Controlled Traffic Farming Across Europe

Report on workshop, 23 – 24 April 2008 held at the
Slovak University of Agriculture, Nitra, Slovakia

Summary

The workshop was organised as part of the ISTRO working group on controlled traffic farming and in partnership with the Slovak University of Agriculture, Agrio and CTF Europe. The workshop was preceded by a one day conference for Slovakian farmers that included an introduction to CTF.

ISTRO aims for the workshop were to draw together researchers interested in collaborative CTF research and to create a European network. Additionally the aim was to provide transparency across all research efforts and to formulate ideas that could provide the basis for an EU funded project under FP7.

Short, research-orientated presentations were made by participants from Slovakia, Switzerland, Czech Republic, Finland, Greece, Germany, Romania, Denmark and the UK. These were followed by a brainstorming session with a guideline questionnaire whose principal outcomes were:

- Common research and measurement methodologies should be targeted.
- Gaps in research should be identified
- There should be transparency in planning and ongoing CTF research.
- Implementation plans and results from practising farms should be made available through the CTF website.
- There should be collaboration with publications and good dissemination of knowledge in different languages.

Actions were planned to address these issues, most of which would come about jointly between the ISTRO CTF working group and CTF Europe. In particular, a spreadsheet would be developed that would allow proposed, agreed and ongoing CTF-orientated research to be identified.

The remainder of the workshop was taken up with farm visits and informal discussions between participants. The farm visits were designed to introduce participants to a range of farming systems and as an opportunity to inspect local soil conditions. Included were the University farm at Oponice, a commercial farm at Jelšovce and a further large farm at Selíce. The soils we saw were highly productive and crops were consistent, but there was widespread evidence that soil conditions could be improved by adopting CTF.

Introduction

The workshop was organized by the Slovak University of Agriculture and Agrio with support from CTF Europe but the umbrella organization bringing people together on this occasion was the CTF Working Group of the International Soil Tillage Research Organization (ISTRO) which had been formed in Brisbane in 2003.

The principal aim of the workshop was to bring researchers together to formulate ideas for future CTF related work and to create transparency across existing and planned or
proposed work. CTF Europe’s interest was also to consider the potential for CTF in Slovakia through farm visits.

The workshop started with introductions of all participants, their ongoing research activities and the staff expertise at their organizations. This was followed by a brainstorming session with the aim of eliciting specific research requirements associated with CTF, the methodologies to use, areas of common and coordinated research and means of dissemination.

Creating a CTF research network

Welcome

We were welcomed to the Slovak University of Agriculture by Ladislav Nozdrovický who considered that CTF was an important tool for increasing the efficiency of field work and reducing costs, but it was not a simple tool to use and came at the price of introducing good machinery management. But, this is why we are all here, to formulate ideas and to provide a common platform for research and he wished us well in our endeavours and for good future cooperation.

Presentations from participants

Slovakia

Ladislav Nozdrovický introduced the University and its work on behalf of himself and colleagues Vladimir Rataj and Jana Havránková. His “Department of Machines and Production Systems” is part of the Faculty of Engineering, renamed a few years ago from the Faculty of Agricultural Engineering, which is one of six at the University. Their research since 1987 has included the effects of tillage machinery on soils, the implementation of precision farming, including latterly an extension of this into ecological and energy optimisation using IT and site-specific applications.

The University has a wide research remit and good contact with both small and large farms. Their research on soils includes the effects of machinery compaction encompassing differential infiltration rate as affected by tillage practices and the effects of soil conservation technologies. They are also using fractal analysis and indirect measurements of soil properties (electrical conductivity) to support these studies. Other equipment to support this work includes a penetrometer, a conductometer (KTN-6), Leica GS20 GPS receiver, a Thetaprobe, Infiltrometer and an N-sensor as well as means of measuring CO₂ soil fluxes.

On the output side of agricultural systems they are studying the economics of soil tillage and precision farming methods, the use of IT and information systems in agriculture and ground-based remote sensing. Their partners in this research programme include two commercial farms (one of which we were due to visit), Agrio Poniky (farm machinery manufacturer and workshop sponsor), the University farm at Oponice and their local John Deere importer and machinery dealer (Agroservis Komárno).

