*English to the last, John Landers treats weeds around the wickets in Central Park in Brasilia*

The system offered a major breakthrough in soil erosion control and this encouraged further uptake and development of associated technologies. Cover crops and rotations were tested on farms and best practice was identified and disseminated. While the system has shown many positive results and higher profitability for farmers it should be remembered that the pioneer farmers faced a different situation. Initial adopters faced costs that were up to ten per cent higher than conventional systems. That said, by the 1990s when significant uptake took place, cost savings of twenty per cent were easily achievable in two year rotations.

While the pioneer farmers suffered early yield penalties, later adopters enjoyed significant yield gains in maize, soybeans, edible beans and wheat. In Landers' view better technology and higher management levels were responsible for these advancements. Labour costs were reduced by up to thirty per cent mainly due to reduced tractor numbers and lower labour requirements. Regional farm surveys found an average reduction of over forty per cent in tractor investment<sup>14</sup> among farmers practicing CA.

Landers has also monitored and reported on the complex framework of organisations<sup>15</sup> and institutions through which support for CA was developed. The involvement of the agribusiness sector was critical although isolated efforts by researchers or individual farmers had little impact until farmer organisations were involved in the transfer of information. Significant work was done by local Clubes Amigos da Terra<sup>16</sup>(CATs) that had a network of branches and provided a practical bottom-up solution to the adoption and improvement of CA at farm level. These clubs disseminated, in a practical way, new developments and research findings.

**Table 1:** Activities of the Clubes Amigos del Terra ('Friends of the Land' clubs)

<b>Activities of Clubes Amigos da Terra(CATs)</b>		
<b>Adoption Phase</b>	<b>Mature Phase</b>	<b>Advanced Phase</b>
<ul style="list-style-type: none"> <li>▪ Basic instruction</li> <li>▪ Farmer to farmer contact</li> <li>▪ Short Courses</li> <li>▪ Lectures, Field Visits/Tours</li> <li>▪ Machinery Clinics</li> </ul>	<ul style="list-style-type: none"> <li>▪ Specialist Seminars</li> <li>▪ Field Days</li> <li>▪ On-farm research trials</li> <li>▪ University linkages</li> <li>▪ Field Tours</li> <li>▪ Professional and Organisation Training</li> </ul>	<ul style="list-style-type: none"> <li>▪ Rural Leadership Courses</li> <li>▪ Financial Management</li> <li>▪ Research Partnerships</li> <li>▪ Advanced Management Courses</li> <li>▪ Workshops</li> <li>▪ Discussion Groups</li> </ul>

Landers now believes that CA is a gateway to enormous change in core farming values and represents a qualitative leap forward in Brazilian agriculture. The farmer progresses

<sup>14</sup> Expressed as hp per hectare

<sup>15</sup> See Appendix 2

<sup>16</sup> Friends of the Land Clubs

towards higher profits while at the same time accepting greater environmental responsibility. There is also a social conscience in the CA movement with technology transfer from large to small scale farmers and from adopters to non-adopters.

#### Private sector involvement in Conservation Agriculture

Marcio Scalea is the No-Tillage Manager for Monsanto in Brazil. He has worked in this area for nearly three decades. His work, during that time, can be divided in a number of different phases. In the early 1980s he co-ordinated herbicide<sup>17</sup> research and development advising farmers on best practice. From the mid eighties up to 1993 he concentrated on new agriculture systems uptake mainly conservation-tillage and no-tillage. For the remainder of the nineties Scalea developed CA systems for crop and pasture integration (CPI) as many customers of the company had mixed enterprises.

There was huge variation in cattle price, up to sixty per cent in some instances, where some farmers using feedlot systems made a lot of money while many others went out of business. With CPI systems there is not as much variation in income. However, despite best efforts, CPI promotion wasn't very successful due to barriers within the company. The system worked where there was a motivated representative who created new dealerships around CPI. However, with 35 million hectares of degraded pastureland<sup>18</sup> in Brazil, work in this area is vitally important.



*Marcio Scalea of Monsanto plots the development of No-tillage in Brazil*

In recent years he has returned to no-tillage promotion. Company information revealed that there was sixty per cent uptake of no-tillage and most large-scale producers had already been identified. The remaining forty per cent were small holders, but from a commercial

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<sup>17</sup> Lasso and Roundup

<sup>18</sup> There are many estimates for degraded pasture area ranging from 35-85 million hectares

point of view this still represents forty per cent of available tillage land. Monsanto's no-tillage strategy was to target areas for fast adoption. Regions with suitable rainfall patterns were identified. These were conducive for the growth of safrinahs<sup>19</sup> where an extra cash crop could be grown in the same season. Sorghum and millet were the main safrinahs grown. This generated extra income for farmers and within three years the cost of a new no-tillage drill could be recouped. Crop residues were of benefit to succeeding crops and the system gave new adopters a chance to experiment and develop the necessary skills for successful no-tillage systems particularly on light soils.

Uptake of CA practices has been extraordinary in some areas. Crop production in the Minas Triangle<sup>20</sup>, an area of five hundred thousand hectares, is now fully devoted to no-tillage.

Brazil is already the largest exporting nation of soybean and it was obvious as the crop was being grown everywhere – even along roadside margins. Due to favourable prices the crop is now an important cash crop and grown in a monoculture system<sup>21</sup>. But even when the crop is grown for four or five years a one-year fallow break is required. Compaction, weed and fertility problems develop and need to be addressed during this fallow break. Another problem that many farmers feel is a direct result of monoculture of soybeans is the increasing spread of soybean rust (*Phakopsora pachyrhizi*). A strobilurin fungicide is now needed to control this disease. Purist no-tillage farmers refuse to grow soybean in the same fields annually as they feel it will jeopardise the many soil and agronomic benefits they have enjoyed using rotations.

Scalea is quite rightly proud of his contribution to the promotion and uptake of no-tillage in Brazil. He believes it has been the foundation for a thriving agriculture sector in his country. The enormous scale of degraded pastureland available means that crop production will continue to advance in the medium term and further developments in no-tillage will allow Brazilian farmers to capitalise by providing food for an increasing world population.

#### Fighting the good fight with Herbert Bartz

Herbert Bartz is frequently referred to as the father of no-tillage in Brazil. He started no-tillage in the early seventies when his chief concern was the prevention of soil erosion on his farm due to heavy rainfall – up to 300mm per day. It is no small irony that he visited ICI in Fernhurst in the UK and a farmer in Kentucky at this time to research the advances of this technique. He bought a no-tillage drill in each country and started seeding his first no-tillage soybeans in 1972. Thus, Herbert Bartz became one of the first farmer to try the technology in Latin America. Some problems developed<sup>22</sup> but Bartz persevered on observing the benefits the system was bringing to the farm. Any early yield losses were soon reduced and eliminated using a mixture of cover crops, rotations, crop residues and good rooting plants. While he believes that in general terms you have to be very flexible to

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<sup>19</sup> Short season cash crops

<sup>20</sup> Minas Gerais State

<sup>21</sup> In some areas two crops are grown in one year

<sup>22</sup> Weed control proved difficult in the early years

succeed at no-tillage he insisted that one should not be flexible with relation to achieving targets. And no-tillage does demand good logistics and planning.



*Herbert Bartz stands in a recently harvested maize field ready for sowing the next crop*

Bartz now owns 240 hectares and has plans to lease between 200-500 extra hectares in the coming years. The crops grown on a rotation basis include soybeans, triticale, winter and summer maize and black oats<sup>23</sup>. These five crops, one of which is a cover crop, are grown in a three year cycle. Winter maize gets 200kg per hectare of fertiliser<sup>24</sup> with twenty per cent less seed sown compared with summer maize which gets double the amount of fertiliser to enhance the greater yield potential. Maize being harvested at that time was being dried using timber as a fuel.

High yielding soybean is direct drilled and only treated with a growth inoculant after an initial herbicide treatment to control any weeds present. Bartz saw huge potential for increased soybean production in Brazil. Forty-five million hectares of soybean were being grown in 2004. There was further potential to increase this to 130 million hectares by utilising available degraded pastures. No-tillage could make these lands productive again simply by applying both lime and phosphate fertiliser, direct drilling the crop and subsequently spraying off grasses. Brazilian farmers can now produce one tonne of soybean for half of the cost of production in the USA due in no small way to the economic efficiency of the no-tillage system. While many American farmers are now trying to buy land in Brazil they are often viewed with mistrust by the local population.

Conservation agriculture in the form of no-tillage has revitalised Bartz's farm. Even three decades after adoption, the full potential of the system is only being realised through the

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<sup>23</sup> Black oats are used to decrease fusarium levels in the soil

<sup>24</sup> A compound N-P-K(8-20-20) is used at drilling

use of cover crops to control weeds and pest species. Over one hundred different species of predator insects like wasps, beetles and spiders have been recorded by researchers on Bartz's land. The practical result of achieving this natural balance is evident in that he no longer needs to apply insecticide to any of his crops. One researcher noted how many of his fields have similar organic matter levels<sup>25</sup> to tropical rainforest areas. In 1986 due to surplus residue in some fields Bartz decided to diversify with an alternative enterprise. He selected water buffalo, one of the oldest domesticated species, with low management input as the breed suffer few if any health problems and no sanitation was required. He made a small lake where they swim and bathe. The buffalo scratch surrounding trees to deter lice. A herd of 75 are run on ten hectares of pasture and fed with surplus residue from some fields and cleanings from the grain drying process. Bartz sells about thirty-two year old young steers annually.



