No-Tillage in Europe - State of the Art
Constraints and Perspectives

Gottlieb Basch, John Geraghty, Bernhard Streit and Wolfgang Sturny
(gb@uevora.pt, info@geraghtyconsulting.ie, bernhard.streit@art.admin.ch, sturny@no-till.ch)

Abstract

No-tillage in Europe contains a brief review of agricultural developments over the last three decades beginning in the late1960s. Reasons for attempts to introduce this soil conserving production method are outlined and obstacles affecting the widespread uptake of no-tillage throughout Europe are identified. Contemporary data are provided for the uptake of both conservation tillage and no-tillage in the member countries of the European Conservation Agriculture Federation.
Further aspects surrounding the low uptake of no-tillage and conservation tillage when compared with other regions in the world are explored. European conditions whether natural, human or political are identified as possible explanations for low levels of adoption of no-tillage in Europe. Despite these issues, increased awareness that soils are a non-renewable resource among farmers, politicians and society as a whole is leading to a gradual change in the overall approach to soil conservation. The implementation of a European Soils Directive is considered to be an important step towards the recognition that conservation tillage and no-tillage are both economical and ecological sustainable methods for agricultural production. It is anticipated that this development will promote the concept of Conservation Agriculture and increase adoption levels throughout Europe.

Review of No-Tillage development in Europe

Early uptake of no-tillage in Europe was voluntary and driven by the need to reduce crop establishment costs. Tillage farmers did not identify soil erosion or degradation as a major concern (Kuipers, 1970). In large parts of Europe there is a cool and wet climate which induces relatively stable weather conditions in contrast to other parts of the world where heavy rainfall and severe wind storms regularly cause soil erosion. In addition, negative effects of repeated tillage by the mouldboard plough such as compaction in plough pans, reduced pore volume in topsoil and sealing of the soil surface have been masked by the ongoing development of more powerful implements used for soil tillage.

It is no small irony that some of the leading pioneers of no-tillage from South America observed and studied developments in Europe in the late 1960s and early 1970s. At this stage Imperial Chemical Industries (ICI) were pioneering direct-drilling techniques in the UK using paraquat herbicide to control weeds. Heavy residue was being burned – a technique that, while well intentioned, proved detrimental to maintaining and improving soil quality (Crovetto, 2006). The increase of grass weeds like annual meadow grass (*Poa Annua* L.) and sterile brome (*Bromus Sterilis* L.) proved problematic as there were few herbicides available for in-crop weed control. In many cases short term no-tillage research was conducted under unfavourable soil conditions with little crop rotation, using inappropriate drills or planters. It is understandable therefore that negative conclusions were made about the suitability of no-tillage systems under European conditions.

The development of a market support system through the Common Agriculture Policy (CAP), while ensuring strong market prices, also hampered efforts to identify solutions to problems encountered

using no-tillage techniques from the early 1970s. Many of the early adopters of no-tillage reverted to plough based production once produce prices strengthened. Meanwhile farmers in numerous regions of South America, exposed to world market price fluctuations, had little option but to find solutions to the same problems their European counterparts were experiencing such as weed control and residue management (Geraghty, 2006). It is likely that a combination of these events prompted the development of no-tillage in favour of the Americas from the seventies to the present day. Furthermore, in both North and South America, agricultural machinery manufacturers have since developed a wide range of no-tillage drills and planters appropriate for local conditions. By contrast in Europe, there are a limited number of manufacturers producing no-tillage equipment specifically designed for crop production in temperate climates which is characterised by high yields and associated high residue levels.

The Current State of No-Tillage in Europe

While over fifteen per cent of the total arable area in the member countries of the European Conservation Agriculture Federation (ECAF) is under conservation tillage of one form or another (Lane et al. 2006), the area devoted specifically to no-tillage is just over one per cent (Table 1). The situation is in stark contrast to adoption trends in Australia and in North and South America in particular. The challenge now is to encourage farmers to move from conservation tillage to no-tillage systems and encourage the adoption of conservation tillage over conventional practices.

Table 1. Area of Arable Land under Conservation Tillage(CT) and No-Tillage(NT) in Member Countries of the European Conservation Agriculture Federation (2005).