In terms of human resources, Ladislav´s Department has 12 lecturers, six research technicians and 7 PhD students.

From autumn 2008, they plan to conduct some pilot trials on CTF and to examine the possibility of introducing CTF on commercial farms in Slovakia. In particular they would
like to collaborate with these farms by setting up large scale experiments. Through these combined activities they would like to become part of a Europe-wide CTF research network and actively participate in an EU funded programme. Their experience with EU projects has included a Thematic Network on Agricultural Engineering and a similar Network on Education and Research in Biosystems, including Biological and Agricultural Engineering in Europe. They also have an INTERREG III project, which is a community-wide initiative to stimulate interregional cooperation to strengthen economic and social cohesion throughout the EU.

Switzerland

Martin Holpp introduced the contribution from Switzerland prepared jointly with Thomas Anken who is head of the research group on Agricultural Engineering Systems. Their centre at Tänikon (ART) has around 360 staff and a research farm of 120 ha. Research departments include Grassland and Arable Farming Systems, Biodiversity and Environmental Management and their own Agricultural Economics and Engineering. Within the research group Agricultural Engineering Systems they have 7 researchers, 2 technicians and 1 PhD student (Martin Holpp). Swiss agriculture is mainly traditional, with ploughing used for around 90% of the maize and sugar beet crops and about 60% of the wheat crop; no-till is practised on around 15,000 ha representing around 0.5% of the cropped area. Reasons for not adopting lower input systems included yield instability, complexity and tradition.

Martin went on to say that their interest in CTF stemmed from 20 years of research into no-till. During this time they had seen poor plant emergence in compacted areas and poor oxygen concentration in moist conditions. They wanted to know if compaction was the cause of relative yield instability in low input systems and whether CTF provided the answers, particularly compared with low ground pressure.

They are well equipped at ART and have a three-year field trial starting this year where they will be comparing ploughing, direct seeding and direct seeding with CTF. They will be using a multidisciplinary approach that involves many research groups at the Institute, including Soil Fertility/Soil Protection, Farming Systems and Work and Farm Management. The research farm is well equipped, having mechanical and electronic support groups and they have industry contacts with Trimble and Pöttinger as well as with growers, to whom they will disseminate practice-orientated knowledge. Most importantly, they also wanted to cooperate to build a strong CTF Research Network across Europe with common and coordinated research. They are interested in task sharing, exchange of measurement methodologies and building the foundation of a research consortium for an EU proposal under EU-FP7 when an appropriate call was published.

Czech Republic

Milan Kroulik introduced the Czech contribution on behalf of the Czech University of Life Sciences and the Research Institute of Agricultural Engineering, Prague. Giving some background, Milan said that the 4.26 million ha of agricultural land in the Czech Republic represented around 54% of the area, of which 3.06 million is in arable production. Of particular interest was the fact that over 50% of the agricultural land is on
slopes of greater than 7%, making it unsuitable for intensive production. Equally, around 60% of arable production is on environmentally sensitive land where soil erosion and compaction are becoming of greater concern. Their group is developing an indirect measurement methodology for spatial and temporal variation in soil properties and crop yields and identifying relationships between recorded data sets. They are also working with GIS applications and the protection of soil against water erosion and compaction. Their indirect measurement methodologies include implement draught forces, “flow accumulation models” and soil electrical conductivity as well as techniques for remote sensing.

In the field they have measured the traffic intensity for three different tillage systems with the help of DGPS receivers in the vehicles. Results showed that 96% of the area was trafficked at least once annually with conventional tillage, 65% with conservation tillage and 43% with no-till. Repeated passes on a particular area for these same systems were 144%, 31% and 9% respectively.

Milan’s department at the University has access to a school farm with 2,900 ha of arable land and they cooperate closely with the department of agricultural machines and with machinery dealers and manufacturers. They have also been successful in securing EU projects in the form of SOWAP and iSOIL.

Their interest in CTF centres on evaluating the effects of traffic intensity on soil conditions, energy consumption, cultivation quality and economics. They also wish to study how methodological instructions can be developed for CTF together with the design of field traffic layouts according to field shape and topography.