*Herbert Bartz stands beside his reconditioned tractor during a break from drilling*

He has been the proverbial 'thorn in the side' of the tillage establishment. With relation to no-tillage he asserted that the farmer has been the researcher. Indeed, in his view many modern-day tillage researchers are no more than specialised idiots. What is really needed in CA systems is multi-disciplinary holistic researchers not specialised botanists, entomologists, soil scientists, or machinery experts. No-tillage is an integrated system with interdependence of all aspects – soil, plants, fauna, and the impact of equipment used. Far too often you encounter 'experts' with little or no appreciation for the bigger picture outside their own specialist area. He was also critical of many farmers and their obsession with image particularly when it came to farm machinery and equipment. It wasn't just talk either as there was no evidence of 'new paint' in Ponta Grossa where he lives. His own vehicle is a well maintained 1951 Chevrolet pickup. The main tractor on the farm is a 1976 Massey Ferguson 255 (78hp). In 2003, the tractor was modified by installing a new Perkins engine

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<sup>25</sup> Some tillage fields have OM >5% while in a rainforest area OM levels range between 4.5-5%

(150hp), a new clutch, front wheel drive and new rear axle with low ground pressure tyres. All these modifications cost \$25,000. The wily farmer had saved in excess of \$100,000 on the purchase of a new 150hp tractor. Drill manufacturers Tatu have fifty per cent market share in Brazil and Bartz acts as adviser to the company with regard to suggesting drill and planter improvements. It highlighted yet again the close contact and mutual respect that has developed between researchers, technicians and farmers in South America.



*A plaque is set on a boulder at the side of Bartz's farmyard testament to the fact that it is thirty years now since he has been practicing sustainable crop production without using the plough*

Bartz is a fascinating character. He recounted how his mother had struggled to rear her family after she had to emigrate from post-war Germany to South America. While he initially appears to be both stern and austere he is compelling company as he recounts his, often hair-raising, experiences during the last three decades. The initial demeanour is understandable because for years he had been ridiculed, vilified, and shunned by his peers and the agriculture establishment for insisting on abandoning the plough while encouraging the adoption of no-tillage. For Bartz, ploughing is quite simply burning soil. It is an invisible flame where organic matter is oxidised robbing the soil of its carbon reserve. Ultimately it is an unsustainable system.

#### Holistic research at IAPAR

A two day visit to the headquarters of the Institute of Agronomic Foundation (IAPAR)<sup>26</sup> was an enlightening experience. The institute is located at Londrina in the southern state of Paraná. With an annual budget of US\$12 million dollars the institute has 550 staff with a further seventeen research facilities throughout the state. But here is the difference. Over

<sup>26</sup> Fundacao Instituto Agronomico do Paraná

seventy per cent of IAPAR's research work is conducted on farm. Medium sized field scale plots, up to one hectare in size, are used for evaluation purposes. Farm machines are used under field conditions. It demands massive effort in terms of coordination and collaboration with the host farmers. But the benefit is that research is more practical, more relevant and more applicable to farm situations. It also encourages a closer relationship between researchers and farmers where the latter are fully involved in evaluating developments in new technologies. The concept has attracted much international attention. Visits to IAPAR had recently taken place from the USA – 7 groups, Canada – 2 groups, Korea, South Africa, Paraguay, Italy, Poland, Germany, Holland, Australia and farmer representatives from other countries in Africa and Asia.

With relation to machinery evaluation, in the previous year, trials were conducted comparing up to thirty drills and planters. Comparisons were made with relation to soil disturbance<sup>27</sup>, ability to deal with different residue levels and types, seed and fertiliser placement, power requirements and speed of drilling. The information is presented to farmers at research open days and via other extension methods<sup>28</sup>. By contrast in Ireland there are only four commercial drills suitable for direct drilling available on the market. No such comparisons have been made in the past five years either at research or farm level. The result is that Irish farmers make their decisions on drill purchase solely based on company information and testimony by other farmers who are using similar machines<sup>29</sup>. Little or no independent comparative research information is available.

#### Researcher with a difference

Dr Ademir Calegari is a researcher based at IAPAR in Londrina. For many years he has conducted research in collaboration with farmers in conservation agriculture techniques both at home and abroad. He is very knowledgeable in the area of use of cover crops in no-tillage. The main winter crops, including cover crops, grown in his region include oats, wheat, radish, vetch, rye, triticale, lupins, barley, ryegrass and moya<sup>30</sup>. Spring and summer crops include maize, soybean, cassava, tobacco and rice. He repeated the phrase 'Tuda tem sua hora', timing is critical, many times with relation to implementing successful no-tillage.

Calegari is passionate about plants and the positive contribution they can make to agriculture productivity. Different plants can enhance natural nutrition levels in the soil as well as increasing organic matter. They can also reduce levels of diseases<sup>31</sup>, pests<sup>32</sup>, weeds

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<sup>27</sup> minimal soil disturbance is considered desirable in no-tillage drills and planters

<sup>28</sup> newspaper articles, publications, conferences etc.

<sup>29</sup> you rarely witness a farmer running down his own equipment – in every sense of the word

<sup>30</sup> an edible bean

<sup>31</sup> *Avena strigosa* versus fusarium in the soil

<sup>32</sup> *Leguminosa melhorada* versus nematodes



*Dr. Ademir Calegari stands in a field with different cover crops currently being used in Brazil*

and even soil acidity. The initial success of conservation agriculture in Brazil has been further enhanced by the widespread use of cover crops in association with cash crops. He cited work conducted by Marcos Penalva<sup>33</sup> that showed conventional cotton yielded 900kg per hectare but with no-tillage and grown after a cover crop the crop yielded 2,210kg per hectare. The main cover crops grown in Paraná State include black oat, radish, vetches and field pea. Cover crop mixes are also popular with combinations of the following plants being used, oats and radish, black oats and vetch, lupins and rye and finally mucuna and crotalaria. Just before flowering the cover crops are flattened, chopped or mulched and left on the soil surface acting both as a green manure and a mulch to inhibit weed growth. In some instances living cover crops are grown in association with the cash crop. Over four million hectares of cover crops are now grown in Paraná State on an annual basis.

#### Cover crops and their uses

Jackbean, *Mucuna puriens* L., is a very popular cover crop grown in highland areas of Brazil. High growth rates make it an ideal green manure crop to boost organic matter levels in the soil. Rapid and complete ground coverage means that it will suppress weed growth and it is often intercropped with maize by farmers on small holdings.

Crotalaria is an excellent cover crop. Used as a nitrogen fixing plant it can provide up to 150 Kg/N per hectare. It also has a great root system and the strength of these roots is useful in breaking through compacted soil. The stem is soft and easy for a drill to disc through - an important consideration for no-tillage.

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<sup>33</sup> researcher in Conservation Agriculture from Uruguay

Vetches, *Vicia spp.*, are sometimes used in organic production systems in Ireland and the UK. The plant has become very popular in Brazil for fixing nitrogen. Research has demonstrated that between 90-120Kg/N per hectare can be fixed in one season.

An awned grass, *Satarica spp.*, is grown primarily in Uruguay. It only takes forty days to flower. With low lignin levels it has a low carbon to nitrogen ratio and as a result is easily broken down in the soil. Suitable crops grown afterwards include wheat and rye.

A plant from the radish family, *Rafanus sativus* L, has been used successfully by IAPAR researchers in the Itapu dam area. By growing this plant as a cover crop they have virtually eliminated the use of chisel ploughs in high clay soils in the area. The root penetrates deep into the ground and is excellent at breaking compaction.

Buckwheat boosts phosphorus levels in the soil and is sometimes intercropped with sunflower. The crop is grown in France and has further potential to be used in Ireland and the UK.

Finger millet is relatively new plant brought in from Africa. It is used there for crop and livestock integrated systems. The high protein content means it is a good forage crop for animals and integrated systems are increasing in importance in Brazil. The plant has very strong roots and is being used as a cover crop grown before soybean, maize and cotton.