Country	CT (incl NT) ('000 ha)	No-Till only ('000 ha)	Arable Land ('000 ha)*	% in CT	% in NT
Belgium	140	0	815	17.2	0.0
Denmark	230	0	2276	10.1	0.0
Finland	1,150	150	2199	52.3	6.8
France	3,870	150	18449	21.0	0.8
Germany	2,500	200	11791	21.2	1.7
Greece	430	200	2717	15.8	7.4
Hungary	500	10	4614	10.8	0.2
Ireland[1]	10	0	401	2.5	0.0
Italy	560	80	8287	6.8	1.0
Portugal	418	80	1990	21.1	4.0
Russia	15,500	500	123465	12.6	0.4
Slovak Rep.	179	37	1433	12.6	2.6
Spain	2,400	600	13738	18.0	4.4
Switzerland	102	12	409	25.4	2.9
UK	2,680	180	5753	45.6	3.1
	30,669	**2199**	**198,337**	**15.5**	**1.1**

***** FAO Statistics 2003 on www.faostat.fao.org

[1] Government Statistics(2005)and data supplied by Conservation Agriculture Ireland Survey(2007)

From Conservation-Tillage to No-Tillage

Farmers traditionally love working with soil. There is an inherent belief that by cultivating and working soil we are doing a lot of good by burying weed seeds, mineralizing nutrients, breaking soil compaction, aerating soil and creating a suitably loose seedbed for sowing a variety of crops. While some of these assertions may be individually true, especially when soil is regularly cultivated, collectively they lead to an overall depletion in soil quality that is unsustainable in the medium to long term both from an economic and environmental point of view. Therefore, the successful adoption of a no-tillage system is dependent on convincing a farmer of the benefits associated with developing a cropping system that requires little soil disturbance.

Increasing farmer awareness and education about the damage one can do to soils through excessive tillage has proven difficult. There is a cultural barrier to overcome with different languages and traditions throughout Europe. Agriculture infrastructure and farm practices vary greatly between different countries. Whereas the principles of no-tillage are the same for all conditions, the adaptation of crop management to local conditions is crucial (Lane et al. 2006). There is, broadly speaking, poor state support for specific research and education initiatives in this regard. Many voluntary organizations at a national level are solely dependent on farmer subscriptions to conduct research and extension work with occasional sponsorship from the commercial sector (Geraghty, 2006). Coupled with these issues there are strongly held views opposing the adoption of no-tillage on a widespread scale in Europe.

Popular Arguments against No-tillage in Europe

There is much skepticism in Europe about the suitability of no-tillage for our climate conditions and cropping systems. Many opponents of no-tillage point to the wide variety of soil types throughout the continent, the perceived high cost of no-tillage equipment and the intensive hands-on management required in comparison with the relative ease and familiarity associated with tried and trusted plough-based techniques. Diverse crop rotations including cereals, legumes and other broadleaved crops are an important feature of successful no-tillage systems. In many regions of Europe, however, arable production has been focused on growing a limited number of crops - mainly cereals or maize. Agronomic issues surrounding weed, pest and disease management have also provoked much debate and discussion among farmers, extension personnel and researchers alike.

It is firmly ingrained in farmer and researcher psyche that weed control is best achieved by a combination of thorough soil inversion and herbicide use. Indeed one of the main setbacks to no-tillage adoption was the proliferation of grass weed species that occurred three decades ago, problems still vividly remembered by farmers and extension workers today. It is frequently noted that the move from ploughing to conservation tillage and no-tillage will increase dependence on herbicides. It is also argued that savings in fuel, time and labour are offset by the increased cost of the extra herbicide application for weed control. Practical experience at farm level has found these observations to be untrue. International research experience also notes that, while there is an initial increase in herbicide use during the adoption phase of no-tillage, overall herbicide usage decreases once all aspects of the system are being practiced (Landers et al. 2002 & Wolf et al. 2003). Two further issues are causing concern for supporters of no-tillage. Tighter regulation within the EU in recent years has led to the withdrawal of herbicides in some countries (e.g. atrazine, simazine and isoproturon) resulting in fewer

efficient weed control options. A strong environmentalist lobby is now demanding the withdrawal of other herbicides that are vital for weed management in no-tillage (e.g. glyphosate in France).

Due to the cool, wet climate in parts of Europe mollusc pests called slugs are an important species in a variety of crops. The practice of leaving crop residues on the soil surface has encouraged the idea that slug numbers will increase beyond acceptable levels under no-tillage. Significant costs would result from associated crop damage or extra pesticide control measures. While these are commonly held beliefs, farmer experience has often been the opposite. In many cases slug control no longer requires the use of pesticide and slug levels have been adequately managed by increased predator populations, such as ground beetles. It appears however that a slug population recovers within the growing season and re-establishes faster in no-tillage systems (Bieri et al. 2007).