The interests and expertise of the Czech participants are as follows:

**Milan Kroulík** is senior lecturer at the Department of Agricultural Machines, Czech University of Life Sciences in Prague. Area of interest is precision farming technologies, especially soil variability description, soil preparation and soil protection. He is interested in projects which are oriented towards precision agriculture and soil protection.

**František Kumhála** is Vice-dean for International Relations, Faculty of Engineering, CULS Prague. Teaching activities are centered on harvesting machines and post-harvesting technologies. Researching activities oriented towards electronic sensors for utilization in agriculture and soil conservation tillage.

**Josef Hůla** is Professor at the Department of Agricultural Machines and Research Institute of Agricultural Engineering, Prague. Structure of research activities: Care for land under conditions with increased demand for environmental protection, machines and technologies for soil tillage, machine impact on soil, reduction of soil compaction, increasing of anti-erosion effectiveness of soil tillage and soil tillage site heterogeneity.

**Jiří Mašek** is senior lecturer at the Department of Agricultural Machines, Czech University of Life Sciences in Prague. Professional life is connected with research in soil tillage area, especially in zero tillage technologies and crop residue management. Next part of research is in hydraulic equipment of mobile machines. In his spare time Jirí enjoys working on his parent’s farm.
Finland

Laura Alakukku from the University of Helsinki is working in their Faculty of Agriculture and Forestry and the Department of Agrotechnology in particular. In the Agrotechnology department, they are working in two main subject areas, Agricultural Engineering and Environmental Engineering in Agriculture and she responsible for the latter. This is a new subject for the University and Laura has only been in the department for one year, but spent the previous 20 years dealing with practical farming issues and with soil science.

Their main environmental research topics which are covered by a multi-disciplinary group, include:

- remote sensing of soil conditions (wireless)
- soil management, including the effects of compaction, tillage and water movement and both direct drilling and conservation tillage

while in agricultural production they are researching:

- automated implement use (Farmix)
- automated plant production (Autocrop)
- automated measurements, modelling and automation in general

Their funding arises from a number of sources including their Ministry of Agriculture, Academy of Finland, National Technology Agency of Finland (TEKES), the EU, private funds, the University itself and from manufacturers. The latter include Valtra (previously Valmet), John Deere (Timberjack), Ponsse, Sampo and Nokian. Laura concluded her talk with emphasis on their expertise in soils!

Greece

Dimitrios Pateras from the Technological Educational Institute of Larissa (TEI) and the School of Agricultural Technology said that his Department of Agricultural Machinery and Irrigation was working in the areas of:

- Precision Agriculture in the cotton crop
- Soil spatial variability in small apple orchards
- Integrated crop management in apple and pear orchards.

In the soil variability work they are looking at how apple quality is affected by soil properties and management of both apples and pears is particularly important because these are crops covering a large area in Greece.

They were particularly interested in participating in a CTF network and the technology for CTF implementation. Their specific research focus would be on development of an EU project in Precision Farming and particularly reducing the need for intensive tillage in arable crop systems.

Dimitrios’s specialist know-how is in soil chemistry and he is presently conducting work on the spatial variability of soil chemical properties using electrical conductivity as a basis (Veris and EM38) because this can be used as a non-invasive measuring technique in orchards and vineyards.

In terms of human and financial resources they have four principal sources, namely:

- Ministry of Education (Archimedes Programme)
- Ministry of Agriculture and Food
- Technological Educational Institute of Larissa – Research Committee
- Periphery of Central Greece which funds research for local farmers

The Institute has good contacts with small local agricultural machinery manufacturers, mostly plough ancillaries and light cultivators and irrigation systems, but they do not have direct contact with larger companies. In terms of acquiring EU-funding they have been involved with a number of projects.
- “Varinuts” which looked at the variability of soil nutrient stocks in sub-Saharan Africa.
- Municipal nutrients for biomass short rotation coppice.
- Wastewater reclamation for irrigation.
- COST 622 regarding volcanic soils in Europe.

They have also submitted proposals in the subject areas of global change effects on water balance, the effects of environmental components on agricultural production systems and the integration of biological aspects to improve the environmental impact of grape nutrition.