**Table 2:** Cover crops and winter second crops used in Conservation Agriculture in Brazil

Sub Tropics	Tropics
<ul style="list-style-type: none"> <li>• Black Oats (<i>Avena strigosa</i>)</li> <li>• White Oats (<i>Avena sativa</i>)</li> <li>• Blue Lupin (<i>Lupinus angustifolius</i>)</li> <li>• White Lupin (<i>Lupinus albus</i>)</li> <li>• Hairy Vetch (<i>Vicia villosa</i>)</li> <li>• Italian rye grass (<i>Lolium italicum</i>)</li> <li>• Spring wheat (<i>Triticum aestivum</i>)</li> <li>• Triticale (<i>Rye x Wheat hybrid</i>)</li> <li>• Barley (<i>Hordeum vulgare</i>)</li> <li>• Rye (<i>Secale cereale</i>)</li> <li>• Oilseed Radish (<i>Raphanus sativas</i>)</li> <li>• Velvet Bean (<i>Mucuna pruriens</i>)</li> <li>• Corn Spurrey (<i>Spergula spp.</i>)</li> <li>• Weed Fallow (<i>Various spp.</i>)</li> </ul>	<ul style="list-style-type: none"> <li>• Pearl Millet (<i>Pennisetum americanum</i>)</li> <li>• Sorghum (<i>Sorghum bicolor</i>)</li> <li>• Black Oats (Above 800m) (<i>Avena strigosa</i>)</li> <li>• Oilseed Radish (<i>Raphanus sativum</i>)</li> <li>• Wild Radish (<i>Raphanus raphanistrum</i>)</li> <li>• Crotalaria spp. (<i>C. juncea, C. ochroleuca, C. spectabilis and C. paulinea</i>)</li> <li>• Pasture Grasses: (<i>B. Decumbens B. razziensis B. brizantha and B. plantaginea</i>)</li> <li>• Pigeon Pea (<i>Cajanus cajan</i>)</li> <li>• Weed fallow (<i>Various species</i>)</li> </ul> <p>Promising new options:</p> <ul style="list-style-type: none"> <li>• Amaranthus (<i>A. ciruentus A. hydrochondriacus</i>)</li> <li>• Quinoa (<i>Chenopodium quinoa</i>)</li> <li>• Guinea sorghums and millets (<i>Eleusine indica</i>)</li> </ul>



*Decayed Raphanus sativus is pulled from the soil showing the big hole the root has created*

Calegari recommends using cover crops for disease and pest control and weed suppression. Specific plants can be used to counteract soil compaction or condition the soil through texture improvement by increasing organic matter levels. By using nitrogen fixing cover crops<sup>34</sup> significant nutrition for associated or succeeding cash crops can be achieved. High mulch cover crops can further promote crop and livestock integration systems. Farmers need to become more aware of plant interactions with the soil as well as other plants. Much of the knowledge is there but it is up to researchers and agronomists to access this information and work with farmers to find new and improved ways of developing sustainable crop production for the benefit of society as a whole.

*Brazil is a rich and wonderful country with beautiful landscapes and a pleasant climate. But this pales to insignificance when compared with the country's magnificent people. Seldom would one meet a more culturally diverse population that are very friendly, talented and modest. It is highly likely that CA development has been enhanced by the special attributes of the people involved.*

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<sup>34</sup> leguminous plants

## Argentina

### Country, people and agriculture

Argentina occupies much of the southern portion of South America. A large country with a land area of just over one million square miles, it extends for 2360 miles north to south and 885 miles east to west at its widest. It is bordered by the Atlantic ocean to the east<sup>35</sup> and the Andes mountain range to the west and south west. The country can be divided into four general regions; the north eastern plains, the Pampas, Patagonia, a semi barren desert, and the Andes mountains. The Pampas lie to the south of the Paraná river and has become one of the world's most productive agriculture areas. The country's climate is variable depending on the region with warm to hot summers and cool winters. The Pampas is a temperate region, humid in the east and dry in the west.

Little is recorded of Argentina's pre-colonial history. Argentina's original Indian inhabitants were much reduced in numbers in the centuries after the Spanish first arrived in 1516. The latter's settlement of the country was quite slow. Until 1776 Argentina was part of the Viceroyalty of Peru later to be changed to the viceroyalty of Rio de la Plata with Buenos Aires as the capital. In 1816 a national government was attempted but several caudillos<sup>36</sup> competed for power. In the Pampas region bloody campaigns against nomadic Indians opened vast tracts of land to ranchers and settlers. By the 19<sup>th</sup> century the population was largely Spanish in character. Nearly three and a half million immigrants arrived in Argentina in the hundred years up to 1950, mainly of Italian and Spanish origin. During this period the centre of population moved from the north and west to the Pampas region. Argentina's population has now risen to 38 million.

Politically unstable during much of the 20<sup>th</sup> century, the country's history during this time is defined by periods of moderate democratically elected governments and military rule following armed coups. In 1982 the Argentine armed forces took possession of the Falkland or Malvinas Islands, as they are known locally, which the country had claimed for over a century. When British forces retook the islands in June the then military junta relinquished its rule and permitted a general election in 1983. The last twenty years are marked by runaway inflation, strikes, high unemployment and frequent changes of government.

Argentina is Latin America's largest exporter of food and other agriculture goods. The country's vast pasturelands make it a world leader in the production and export of beef and hides from cattle and wool from sheep. In recent decades Argentina has tried to break away from the country's dependence on meat-packing, flour-milling and sugar refining. Wheat is the principal cash crop and is grown mainly in the Pampas region. Maize corn, soybeans<sup>37</sup>, sorghum, sunflowers, flax, fruits, sugarcane, vegetables and melons are also grown in large quantities.

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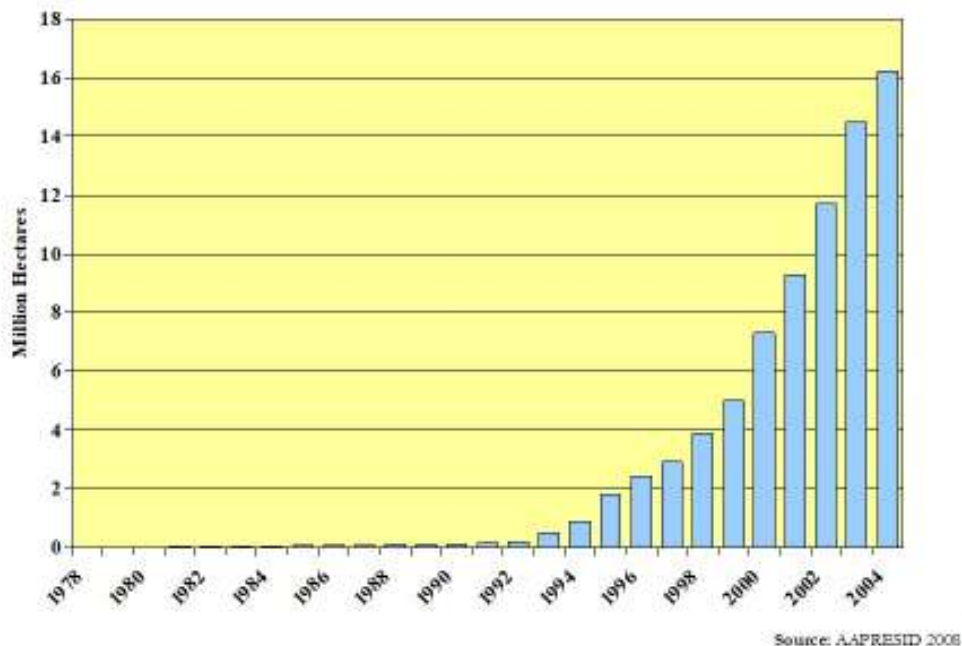
<sup>35</sup> the coastline extends for 2,936 miles

<sup>36</sup> regional dictators and strongmen

<sup>37</sup> soybean production is rapidly increasing in area due to favourable world market prices

### Conservation Agriculture in Argentina

Early adopters of CA technology began their experiences with the system in the late seventies. For many it was an extremely difficult decision to make as many of the farmers interviewed noted that no-tillage systems proved more costly than conventional systems being used at that time. For many of the early pioneers, much like their Brazilian counterparts, the priority was to curtail and eliminate soil erosion on their farms. A number of farmers interviewed observed that The National Institute for Agriculture Technology (INTA) in collaboration with ICI promoted research into no-tillage systems. Information meetings and open days were held at farm level in the early eighties. Farmers used the system to produce two crops in one year and others were impressed with the positive impact on protecting and improving soils. It was the simplicity in operating the system that proved most attractive for early adopters. Availability of machines was the main constraint to development and uptake of CA, but with increased interest and demand new equipment was developed and there are now in excess of thirty different drill manufacturers in the market place.



**Figure 3:** Shows the rapid development of CA in Brazil particularly in the late nineties

The healthy world market price for soybeans has led to the development of continuous production of this crop and consequently some problems have developed with the system. Soil compaction has resulted, there is a proliferation of certain weed species and there is an overall reduction of soil fertility where monoculture of soybeans has been practiced. The more experienced farmers continue to use crop rotations as they feel that short term income gains are negated by the different problems that develop under a monoculture system.

### AAPRESID – El Desafío es Innovar<sup>38</sup>

The Argentine Association of No-Till Farmers (AAPRESID - Asociación Argentina de Productores de Siembra Directa)<sup>39</sup> was founded in 1986 and has been hugely influential at farm level in the diffusion of CA technology. The aim of the founders was to create a researcher and farmer network to exchange knowledge and experiences related to no-tillage systems. To do so, they organized different events, which became more and more frequent, such as Field Days, Seminars, Congresses, Technical Exchange Days, Trials. The association developed and circulated updates on each crop that highlighted progress made after each season. When the association was founded twenty-five thousand hectares were in production using no-tillage technology. Within ten years the area of no-tillage in Argentina had increased to 4.5 million hectares.