In recent years there has been much criticism of conservation tillage and no-tillage due to the increased incidence of head blight disease (*Fusarium spp.)* recorded in wheat and to a lesser extent in maize. This has occurred mainly in Germany, France and Switzerland. The threat of this disease is greatest when wheat is grown after maize and during moist-humid summers at anthesis stage. There is strong evidence that choosing the least susceptible wheat variety along with fine chopping of maize residues leads to lower head blight incidence and reduced deoxynivalenol contents with less mycotoxin contamination (Vogelgsang et al. 2005). Further research is looking at different ways to reduce disease levels such as maize residue management, selection of fusarium resistant wheat varieties and fungicide control.

Considering the above issues, proponents of no-tillage in Europe often find themselves in a situation not unlike that encountered in the 1970s in South America, the 1980s in North America and the 1990s in Australia. A significant amount of time is spent explaining or defending the system to officials in research and extension agencies and at government levels. Against this backdrop it has proven difficult to convince farmers of the practical and economic benefits resulting from no-tillage adoption. Much valuable research work was carried out under the EU-Life Project (2000-2003) to establish accurate information and investigate some of these agronomic issues with very positive results. However further funding has not been available to continue much needed research and extension initiatives on a Europe-wide basis.

Common Agriculture Policy, CAP Development

The European CAP has been subject to ongoing reform since it was implemented in the second half of the last century. There has also been a concerted effort since the early 1990s to link agricultural and environmental policy. More recent developments include a transition from production-linked subsidies to a farm payment system that is separate from production. Presently farm subsidies are also subject to deductions called modulation whereby increased percentages of a farmer's overall payment are redirected towards alternative rural development and environmentally sensitive initiatives. Coupled with annual inflation, the net value of farm subsidies is decreasing annually. After 2013 it is highly likely that any future payments will be strongly linked towards environmental protection. Even outside EU Member States other national governments on mainland Europe are placing increased emphasis on environmentally sensitive practices and climate change strategies and are willing to fund such initiatives with public money (Table 2).

Table 2. Incentive programme detailing contributions towards a five year transition period from Conservation Tillage to No-Tillage in the Canton of Berne, Switzerland (1996 to date)[2]. Plough based tillage is a breach of contract and will be fined.

	Conservation Tillage Transition [€*ha^{-1}y^{-1}]	**No-Tillage Target [€*ha^{-1}y^{-1}]**
Crops	**Years 1 – 5**	**Years 1 – 5**
Cereals	102	204
Oilseed Rape	204	340
Maize (strip tillage)	306	-
Maize	204	340
Sugar Beet	238	374
Peas and Beans	170	272
Sunflowers	204	340

New EU Legislation for the Protection of Soils

After three years of widespread public consultation the Soil Thematic Strategy was ratified by the European Commission on September 22, 2006.

'*It creates a common legal framework to ensure that EU soils stay healthy for future generations and remain capable of supporting the ecosystemson which our economic activities and our well-being depend.'*

(EU Commission, 2006)

The strategy aims to address soil degradation throughout 27 EU Member States under the following parameters: erosion, organic matter decline, salinisation, compaction, sealing, contamination, flooding and landslides and biodiversity decline. Despite the fact that nine Member States have specific soil protection legislation there has been a significant increase in soil degradation processes in recent decades.

Water and wind erosion affects 157 million ha of Europe's total land area (cited in Tebrügge, 2001). Approximately 90 percent of soils in Europe have low to medium organic matter levels, 45 percent of these with less than two percent organic carbon and a further 45 per cent with between two and six per cent organic carbon (EU Commission, 2006). Decline in organic matter is an important issue in Southern Europe but regions further north have also recorded significant losses in soil organic matter levels over the last thirty years particularly on land where continuous tillage has taken place. Compaction affects up to 36 per cent of subsoils while 3.8 million hectares are affected by the accumulation of soluble salts. Several of the parameters surrounding soil degradation are further exacerbated in recent years by the effects of climate change such as increases in temperature, rainfall amounts and extreme weather events. The Commission now estimates that soil degradation could be costing the EU up to €38 billion annually.

[2] At least two main crops, other than cover crops, must be no-tilled during the first five years

The strategy will be adopted as a Soil Directive by the EU parliament in spring 2009.
The Directive places emphasis on the following areas:

- Identification of risk areas at appropriate levels within five years of adoption
- Use of common criteria (e.g. soil type, texture, density, hydraulic properties, topography, land cover, land use, climate, etc.)
- Use of empirical evidence or modelling
- Findings to be made public and reviewed every ten years