**Bavaria**

Markus Demmel and Robert Brandhuber, both of the Bavarian State Research Center for Sustainable Land Use and Food Production in Bavaria, (which has 3.3 Mha of agricultural land) said that the Center divided its activities into two main functions under a problem orientated approach. Under Technical Functions the Center carries out problem-orientated research and development and support for agricultural administration. This runs parallel to monitoring, advisory and consultancy work, technical support for and cooperation with national and international bodies and providing system development and evaluation. The other main function of the Center is Executive, providing both Technical and Financial support to local and national organizations, mostly in the context of legislation and training.

In terms of specifics, the Center is studying:
- Soil fertility, tillage, soil protection and soil monitoring
- Nutrient flows, plant nutrition, fertilization and environmental protection
- Coordination of organic research and plant production
- Cultivated landscapes, agro-ecosystems and flora and fauna.

Their work on Agro-ecology mostly centres on legislative requirements including both soil protection and fertilizer requirements.

In agricultural engineering they study both plant and animal production, providing expert reports on this sector as well as animal husbandry and emission control.

Robert Brandhuber’s particular expertise and experience relates to:
- soil physical properties
- soil stress and compaction
- terramechanics
- erosion modelling and control.

Markus Demmel’s work centres on:
- mechanization of plant production
- mechanization concepts
- technical solutions to prevent soil compaction
• precision farming technology
• autoguidance and other GPS applications.

Their interest and current activity in CTF is focussing on adaptation and evaluation of CTF systems for arable and grassland farming under Bavarian conditions. They see CTF as a powerful strategy/tool for improving the efficiency and sustainability of arable farming, especially under the threat of climate change. A proposal entitled:

_Establishment, comparison and evaluation of traditional (ploughing), mulch tillage and arable farming systems with CTF on an intensive/high yielding farming area (experimental farm) in Lower Bavaria._

was submitted to the Bavarian State Ministry of Agriculture earlier this year and a decision on this is expected in June.

Romania

Jorgen Boe Hansen and Mircea Trulan provided an overview of the CTF system they adopted in 2007 on their 2600 ha farm in Romania. Based on a 9 m module and a 2.25 m track gauge (their harvester is on rubber tracks) they are growing maize, soy beans, wheat, sunflower and sorghum in a mainly non-plough regime.

Czech Republic 2

Pavel Milata of Leading Farmers said that his was a small company that supplied products and services into the Czech Republic and Slovakia, mainly in the area of precision farming, supplying products such as GPS systems, mapping and the N-sensor. Pavel saw CTF as a tool to help them work more closely with their customers.

Slovakia 2

Milan Králik whose company Agrio was helping to sponsor our CTF workshop said that his company supplied both trailed and self-propelled sprayers ranging from 18 – 36 m in width and with capacities of between 800 and 8000 litres. They exported these products to Poland, Germany, Romania and special products to the UK. They too also supply the N-sensor and GPS guidance systems. A completely different business is in the supply of drainage cleaners which they export to the Netherlands and from there to eleven countries in Europe.

Denmark

Hans Henrik Pedersen of AgroTech and CTF Europe provided us with an overview of his activities under these two organizations. AgroTech, formed and owned by the Danish Agricultural Advisory Service, had become a technological service institute in 2007. Their remit, as well as undertaking research and field trials, is to help mainly smaller innovative companies working in the areas of:

• high precision steering
• spraying
• waste management, slurry and nutrient management
• biomaterials
• climate change/sustainable agriculture
Their current interests include establishing themselves as a test centre for the accuracy of GPS systems, working with companies and farmers on the precise management of rows and single plants and in extension and communication, including provision of editorial for the CTF Europe Newsletters.

In the future they will be focussing on sustainable management systems using the concept of Conservation Agriculture (as promoted by FAO) requiring less input and leading to improved soils and less soil loss. They will also be looking at improved seeders for No-till and CTF and keeping pesticides at an increasingly lower level. Primarily they focus on “close to practice” research. In terms of CTF, they will be studying what happens to field variation when compaction is eliminated from the main crop area.