*AAPRESID President, Jorge Romagnoli, began no-tillage in the eighties on a small scale.*

Jorge Romagnoli is the current President of AAPRESID. A qualified agricultural scientist he began farming on a small scale in the 1980s. The transition to no-tillage was not easy as, at that time, the system was more expensive to adopt than the conventional plough-based alternative. He persevered and having overcome some early teething problems he now runs a successful farm enterprise. On-farm trials are conducted each year with different input levels and various rotations, the objective being to perfect the system in a variety of situations. Romagnoli emphasised that the choice of rotations was crucial for soil improvement and management. One of his trials clearly demonstrated the impact of rotation choice on root development in the succeeding crop.

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<sup>38</sup> The Challenge is to Innovate

<sup>39</sup> [www.aapresid.org.ar](http://www.aapresid.org.ar)



*Different root masses after preceding crops highlight the importance of rotation choice. On the left is maize after sunflower while the right is maize after soybean.*

AAPRESID now has two thousand members with twenty-three active farmer groups but it was a struggle the whole way. Even up to a couple of years ago senior researchers and agronomists in Argentina poured scorn over the development of no-tillage and its appropriateness under a variety of climate and soil conditions. APPRESID is well resourced with revenue coming from membership fees, commercial sponsorship and receipts from advertising, publications and conferences. The organisation holds a major conference in August each year in Rosario. Over two thousand delegates, mainly farmers, attend the conference over the three days.

Victor Trucco, a former president of APPRESID had some pertinent advice for researchers and farmers in Ireland and the UK;

*“Don’t waste time and money doing research from scratch. Spend your time and finances on developing demonstration sites and tasks with farmer involvement. Much of the necessary research work has been done already. What is important now is farmer uptake and development of CA with new methods at field level.”*

The APPRESID association has up to twenty full-time agronomists one of which is Agustin Bianchini. Augustin’s role is the promotion and dissemination of new developments in CA. This is conducted by a range of methods including farm visits, farm meetings with some of the twenty-three farmer groups and the organisation of on-farm trials and related open days.

He noted how beneficial it was to get farmers together to openly discuss the problems they were encountering at these events. Many of the solutions are identified by other participating farmers at these meetings. The annual FERIAGRO show provides an excellent opportunity to recruit new members to the association and sell technical publications to farmers – both important sources of revenue. It is this revenue that allows farmers access to

the technical support provided by Bianchini one of the new 'breed' of forward thinking agronomists.



*Augustin Bianchini demonstrates the deep root development of soybean in a field where no-tillage has been practiced for a number of years*

#### Integrating CA and livestock production systems in the Pampas

Leonardo and Martin Herrera-Vegas farm 3,300 hectares near Tandil, in the south of Buenos Aires province. Leonardo bought Santa Rosa farm in 1946. Situated on undulating land, 1,500 hectares is extensive grazing on upland areas with 500 hectares of grazing land. The remainder is devoted to the production of soybean, wheat, oats, maize, and sunflower. Annual rainfall is 900mm and while the winter season lasts from May to September, sixty days frost during this period slows residue decomposition down in the field. Thanks to no-tillage the organic matter level is maintained at six per cent across the entire farm.

The attraction of no-tillage in the 1990s was that it was a simpler system to operate. There are now only two jobs to do - sowing and spraying. There is only one tractor on the farm with lower horsepower required than what was previously necessary. This has resulted in significant savings in terms of labour and diesel costs. Less capital is now tied up in the business on an annual basis. Some increased inputs were necessary with the no-tillage system. Extra phosphorus is now being used and with increased numbers of pests<sup>40</sup> and diseases<sup>41</sup>, especially in soybean and sunflower crops, extra sprays are at times required.

There has been a significant increase in the area devoted to soybean production in Argentina. This has happened for two main reasons; the healthy average 2004 world market

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<sup>40</sup> crickets, caterpillars, and white weevil

<sup>41</sup> drechslera, septoria, sclerotina spp.

price for soybean<sup>42</sup> and the popularity of genetically modified (GM) soybean<sup>43</sup>. The attraction of GM soya is the simplicity of production – you only have to sow, spray and harvest the crop.

A rhizobium inoculant is used on the soybeans at sowing costing \$3-4 per hectare. No further nitrogen is necessary. Phosphorus at 40kg per hectare is applied at sowing. Herreras Vegas remarked that the proliferation of genetically modified soybean landscape will make a desert of South America in the coming years. The increase in incidence of Soya Rust<sup>44</sup> was becoming a concern. Rotations are being abandoned which are essential for successful no-tillage systems and the associated management of weed and pest species. He is adamant that monoculture is bad for the land and bad for the farmer.



*Leonardo and Martin Herreras Vegas inspect an eroded gully on Santa Rosa farm*

Conservation Agriculture principles are followed for the beef production system on Santa Rosa also. The main breeds are Aberdeen Angus, Hereford and Shorthorn crosses reared to two years and exported to Europe. Cattle graze excess crop residues after harvest on selected fields. For pasture regeneration ryegrass in the existing sward is left to go to seed. The seed falls to the ground in December and undesirable vegetation is sprayed with glyphosate. The new ryegrass growth is grazed off once and urea fertiliser is applied to encourage further establishment, tillering and development of the new sward. Other grass species like cocksfoot and brome are direct drilled with clovers and trefoils for pasture establishment.

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<sup>42</sup> \$212/tonne compared with \$88 for Maize, \$120/tonne for wheat and \$200 for sunflower

<sup>43</sup> almost all soybeans grown in Argentina are genetically modified

<sup>44</sup> *Phakopsora pachyrhizi* is increasing in incidence and now requires extra fungicide treatments

### The farm manager's view – Sebastian Lahore

Sebastian Lahore works as an agriculture consultant with a slight difference. He only has two clients. The clients are a husband and wife team and between them they own seven thousand hectares in an integrated crop and livestock system. Lahore effectively manages the entire operation from selecting crop varieties and rotations and he oversees<sup>45</sup> field preparation, sowing, fertiliser, and pesticide applications where required. He manages the livestock enterprise up to and after point of sale whereas the crops are managed right up to harvest and storage. Time of sale is decided by the two owners.

Lahore has insisted on using no-tillage across all crops but believes that rotations are very important. He has successfully implemented a double crop<sup>46</sup> of soybean after wheat. In the field pictured below wheat was harvested in late December with a stripper header and the soybean was direct drilled into the standing wheat stems on the same day. They would be harvested within four months. He noted that no agronomic skills were required to grow GM soybean. Lahore considered it crazy that the growth of transgenic crops in Europe was not allowed.



*Sebastian Lahore stands in a field of soybeans no-tilled into standing wheat stubble*

Other crops he uses in rotation with soybean and wheat include sunflower and maize. Through experience he has learned that growing wheat after maize is too difficult. Most stubble is left standing tall after harvest. South American designed no-till drills can cope with difficult seedbed situations. Lahore had strong views on no-tillage organisations and was against too much commercial involvement in the latter. The needs of small-scale producers are often ignored and large-scale operators benefited most from organisation

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<sup>45</sup> often from horseback – a saddle is always carried in the back of his pickup

<sup>46</sup> two crops in one season

activities. This issue aside, Lahore is very optimistic about the future development of CA in Argentina.

*Many other visits in Argentina yielded similar information and experiences. Pioneering farmers placed great emphasis on rotations in order to succeed at no-tillage. It is obvious they are a few years behind Brazil in CA developments on farm. Very little reference was made to cover crops or their potential use. In many instances, farmers had gone back to monoculture of soybeans and there was evidence of some issues arising with regard to fertility, pests, disease, and weed control. Despite this the development of CA is intriguing because, as one CREA<sup>47</sup> extension officer noted, 'Argentines are renowned for their arrogance and pride both within and outside the country. The openness and co-operative spirit necessary to make farmer groups work does not therefore come naturally to them'. Not that one would have noticed as they still are among the world leaders in CA development.*

## Paraguay

### Country, people and agriculture

Paraguay is a small landlocked state in South America, lying between Argentina to the south, Bolivia to the northwest and Brazil to the northeast. With a land area of 157 thousand square miles the Paraguay river flows north-south through the country, dividing it into two very distinct areas. The western region forms part of the flat plains of the Gran Chaco, which extend into Bolivia and Argentina, and the eastern region rises gently from the floodplains of the Paraguay and Parana rivers to a series of low mountain chains along the Brazilian border. The climate is described as sub-tropical with seasonal rainfall of 52 inches (1,300 mm), heavy in the east, which is prone to flooding, and sparse in the west, where droughts are frequent.

The first European explorers to Paraguay found the country inhabited by friendly Guaraní peoples. In 1776 Paraguay became part of the Viceroyalty centred on Buenos Aires. During the nineteenth century Paraguay was ruled by dictators, namely Carlos Lopez (1790-1862) and his son Francisco Lopez (1827-70), who ended historical isolationism and encouraged Paraguay's development, they embroiled the country in conflicts with its neighbours. The War of the Triple Alliance (1865-1870) ended in total devastation, when nearly all Paraguayan males between the ages of 15 and 70 were killed. It became the custom for families to be headed by women and marriages were infrequent. While the balance of the sexes has all but been restored, some 50 per cent of all births today are outside marriage. The population has since increased to in excess of 5.9 million in 2003 of which ninety per cent are ethnically Mestizo. The main spoken language is Guaraní alongside the official language, Spanish. Most Paraguayans are nominally Roman Catholic. The form of government is a multi-party republic with two legislative houses.