Key factors for the Successful Adoption of No-Tillage

The implementation of a Soil Directive will have far reaching consequences for the development of no-tillage in Europe. Over fifty per cent of agricultural land throughout the EU is devoted to crop production. The vast majority of this area is still prepared using traditional mouldboard plough-based systems leading to an increased risk of soil degradation (Garcia-Torres et al. 2001). The widespread adoption of no-tillage would guarantee the realization of many of the objectives set out in the Soil Thematic Strategy especially on our most vulnerable soils. It is therefore in every Member State's interest to initiate new, and improve existing, education and research initiatives targeted at accelerating the uptake of no-tillage at farm level using *pull factors* such as:

- Effective knowledge and technology transfer using scientific and practical expertise from a range of climatic regions across Europe - already a priority among ECAF's 15 National Associations
- Extend 'incentive programmes' for conservation and no-tillage under existing agro-environmental measures
- Establish a network of no-tillage demonstration farms with special focus on crop rotation, cover crops and plant protection measures
- Field events including practical hands-on farmer demonstrations (e.g. annual national festival for non-inversion and no-tillage in France and Switzerland)
- Develop and introduce appropriate no-tillage drills and planters to handle field conditions found in Europe
- Long-term research projects with continuous no-tillage systems at both farm and research levels
- Extension services with specialized no-tillage advisers skilled in 'farmer to farmer' knowledge transfer resulting in a multiplier effect in the sector
- Active involvement of stakeholders including administrative authorities, political agencies, farmer organizations, food and agricultural engineering industries and consumer organizations
- Establish a market for carbon credit trading based on soil carbon sequestration

Wide ranging benefits to society would accrue with no-tillage adoption resulting in a significant reduction in energy consumption, thereby reducing production costs by introducing farming practice that enhances soil, water, and air quality.

Future Trends

The replacement of production-oriented subsidies with a single farm payment has refocused farmers' minds on the economic sustainability of the production systems they operate. Some farmers will consolidate their production system by sharing management inputs with neighbouring farmers or by using contractor services in an effort to reduce fixed costs. Others, deciding that their land area is

inadequate to realise a sustainable income, will leave the arable sector in the coming years. This will provide an opportunity for those who are committed to farming and who wish to expand their arable area. Under either scenario, expansion or consolidation will necessitate the adoption of more efficient farm management practices. In Eastern Europe, low cost agricultural production will decide the success or failure not only of individual farms but the overall agricultural sector in these countries. The adoption of no-tillage systems would facilitate positive developments in all these instances.

While recent trends show a strengthening of commodity prices it is noteworthy that subsidies to European farmers are declining in value each year and any future payments made to producers will be strongly linked to environmentally sensitive practices. New soils legislation throughout Europe will ensure that soil protection becomes a legal responsibility within each Member State. Further emphasis on conservation practices in agriculture would necessitate the adoption and development of no-tillage systems.

No-tillage is a sustainable agricultural system that meets the economic needs of farmers, addresses the concerns of consumers and minimizes the impact on the environment. It is vitally important for European farmers to adopt sustainable low cost systems in order to optimize profitability on their farms. The ECAF has a pivotal role to play in the coming years in assisting with the promotion and adoption of no-tillage systems throughout Europe.

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Note on the Authors

Gottlieb Basch(PhD) is Pro-Rector and Professor of Crop Science at the University of Évora in Portugal. Over a twenty year period he has been involved in and directed research and education initiatives in agricultural science with an emphasis on soil tillage systems for sustainable agriculture. He is the Director of the Portugese Association for Conservation Tillage(APOSOLO) and President of the European Conservation Agriculture Federation(ECAF). E: gb@uevora.pt

John Geraghty(MAgrSc) is an Agricultural Consultant and specializes in conservation agriculture systems. He has previously worked with the GTZ and the United Nations in Africa in development projects, on-farm research, extension, and food security. He is a lecturer in Sustainable Crop Production with the Waterford Institute of Technology and guest lecturer in Sustainable Agriculture in Unversity College Dublin. He is National Representative to WASWAC. E: info@geraghtyconsulting.ie

Bernhard Streit(PhD) is a no-tillage researcher and agronomist in the Agroscope Reckenholz-Tänikon Research Station in Zürich, Switzerland. He is a lecturer in Weed Science at the Federal Institute of Technology in Zürich and is General Secretary of the Swiss No-Till organisation.
E: bernhard.streit@art.admin.ch

Wolfgang G. Sturny(PhD) is Head of the Department of Soil and Crop Protection for the Canton of Berne in Switzerland. In his role he provides advice to farmers on no-tillage and has published numerous papers in agricultural research journals and publications. A regular contributor to conferences at home and abroad he is a member of the Board of Swiss No-Till and is Vice-President of the European Conservation Agriculture Federation(ECAF). E: Sturny@no-till.ch