Hans Henrik, who had been working closely with GPS systems for 15 years, said that there was now a “pull” for this technology from growers, rather than a “push” from the suppliers. He completed his talk by highlighting the upcoming CTF workshop in Denmark on CTF in grassland production, which would take place on 9th and 10th June.

**UK**

Tim Chamen of CTF Europe Ltd said that the company had been set up in 2007 as a means of facilitating interaction between people interested in CTF, particularly practitioners, and for creating links with other parts of the world and with global research on the subject. At Agritechnica in November 2007, a Europe-wide membership scheme had been set up to provide a means of funding the activities of CTF Europe and providing services in terms of information, workshops and interaction between its members. CTF Europe representatives are now available in Denmark, Germany and the Netherlands and further representation in other countries is being actively sought [Since the workshop, Jana Havrankova has agreed to be the CTF Europe representative for Slovakia]. The strength of CTF Europe had been built on a UK membership started in 2005, which consisted mainly of growers, most of whom were now in processes of conversion to CTF. Initiation of interest in CTF had been the result of a number of commercial sponsors responding to Unilever’s offer in 2004 to provide a demonstration site on their 40% clay soil research farm in Bedfordshire, UK. This site, which started as one 8 ha field has now been expanded to 73 ha and nine fields growing wheat, oilseed rape, field beans and a spring crop. Presently an 8 m ComTrac system is being used, but for practical demonstration reasons, this will be converted to an 8 m OutTrac system later this year. The aim of the project has been to assess the sustainability of CTF within a commercial environment and so far this has proved perfectly feasible.

Tim has a long history in soil compaction, undertaking research in the 1980s and 1990s, which led him to the discovery of the enormous benefits that isolation of compaction could achieve. Although he is currently undertaking some research and measurements on the Unilever site, there is no actively funded programme. The involvement of around ten commercial partners does however provide the potential for collaborative work and matched funding from national governments or the EU. Tim has experience of submitting an EU project under their “Research for SMEs” programme (not successful) and has also been an EU evaluator under this same programme.
**Research on CTF in Europe**

**Introduction**

Thomas Anken and Martin Holpp had prepared a questionnaire for this session and Thomas stressed the importance of coming up with some concrete ideas for cooperation, whether this was in terms of sharing the resource of a field experiment, sharing equipment or in developing a coordinated programme. It would also be useful to identify “centres of competence” and gaps in knowledge.

Thomas also outlined what he and his colleagues believed CTF could deliver. It would for example be of little benefit to continue within a conventional ploughing regime – CTF was all about reducing the intensity of and depth of tillage inputs while maintaining or increasing yields. It was also necessary for us to be aware of the constraints of CTF and these differed from country to country. In Switzerland for example, even machines as wide as 6 m were uncommon whereas in Slovakia and elsewhere, they were readily available. CTF also required driver skills and qualification and motivation of the farm management – it required planning effort to achieve.

Thomas then asked us to divide into three groups and try to come up with at least two concrete suggestions for cooperation.

**Outcome of research discussions**

These are best presented under the questionnaire headings with specific country information where this is available.

**Question 1. What project ideas, plans or activities related to CTF research or on-farm projects do you have in place, if any?**

<table>
<thead>
<tr>
<th>Country</th>
<th>Project</th>
<th>Description</th>
<th>Contact</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>CTF/Colworth</td>
<td>Demonstration with some soil and crop measurements, e.g. penetrometer, moisture profiles, infiltration, N₂O emissions, but these measurements are fragmented.</td>
<td>Tim Chamen</td>
<td>Running since 2004</td>
</tr>
<tr>
<td>Bavaria</td>
<td>CTF/Field trial</td>
<td>Working with farmer on problem soil using conservation tillage looking at environmental effects – soil physics, water movement, erosion and yields</td>
<td>Robert Brandhuber</td>
<td>Planned</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>CTF on farms</td>
<td>OutTrac system being used on one or two farms. Different crops, machines and GPS systems. Very willing to carry out measurements.</td>
<td>Pavel Milata</td>
<td>Running</td>
</tr>
<tr>
<td>Slovakia</td>
<td>CTF/Field trial</td>
<td>Plough/No till/No till with CTF. Also drill opener design for maize in range of crop residues. CO₂ in relation to tillage.</td>
<td>Ladislav Nozdrovický</td>
<td>Planned</td>
</tr>
</tbody>
</table>
Question 2. What expectations do you have for a CTF research network?

a. *Exchange of research methodology and results*

There was a widespread willingness to exchange research methodology and experiences so that results would be more comparable. As a means of starting this dialogue and interchange, the following table lists the various measurements that are being conducted in some of the different countries represented, but more information about this can be found from the individual presentations already summarized in this document.