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<sup>47</sup> Consorcio Regional de Experimentacion Agricola was founded by Pablo Hary in 1957. Based on a French model, it is a research and development organisation funded by private farmer members.

The economy has traditionally been based on agriculture, which is still a major source of income. While cattle production on ranches is the main pursuit, crops such as cotton, sugar cane, and soybeans are gaining in importance. Outside agriculture there are no significant mineral or energy reserves but the hydro-electric potential is enormous and Paraguay is already a leading exporter of hydro-electric power.

#### Conservation Agriculture in Paraguay

CA systems were not adopted until the early eighties in southern Paraguay. Many farmers experienced problems with imported drills being used and many reverted to conventional systems. A soil conservation project that began in 1993, as a collaborative effort with the German government, led to the steady development of no-tillage and diffusion of appropriate skills at farm level. By the late nineties, half a million hectares had been converted to CA mainly for the production of soybeans. Paraguay is now the leading country in the world in terms of percentage of arable area devoted to no-tillage production systems (Derpsch, 2005).

Based on experiences gained in other countries, a concerted effort was made to increase farmer awareness on weed identification, biology and control. Farmer training days highlighted best weed management practice, but it was the publication of technical weed control guides that contributed significantly to the initial success of CA systems. Further developments have since taken place and farmers are now using less herbicide for weed control than ever before. Cover crops are grown and before flowering the plants are flattened or mulched before the subsequent cash crop is sown. One consultant observed that twenty years after initial adoption the Paraguayans are only now beginning to understand the inter-relationships between various plant species and the real potential of CA with regard to allelopathy<sup>48</sup>, soil fertility and plant nutrition.

#### Developments in Conservation Agriculture and no-tillage



Rolf Derpsch is one of the world's leading consultants in CA and is based in Asuncion, the capital of Paraguay. Derpsch believes that the adoption of no-tillage requires a complete change of mindset. Too many farmers, researchers, extension officers and consultants embrace aspects of the system without fully appreciating that it is a holistic approach to crop production and full benefits will not be realised without adoption of all facets of the system. Wherever possible it is necessary to reduce and eliminate excessive soil movement when establishing a crop. Maintenance of constant soil cover with either cover crops or previous crop residues is necessary and the appropriate use of rotations is essential.

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<sup>48</sup> The chemical inhibition of one plant by another due to the release of natural growth inhibitors from plant roots.

Brazilian farmer Herbert Bartz was considered crazy in the 1970s, and greater part of the 1980s, for his promotion of no-tillage. Individuals from research agencies and other farmers frequently criticised his bullishness about this crop production system. Derpsch had worked with Bartz back in the 1970s and much of the work the farmer was doing was documented as a result. Different methods and techniques adopted led to resolving some of the problems that had occurred including residue management, seed placement, and weed control. Use of *safrinahs* and black oats as cash and cover crops respectively were practices by which weed and disease pressures were reduced.

Derpsch does not like tine<sup>49</sup> implements as they are aggressive and result in too much soil disturbance. He also noted that they do not manage high residue levels satisfactorily. He has seen their use in Australia where the top 5-10cms of soil became too dry and crop seed needed to be sown deeper as a result. A tine knife is used to rip soil down to moisture to enable germination and development of the sown crop. The phenomenon of surface dryness could be addressed through the use of cover crops and constant residue cover by maintaining moisture nearer the soil surface<sup>50</sup>. He believes for this reason that disc systems are better for no-tillage systems.

Derpsch believes that residue management needs to be rethought. Agronomists tend to believe that shorter residue is easier to deal with than longer residue. One of the successful techniques used to avoid hair-pinning<sup>51</sup> is through the use of longer stubble. A higher cut on the harvested plant combined with even distribution of chaff and straw that has been cut would avoid the problem of poor seed placement. This practice has been adopted in Switzerland with good success.

### Weed control developments

One of the big problems that can occur when no-tillage is adopted is the proliferation of weeds and different weed species. In early 1970s there were only two herbicides available for the control of weeds but there are many more now<sup>52</sup>. The problem is that very often the information on such herbicides is located in different company manuals at different points of origin. If you are a farmer this information is often not easy to understand and is time consuming to access. One of the successful approaches developed in Brazil, Paraguay and Argentina has been the development of specific herbicide and weed control guides for no-tillage. These have been distributed, in many cases free of charge, to farmers and have proven very popular. They are updated every five years as older products are restricted and new products become available. Some guides show pictures of weeds at various growth stages and contain simple information on weed growth and habit. By increasing farmer

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<sup>49</sup> knife-like drill part that places seed in the soil behind the tine

<sup>50</sup> during a visit to Australia in 2005 an agricultural journalist informed the author that Derpsch's assertions about cover crops were inappropriate for arable systems in Western Australia

<sup>51</sup> This is a situation where seed is placed in crop residue with poor contact with the soil; the seed germinates but doesn't thrive due to poor nutrition and the sterilising effect of toxins released by decomposing crop residue

<sup>52</sup> at the time of writing there are fourteen registered graminicides in Ireland

awareness the prospect of achieving good weed control and success with the system is greatly enhanced.

Derpsch noted that soil cultivations actually promote weed germination and this is not necessarily what is wanted. The key to weed control is to kill the weed before it goes to seed. Once a weed produces seed the potential for another generation to grow and develop exists. Many benefits in weed control may be derived from growth of cover crops that suppress weed germination, constant cover that provides a mulch effect, and using rotations that will enable the use of different herbicides and different techniques for weed control. On farm experience with cover crops is a must and should be developed and monitored by documenting results obtained – both successes and failures. We are now only beginning to understand the inter-relationships between various plant species. This will have a dramatic effect in developing weed and pest management techniques together with enhancing subsequent crop performance and yields. For example, black oats have given excellent results in terms of weed suppression with various crops. Soybean yields have increased dramatically when black oats have been used as the preceding cover crop. There has also been a reduction in herbicide use for weed control with only two herbicide applications used in five years in some situations.



*The knife roller was developed by farmers to flatten and break down cover crops before sowing*

A simple implement called a knife roller, developed at farm level, has revolutionised weed control in Paraguay and southern parts of Brazil. Again, the key to effective use of this implement is to knock down the cover crop before plant seed becomes viable at the milky ripe stage. The plants are rolled flat and their stems crushed by lengths of angle iron welded onto the drum of the roller. If you can control the plants at this vegetative stage further growth should be eliminated. This residue cover left behind acts as mulch and is very effective in suppressing weeds in the succeeding cash crop. Drilling straight behind the knife roller is desirable.

#### Increasing worldwide adoption of Conservation Agriculture

Success at farm level is crucial for effective dissemination and development of the system. Derpsch has found over the last three decades that maintaining extension and technical

support with early adopters to the system is crucial. Working in isolation means you end up spreading yourself too thinly with too many people who demand too much technical support. The consequence is you are left with incomplete uptake and adoption and the advancement of the system on many farms suffers. Pioneer farmers can act as focal points for farmer-to-farmer extension methods but they must be respected by their peers.

Research needs to be done on-farm with technical back-up by researchers and extension staff who promote solutions to problems that have been identified with farmer groups. Many researchers are too specialised and have no place in assessing or evaluating the no-tillage system as they have an inherent tendency to look at their own area and discipline to the exclusion of other inter-related factors. Did you ever see the performance of a drill or cultivator evaluated on the basis of the impact the machine has on the soil, and what consequences that may or may not have for weed, disease, pest development or subsequent crop performance?

Derpsch is adamant that farmer experiences need to be documented and quantification of developments is vital wherever possible. The dearth of published material has an inherent effect on the uptake and development of successful techniques and creates a vacuum in which unsubstantiated criticisms abound. Arrogance also poses a big problem in trying to promote uptake and adoption of conservation agriculture. Primarily this is present among many established researchers and extension agents, but it should also be remembered that arrogance is present at farmer level also and Derpsch feels this is most difficult challenge to overcome.

*It is noteworthy that in Paraguay over sixty-five per cent of arable land is under no-tillage - the highest rate of adoption in any of the countries visited in South America. The success of no-tillage in this country is all the more notable considering that early adopters to the system reverted to ploughing during the eighties when they experienced problems with imported drills. Rolf Derpsch has had a major input into the dramatic increase in successful adoption of CA in Paraguay since the mid nineties while a farmer no-tillage organisation called APASCU has been very supportive in assisting farmers with the change process.*

## Bringing it all back home

### Constraints to farmer organisation development

There are an impressive number of dynamic farmer organisations and clubs throughout South America focused primarily on the development of CA practices (see Appendix 2). Similar organisations exist throughout Europe and all are associate members of the European Conservation Agriculture Federation (ECAAF)<sup>53</sup>.