<table>
<thead>
<tr>
<th>Country</th>
<th>Measurements being conducted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Czech Republic</td>
<td>Near infra red, infiltration, soil physical properties, rainfall impact using a simulator, CO₂, O₂ fluxes at the soil surface, implement draught force, fuel consumption</td>
</tr>
<tr>
<td>Slovakia</td>
<td>Near infra red, soil physical properties, electrical conductivity, satellite images with digital analysis, machine tracking, economics, CO₂ in the field, N-sensor and mapping.</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Soil physical properties, 3-point linkage pulling forces, in situ O₂ and CO₂, economics, labour requirements.</td>
</tr>
<tr>
<td>UK</td>
<td>N₂O, penetrometer, infiltration</td>
</tr>
</tbody>
</table>

The point was also made that we should in all CTF experiments be able to make a clear distinction between trafficked and non-trafficked areas of the field. Only in this way would we be able to properly measure differences in yield, infiltration, soil physical properties etc.

b. *International use of field trials*

Sub-headings for discussion

- *collection of soil samples from different European sites*
- *measurements of machinery work rates in different countries*

International use of field trials was considered to have very valuable potential. The fact that one could bring in expertise and instrumentation to measure things that you didn’t have the resources to do was an interesting proposition. Equally, to have field experiments available where you could conduct measurements in different soil types and/or climate, when perhaps one’s own resources would not allow you even to set up experiments, was also an interesting proposition. This is not a new idea, but making it work in practice would be made much easier if it were included in the planning stages. It would also strengthen any proposals containing this intention as far as an EU project was concerned.

c. *Common research projects*

Having common research projects was certainly attractive in theory, but often difficult to achieve in practice and constrained by funding. This prompted discussion about a database of CTF projects (discussed further under the next topic). Common research projects suggested were for:

- *Maize*. A crop that is grown extensively across Europe, but **not** one in which CTF had been widely explored. This crop is particularly sensitive to compaction and
compatible CTF systems were perfectly feasible and practical. Maize growers are also often grass growers, and there is great potential for extending CTF in the maize crop to subsequent grass swards for forage production.

- **Permanent wheel tracks on slopes.** Considerable concern had often been expressed about the potential of CTF to increase erosion problems, but this was usually considered in the context of conventional traffic with no allowance for the additional infiltration afforded by CTF. (how much across-slope flow has there been in the photo on the right?). Design and management of the permanent wheelways needs to be researched.

- **The role of CTF in conservation agriculture.** Although conservation agriculture is considered more sustainable than traditional methods, it can still be challenged by compaction. The Australians have made no-till work much better when it has been combined with CTF and evidence from the UK would suggest it is doing the same there. But, there has been relatively little research on this very specific topic. The FAO would be a good partner for this work and it fits nicely with the topic on the EU list entitled: *Reducing the need for intensive tillage in arable cropping systems.*

- **The role of CTF in reducing within-field variability.** Precision farming methods are all aimed at reducing variability and yet little attention is paid to the role of random compaction in introducing variability. Contrasts in variability should be measured.

**d. Coordinated research agenda**

Sub headings for discussion:

- *systematic approach to the analysis of CTF knowledge*
- *identification of knowledge gaps*
- *creation of international focus projects with one lead institution*

There was general agreement amongst the groups that we should work actively to promote a coordinated agenda. Several key things came out of the discussions, namely:

- Gaps in knowledge should be researched and identified.
- There should be agreement on measurement methodologies.
- Intellectual property rights must be dealt with early in any discussions on a coordinated approach.
- There should be transparency across all the research projects starting from the earliest planning stages.

In terms of the last point it was suggested that we create a spreadsheet which clearly identified who was planning or carrying out research that included a CTF element. It would also be important to try and involve industry in any of the projects planned, whether this was growers, machinery suppliers or agronomists.

These coordination activities would almost certainly come under the umbrella of the ISTRO CTF Working Group, but would also be supported by CTF Europe whose website could be used as a focal point for researchers and practitioners alike.
e. Dissemination of CTF results and implementation plans

All agreed that dissemination of results would be a vital part of any research undertaken as well as for farms that were operating a CTF system. There were a number of ideas about how this could be done most effectively:

- **Creation of a knowledge or internet platform.** This would provide:
  - a project overview
  - a methodology overview
  - a scientific reference list on CTF where information can be found.
  - educational material for students.

  It was considered that the CTF Europe website was a good place to launch such a platform and to act as a channel to disseminate a wide range of information.

- **Lifelong learning programmes.** The LLP is a European funding programme details of which can be found at: [http://www.lifelonglearningprogramme.org.uk/](http://www.lifelonglearningprogramme.org.uk/). Within this programme, the “Leonardo” project seems to have particular relevance and might be integrated with Interreg III perhaps.

- **Europe-wide joint publications.** This would be an attempt to publish all CTF research under a common publishing platform. It would require common sampling plans laid down at the outset of experiments and reporting in a number of different languages to make all the information available to as wide an audience as possible. For example, a researcher in Slovakia would publish not only their own results in their own language, but also those coming from Switzerland or Greece working under the coordinated programme.

  This is ambitious, but could receive additional financial support from a number of funding bodies, but crucially, would need an individual within the coordinated project to make sure it happens.

- **Translation services.** Presently most of the information on the CTF website is in English, limiting its availability to a very large number of practitioners across Europe. Finding partnerships that could provide the resources to translate this material would be of considerable benefit. [Might this be available on the web?]

- **Implementation plans or case studies.** This would be at the very practical end of the dissemination programme, with individual farms listed (with their approval or their anonymity maintained), what system they are using and the results they have achieved. Again, the CTF website would be ideal for this and some examples were already available, but needed updating.

A cautionary note was struck about very large farms and the adoption of CTF. At present, these farms often have a very wide range of tractors and harvesters supplied by different companies. Creating a common CTF system could be complex and time consuming. It may be that these farms would have to be divided into smaller autonomous units in terms of CTF adoption.

**Discussion**

**Funding for research**

It was accepted that presently there was no appropriate “call” under the EU’s Seventh Framework Programme (FP7) that CTF would fit into, but there was other funding potential that might be pursued. The ERA-NET scheme was one of these ([http://cordis.europa.eu/coordination/era-net.htm](http://cordis.europa.eu/coordination/era-net.htm)), and although this didn’t fund research...
directly, it could help to fund our aspirations for creating a coordinated CTF research programme. However, this scheme is directed at ministries, research councils and agencies responsible for funding rather than the research organizations themselves, so might not actually be appropriate at individual research institution level. Another possibility mentioned was COST (http://www.cost.esf.org/). Outwardly, this programme seems to offer the sort of thing we are looking for because it states: “the initiative of launching a COST Action comes from the European researchers themselves” and in further literature it states that: “The funds provided by COST support the coordination costs of the research networks (Actions), while the research is funded nationally”. But, more investigation is needed to determine exactly what this scheme is about and what its constraints are.

**Funding for farm implementation of CTF**

A question was raised about whether there was likely to be any funding available for farmers who implemented CTF, particularly in the early days of adoption? It was generally accepted that CTF addressed environmental issues such as flooding caused by poor water infiltration into the soil and so should receive encouragement. The consensus from the group was that the EU would be unlikely to support farmers directly, but local governments might or perhaps water providers.

**Farm visits**

**Farm at Jelšovce**

The first farm we visited was created as an 880 ha cooperative in 1959 from a number of small farms, some on a voluntary basis, others not. In 1975 the farm became part of a much larger 5300 ha cooperative when ten farms were joined together but this split up again in 1991 to return to the original. The area has now extended slightly to 900 ha, employing 32 people who are employed across all the enterprises. Most of the land is rented. The farm grows oilseed rape, barley, sunflower, sugar beet and onions and has 2500 fattening pigs, 65 breeding sows, a 65 cow dairy herd and Simmental beef animals. Cropping consists of 330 ha winter wheat, 230 ha spring barley, 50 ha sugar beet, 200 ha oilseed rape, 40 ha sunflower, 60 ha of corn and silage maize and 40 ha of lucerne (alfalfa).