A good structure is already in place that could provide the basis for focused interaction between researchers and farmers in these countries. Lack of finance is inhibiting the development of further international collaboration. The majority of the fourteen-member organisations have experienced funding problems in recent years<sup>54</sup>. Much of their administrative and organisational work is conducted on a voluntary basis while events, newsletters and meetings are



financed mainly by membership subscriptions from farmers. Commercial support from the private sector is difficult to organise and is usually tied to specific events. Some of the more successful groups like AEAC<sup>55</sup> in Spain receive government funding to carry out their activities. In the UK, the Soil Management Initiative (SMI) has carried out very useful research and extension work but the organisation had to be disbanded in 2004 due to lack of funding. In Ireland, Conservation Agriculture Ireland (CAIR) has been instrumental in bringing farmers who have ceased ploughing together for field meetings and a quarterly newsletter is distributed to members. The main problem for organisations like CAIR and the SMI is that with slow adoption of CA there is no increase in membership and resultant funding. It is also hard to encourage adoption at farm level without holding information meetings, field activities or producing technical support manuals aimed at increasing farmer awareness and education. It is an ongoing struggle.

### Changing farmer practice

Figure 5 shows that reduced incidence of ploughing (red line) in the UK has thus far been replaced mainly by minimum tillage and reduced cultivations (green line) and to a lesser extent by direct drilling (blue line). So, change in cultivation practice is occurring in the UK but not necessarily towards CA systems. In Ireland, CAIR estimates suggest that only

<sup>53</sup> The ECAF Website gives contact details of member organisations: [www.ecaf.org](http://www.ecaf.org)

<sup>54</sup> Funding for research and extension was available through the EU Life project previously

<sup>55</sup> Asociación Espanola de Agricultura de Conservación: [www.aeac-sv.org](http://www.aeac-sv.org)

four per cent<sup>56</sup> of the total arable area is being min-tilled on an annual basis. Direct drilling is rarely practiced in either country for crop establishment or even grassland regeneration. Indeed, only one million of the UK's six million arable acres (17.8 per cent) was deemed suitable for no-tillage by 'experts' in a report by the Statistical Office of the EU Communities<sup>57</sup> in 1996. Throughout nine other countries in Europe, excluding Ireland, it was estimated that an average of forty per cent of the total arable area was suitable for no-tillage. Information gathered during the course of this study would suggest that these estimations are both understated and grossly misleading.

Experienced practitioners and CA soil scientists from North and South America, Australia, and the UK were adamant that no-tillage could be practiced in any location or region throughout the globe where arable crops were already being produced. It was however noted that changes may be required in crop selection, drill technology, rotation, and cover crop usage but the principles of CA were essentially the same wherever crops are grown.

Change in farmer practice is happening but at a very slow rate and not at a magnitude that would enable our arable farmers adopt economically sustainable systems independent of further EU subsidies. There is therefore a dramatic need for increasing awareness and education with a view to changing cultivation practices.

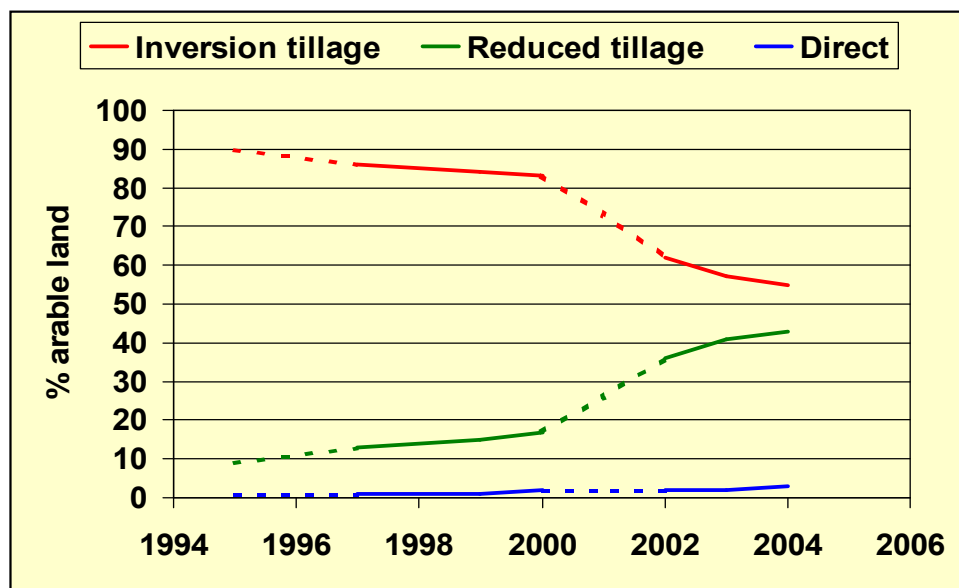


Figure 5: Changes in cultivation practice in the UK (SMI Survey 2003)

#### Conservation Agriculture and organic farming

It may be construed that there is no fundamental difference between CA and organic farming. However, farmers practicing CA use the latest technological developments including pesticides, artificial fertilisers, and genetically enhanced crops when deemed necessary. In the early stages of CA adoption, for example, there may be an increased

<sup>56</sup> Approximately 15,000 hectares

<sup>57</sup> ECSC-EC-EAEC, Brussels, Luxembourg, 1996

dependence on herbicide usage for the first few years with an overall reduction noted once soils stabilise. On the other hand, organic crop production is dependent on intensive cultivation of the soil for weed control and green manure crops are often incorporated by discing in or ploughing. None of these practices are desirable in CA where the soil is largely undisturbed and residue covers and manures are left on the soil surface.

Much valuable information that could complement our understanding of best practice for CA is already available from the organic sector. The suitability of different cover crops under our climate, field conditions, and soil types are already known from research and practice undertaken by organic tillage farmers. Plants such as phacelia, mustard, vetches, rye, and oats have already been used for improving soil structure, nitrogen absorption and fixation, and disease and weed control. The use of such plants as cover crops in intensive commercial production is largely untried.

Our crop production systems could best be served by adopting some of the principles of organic production and combining them with new advancements in conventional and conservation agriculture. Environmentally sensitive production will only gain widespread acceptance when it is profitable to adopt relevant practices because in the view of John Landers, 'Farmers in the red cannot look after the green'.

### **Main findings from the study**

#### **1. The mentality and attitude of farmers, advisers and researchers involved in developing CA is very different to that traditionally observed.**

There is a genuine commitment to life long learning and successful farmers display a large amount of humility. Concerning the latter trait, farmers interviewed were extremely open-minded and genuinely felt that they could greatly improve their techniques. Great flexibility was seen as desirable to succeed with the system as timely management is essential to optimise CA benefits. It was also evident that researchers and agronomists were well received by farmers and many instances emphasised the mutual respect that exists. Farmers' experiences and observations are frequently documented by professionals in an effort to improve their own understanding of developing CA practices.

#### **2. Lack of practical knowledge and relevant information is the main constraint to adoption of CA at farm level.**

Information has to be relevant, factual and of practical use to farmers. It may seem obvious but how often are presentations to farmers overly technical with graphs and tables used to explain a concept rather than a simple picture? A conference room lecture is preferred to a practical field demonstration. But who determines this agenda? For this reason greater emphasis is put on farmer to farmer training in farmer groups and clubs in all the countries visited.

**3. Weed control has proven difficult for some farmers adopting and managing CA systems; greater understanding on weed species and biology is essential together with ready access to information on herbicide choice and availability.**

Many interviewees identified that this was particularly difficult in the early adoption phase. Inadequate knowledge about weed species and biology and effective herbicide usage were cited as being the main problems. By recording how farmers managed particular weeds with crop rotations and cover crop mulches and combining this information with updated instructions on best practice for herbicide usage new solutions are presented at farm organisation meetings and distributed in weed control guides and manuals.

**4. Greater knowledge about soil properties - physical, biological and chemical - are vital for successful management of CA; different methods for fertilisation of crops and building soil fertility are required for CA.**

Rarely at an arable farmers meeting held in Ireland or the UK would you hear any significant reference to soil protection or management being of paramount importance in reducing costs and increasing profitability in crop production. Much attention is devoted to the use crop inputs in order to maximise yields. Yet at each farmer event in South America the main topics for discussion are soil protection and management and improving soil fertility. Researchers, agronomists and farmers are very knowledgeable about soils.

**5. The importance of constant soil cover, either with residue or cover crops, cannot be over emphasised; farmers are obsessed about and insist on constant soil cover.**

In Europe even among farmers that have adopted minimum tillage there seems to be an inherent assumption that crop residues need to be incorporated and mixed thoroughly through the top few inches of soil. This has led to deeper cultivations and in many instances, farmers are practicing maximum rather than minimum tillage. Once farmers can see soil they are happy. The opposite is the case throughout South America. High and low residue crops are grown sequentially to avoid build up of excess residue in fields. Cover crops are normally flattened, crushed and left on the soil surface rather than mulched and mixed with the soil with disc implements. Protection of the soil is sacrosanct.

**6. Compared with South America there is poor choice and availability of adequate and appropriate drills and planters for CA systems in Ireland and the UK.**

Farmers may need to adjustment to drills and planters as companies are often reluctant to make the most basic of changes to their seeding machines. There is also the argument that it is not in a machinery company's interest to develop such drills. If all farmers were to adopt no-tillage systems both tractor and drill sales together with sales of parts resulting from wear and tear would drop to twenty per cent of their existing levels. Is it therefore in the commercial interest of machinery manufacturers to develop drills suitable for no-tillage?

## Recommendations arising from the study

- 1. Conservation Agriculture is a truly sustainable form of agriculture and crop production and should be supported by government, promoted by research and extension agencies and developed by agri-businesses involved in the arable sector.**

Not alone is CA not promoted sufficiently in Europe, the system is regularly frowned upon by established researchers, agronomists, farmers, and journalists alike. The reservations expressed are often due to a lack of general and specific knowledge concerning teething problems with CA adoption, a situation no different to what occurred in South America in the seventies and eighties. Considering this fact much of the pioneering work and expertise internationally has been gained by farmers themselves. Their on-farm experiences, both positive and negative, need to be documented and disseminated to a wider audience. This work will only be conducted by professionals dedicated to the concept, principles, and adoption of CA and will necessitate collaboration with practicing farmers based on mutual respect.

- 2. More specific and focused research based on farmer needs is required such as soil structure improvement, soil fertility building, cover crop interactions with cash crops, weed suppression, crop nutrient requirements under CA systems and related topics.**

Ironically while the EU Commission is in the process developing new soils directive policy aimed at soil protection, throughout member states, knowledge about and appreciation for the importance of soil management has never been poorer among the agriculture community. Specific and practical research needs to focus on addressing soil structural problems on arable farms, boosting soil organic matter levels, alternative weed management techniques and reassessment of crop fertiliser needs under CA systems. One major constraint for development of this work is the anticipated lack of public sector funding to conduct this research.

- 3. Agricultural education institutions need to place greater emphasis in relevant courses on sustainable soil management to ensure that adequate knowledge and appreciation for the soil resource base is present in the agriculture services sector.**

A visit to Goiânia University in Brazil highlighted the difference in approach to academic research and education. A new **Soil and Water Management Department** was being established and a recruitment process had begun for two soil scientists, a soil pedologist, and a hydrologist. Meanwhile in University College Dublin, in Ireland, ongoing development of the Agricultural Science degree programme has resulted in soil science being demoted in importance with fewer lectures and practical hours available to undergraduates in recent years.

**4. Farm based research and farmer to farmer dissemination of experiences is essential to improve the rate of uptake and advance the techniques used.**

It was noted earlier that much formal research by the public and private sector is conducted on-farm using farm equipment in South America. Larger scale field plots up to one hectare in size are used for both trial and demonstration purposes and farmers are encouraged to formally assess positive and negative aspects of new technologies. However much of the contemporary formal research conducted in Ireland and the UK is located in research stations using small plot trials on ploughed ground. Farmers are neither involved in the design, planning, implementation or evaluation of such research. Research scientists then present their findings at field days or conferences with reduced farmer involvement. Active farmer discussion groups are vital in identifying solutions to teething problems in CA adoption. The South American model is far more effective and practical for dissemination of new technologies and techniques.

**5. Appropriate drill technology already exists and every effort should be made to import and/or modify suitable machinery for use in CA systems in north-western Europe.**

The availability of new drills suitable for direct drilling or no-tillage is improving throughout Europe. UK and Irish arable farmers need to understand however that management of crop residues is of great importance for successful crop establishment and this involves the judicious use of rotations, cover crops and straw management as much as the selection of an expensive drill. While disc drills are preferred in South America, our higher yields and associated residue levels may pose problems for similar drills in this region and tine drills may be more appropriate, particularly where high residue cereal crops predominate in the rotation. Farmers would definitely benefit from visiting and looking at machinery developments in other countries. They would get many ideas on how to develop and modify certain seeding mechanisms in drills for their own benefit. Successful no-tillage work has already been conducted in Europe using both disc and tine drills sourced in the southern hemisphere.

**6. In view of the positive impact on the environment it would be entirely appropriate for government to offer temporary subsidisation to farmers during the early adoption phase of CA systems as such initiatives are already in place in other EU member states.**

It is ironic that the many benefits accruing from CA practices are ‘part and parcel’ of desired objectives in agri-environment directives at EU level, and member states are required to implement these directives at national level. Already specific environmental subsidies, ranging from €25 - 115 per hectare, are available to farmers in Switzerland, Germany, Spain, and Portugal for adoption of different CA techniques on a regional basis. Graded subsidies are available for straw incorporation, inclusion of cover crops in rotations, and reduced cultivation techniques such as minimum tillage and no-tillage. Indeed, so

committed are national and local governments in these regions to soil protection and management at farm level that national exchequer funds are being used for these subsidies rather than funds sourced at EU level. Considering the projected elimination of subsidies by 2013, would it not make sense for the respective Departments and Ministries of Agriculture ,in both Ireland and the UK, to redistribute some modulated funds in the coming years to encourage farmers to adopt CA techniques thereby making our arable enterprises both economically and environmentally sustainable?

### **Addendum and update - April 2006**

Since the initial study was completed there have been a number of developments in Ireland and the UK which could accelerate the rate of uptake of conservation agriculture practices.

The replacement of production-oriented subsidies with a decoupled single farm payment has refocused farmers' minds on the economic sustainability of the systems they operate. Many farmers, deciding that their land area is too small to realise a sustainable income, will leave the arable sector in the coming years. This will undoubtedly provide an opportunity for those who are committed to farming and who wish to expand their arable area. In this context expansion will also necessitate the adoption of more efficient farm management practices in order to cover the extra area being farmed.

As a direct result of sugar beet reforms, the phasing out of the sugar beet industry in Ireland during 2005 and 2006, while dealing a serious blow to profitability on many tillage farms, has eliminated one major impediment to the uptake of CA. There was and is a popular view held by Irish farmers that soils need to be ploughed and loosened for growing all crops - especially root crops. And while this is not true, it is a large part of the mindset change that needs to be adopted by individual farmers. Minimum tillage will now be considered on many farms which previously were committed to plough-based tillage. However, it is the view of the author that adoption of reduced cultivations is merely a transition towards a more economically and environmentally sustainable method of production that being conservation agriculture in its purest form .... no-tillage or zero-tillage.

New cross-compliance (2005) and nitrates directive (2006) measures will also mean that arable farmers will have to refocus the management of their holdings and farm in a more environmentally sensitive way. Conservation Agriculture practices would allow them to realise these objectives without incurring any major penalties with regard to crop productivity and yield.

During 2005, a series of articles outlining the preliminary of this Nuffield study were published in the farming press in the UK; namely, Arable Magazine and Farmers Weekly. As a direct result of this press coverage farmer group meetings on international developments in CA have been held in Shropshire, Gloucestershire, and Kent in mainland UK and soil management workshops for arable farmers have been held in Downpatrick and Coleraine in association with the College of Agriculture Food and Rural Enterprise (CAFRE) in Northern Ireland. In the Republic following approaches to different third level

institutions, Waterford Institute of Technology in south-east Ireland will introduce courses in sustainable cropping systems in their undergraduate agricultural degree programme from September 2006<sup>58</sup>. This is the first time such courses will be taught and examined on a formal basis at third level in Ireland.

While all these developments are most welcome the National and World Ploughing Championships will again be held in Ireland in September 2006. No doubt the event will be heralded as the largest of its kind in Europe and the publicity and hype surrounding these championships will ignore one fundamental scientifically based fact. A plain and simple truth will be lost among the organisers, promoters, and the vast majority of trade exhibitors, arable farmers and general public attending this event.

Ploughing is an unsustainable system that is ultimately costing Irish and UK farmers money while causing increased damage to our soils and the environment in which we live.

### **Reflections on the Nuffield experience**

It was highly unlikely that I would have spent over ten weeks during spring 2004 travelling throughout South America without being awarded a Nuffield Farming Scholarship. And little did I realise it would have been the eye-opening experience that it proved to be. It is almost impossible to recount or record the wonderful experiences I had meeting and discussing the future of agriculture production with farmers, agronomists, teachers, and researchers. The one central message I took back from South America is that there is a future for agriculture, and a very bright one at that. The big problem for us here in Europe is that we are not inclined to think that way, nor are we prepared to make the necessary changes to what we do in order to create a sustainable future for ourselves.

None of the countries visited participate in the Nuffield Farming Scholarship programme. Consequently, there is no network of contacts to lend assistance or advice during a study tour undertaken in this region. Despite this, the farmers and professionals encountered, often on an informal basis, offered unconditional support in assisting with the progression of this study. Facts and figures were readily made available highlighting progress achieved on many farms. Offers of further assistance were made when 'thanks' and 'goodbyes' were exchanged.

The abiding memory though is the obvious humility of the people in all the countries visited. They were genuinely surprised that someone from Europe would take an interest in what they were doing. They don't see themselves as being world leaders when it comes to crop production. They don't even see themselves as being world leaders when it comes to Conservation Agriculture. And you know maybe that is their strength. That is why they are so good - they don't believe that they are. What they do believe is that they are learning little by little with each passing season and each crop produced. CA is an ongoing process.

Do Irish or UK farmers possess the same traits? Why is it that we are so reluctant to change over to what is an already proven technology? There are obviously going to be problems as there would be with any new undertaking. But do we not realise that solutions to many of

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<sup>58</sup> B.Sc.(Hons) in Land Management (Agriculture)

these problems have already been identified, tried and tested? Or are we just satisfied to simply write off a system that has made South American crop producers the most competitive in the world? Are we well-served by our researchers, agronomists, technicians, and even our agricultural journalists? Is arable research appropriate and based on international developments while dealing with existing, and anticipating future, farmer needs? Is the advice our farmers receive knowledgeable, balanced and accurate? Do technicians take due consideration of farmer observations and findings when changes to technology being tested are necessary? And do our agricultural journalists present us with well investigated facts or just a record of their own or others' opinions?

We have very difficult decisions to make in the arable sector throughout Europe. It is clear that subsidies cannot last indefinitely, nor should they under their present guise. It is also clear that we cannot continue to farm in an unsustainable way both, from an economic and environmental point of view. Are we so obsessed with traditional practices that we refuse to acknowledge that there just might be a better way?

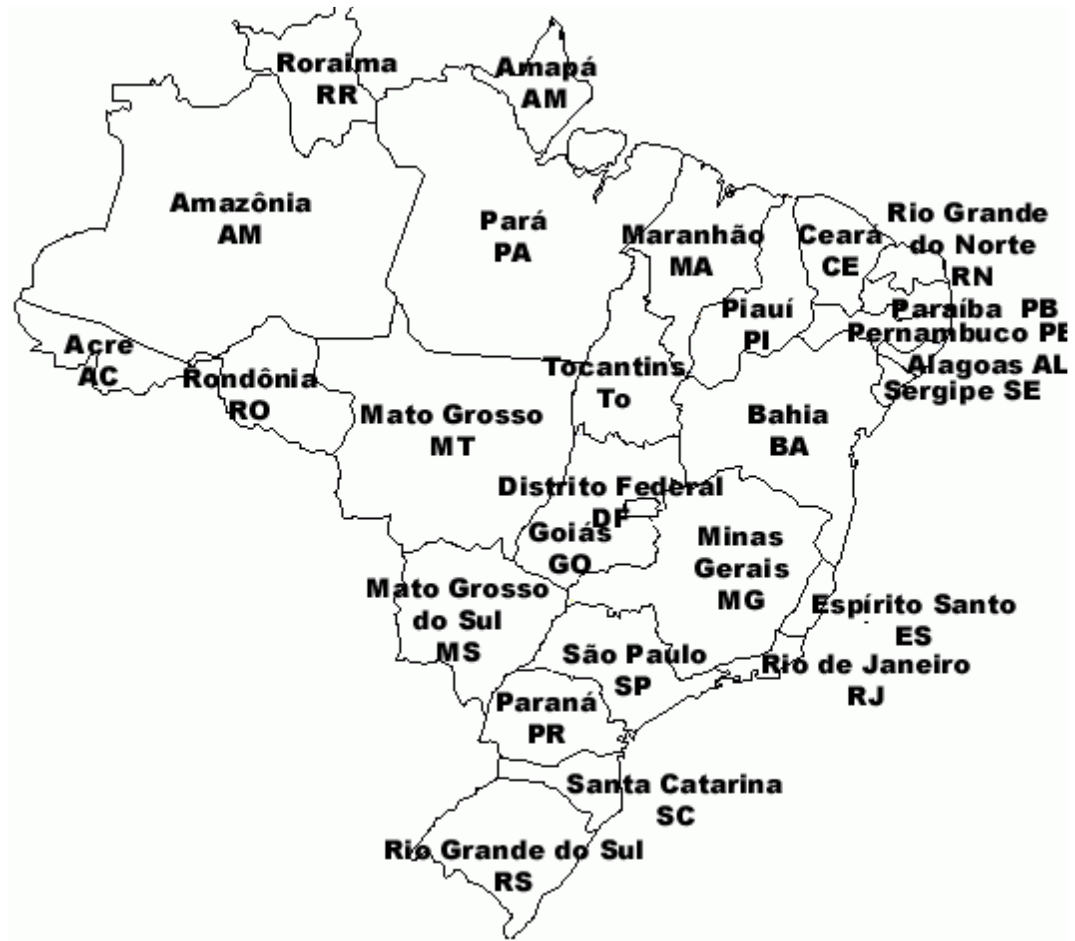
On a worldwide basis there are now 95 million hectares devoted to crop production where neither the plough nor cultivation implements are being used. The seed is simply placed in undisturbed soil. The facts speak for themselves.

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## Appendix 1

### States of Brazil

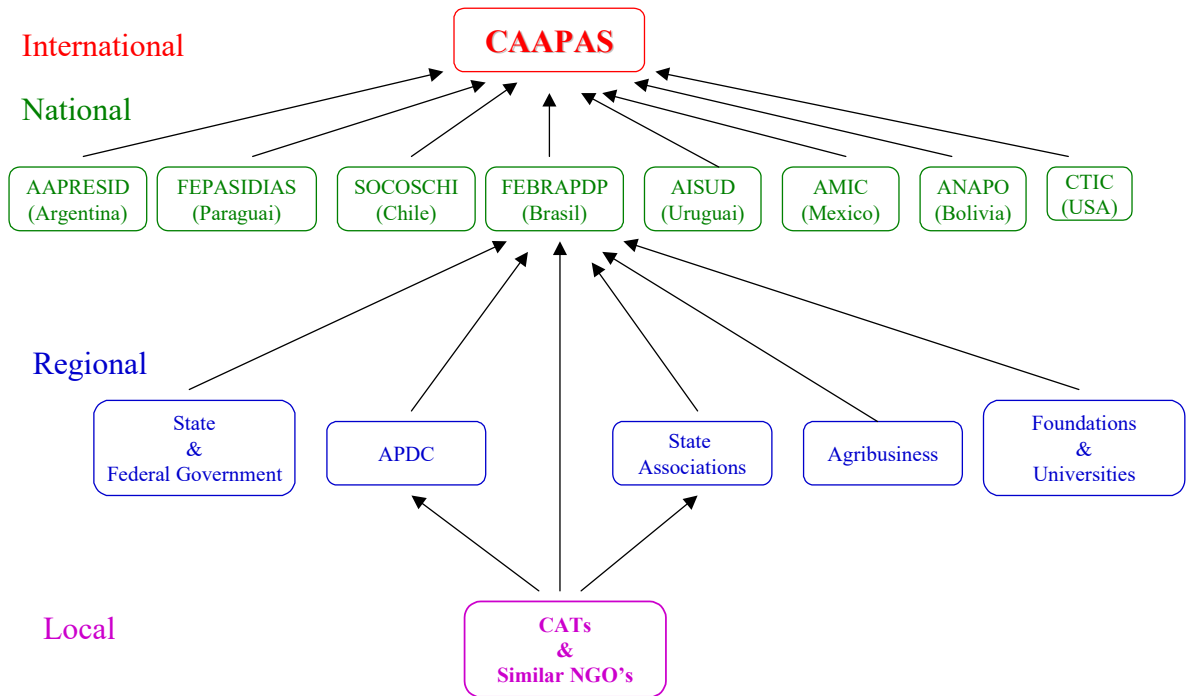


States visited included Mato Grosso, Mato Grosso do Sul, Goiás, Distrito Federal, Minas Gerais, Rio de Janeiro, São Paulo and Paraná

## Appendix 2

### Local, Regional, National and International Organisations (South America)

#### Organogram of Zero Tillage NGOs in Brazil and the Americas



Source: Landers, 2004

### Appendix 3

## Summary of the phases of Conservation Agriculture development in Brazil

	Sub-tropics (mechanized)	Sub-tropics Smallholder	Tropics (mechanized)
<b>PIONEER PHASE</b>			
On-farm technology development by few farmers Little expansion. Beginnings of research. No extension. Private sector support. Testing of cover crops. Beginning of ZT farmer organization and dissemination events.	1972-1984	1985-1991	1981-1986
<b>CONSOLIDATION PHASE</b>			
Improvements in technology, better planters, more weed control and cover crop options. Fertilizer/lime recommendation under CA. Expansion slow, little extension and formal teaching. Private sector support increasing.	1985-1990	1992-1996	1987-1992
<b>MASS ACTION PHASE</b>			
Increasing adoption by extension in teaching curricula. Technology refinements and wide range of research recommendations. Incentives limited to small/medium farmers. Significant private sector support. Rapid expansion – private and public sector.	1991-2000	1997-2010	1993-2000
<b>DOMINANT PHASE</b>			
CA is the norm. Full research priority to avoid second generation problems. Widespread adoption by extensionists and teaching establishments. Incentives to intensification in CA. Full private sector support.	2001 - 2100	2010 – 2100	2001 - 2100

Source: Landers, 2004

## Appendix 4



*APPRESID Agronomists demonstrate changes to soil structure under no-tillage to farmers attending Feriagro Agriculture Show, San Pedro, Argentina on the 18<sup>th</sup> March, 2004*



*Martin Herreras-Vegas (Argentina) shows the development of deep roots in no-tilled soybeans*