Their tractor fleet consists of:

- 260 hp x 1
- 180 hp x 5
- 80 – 100 hp x 10

They have their own Agco 7274 grain harvester which copes with most of the harvest but contract out the sugar beet harvesting. They store and process their grain for animal feeding [Author note: not sure whether this was all of their grain, or just some of it]. Annual rainfall at the farm is 550 mm and the land is on two main soil types, a black Chernozem and a heavy clay. Average yields were quoted as:
<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield, t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>6.3</td>
</tr>
<tr>
<td>Barley</td>
<td>5.4</td>
</tr>
<tr>
<td>OSR</td>
<td>3.1</td>
</tr>
<tr>
<td>Maize</td>
<td>8.0</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>68</td>
</tr>
</tbody>
</table>

Seeds of barley are sown at the rate of 300/m² and wheat at 400/m², both at 12.5 cm row spacing. Tillage is constrained by crop residues.

We were then driven to one of the nearby fields to get first hand experience of the soils and crops. The field had been sown with peas which were a few centimetres tall. Inspection showed signs of compaction typical of randomly trafficked soils, as indicated by the photos below. This soil seemed highly fertile and as we learned from the farms’ manager, was capable of producing some high yielding crops from relatively low rainfall.

This field at Jelšovce had been sown with peas following ploughing. Compaction was severe in places as indicated.

We were convinced that this soil would respond well to CTF and low inputs providing the residues could be managed.
University farm at Oponice

We were introduced to the farm by the farms’ director Ing Peter Brezovsky (standing, left) and their agronomist, Ing Mrs Kubalova. Although the farm is owned by the University, Church and other institutions, it is run as a separate limited company with its own financial independence. Buildings and machinery are rented from the University as are the 2300 ha of arable land divided into two farms, one of 1000 ha, the other 1300 ha, one of which is managed traditionally (Oponice), the other under an agri-environment scheme. The main purpose of the farm is to produce conditions for student learning based on high quality crop and animal production with maximum yields.

Crops are mainly cereals but they also grow sugar beet (50 ha with average yields of 55 t/ha and 18.6% sugar) and the oil crops canola, poppy, sunflower and pumpkin along with silage maize (stored in bags) and lucerne for animal feed. Wheat, barley and oilseed rape are also grown for seed as is 70 ha of maize and they have a 25 ha of vineyard (more of which later!). A wide range of other crop species, including herbs and salix are grown specifically to introduce diversity to the students. Livestock similarly includes a wide range of breeds but commercial stock is a 550 cow dairy herd, 85 breeding sows, 500 sheep and some pheasants.

They employ 115 people on the farm, but this was around 500 in communist times.

Principal machinery includes:

<table>
<thead>
<tr>
<th>Tractors/horsepower</th>
<th>Harvesters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fendt 270</td>
<td>Claas Jaguar 850 for forage</td>
</tr>
<tr>
<td>John Deere 170</td>
<td>6-row Matrot for sugar beet</td>
</tr>
<tr>
<td>Zetor about 100 (being replaced)</td>
<td>John Deere (x 4) for grains</td>
</tr>
<tr>
<td>New Holland 100-140 to replace Zetors</td>
<td>Pumpkin harvester (Austrian)</td>
</tr>
</tbody>
</table>

They also have two Agrio sprayers that they considered to be of good value and quality.

The University has a number of major projects with 50% funding from the EU. One is for 55M SKK (€1 ≈ 30 SKK), of which 25M SKK was used to replace old machinery and another project worth 10M SKK for improving animal welfare. The average farm worker’s salary is 17,000 SKK/month (€6,720 per annum).

The Agri-environment programme is aimed at preventing soil erosion by maintaining 70% of the land with crop or residue cover. This allows 30% of the area to be left bare after ploughing. The programme also restricts spraying, allowing only certain chemicals and fertilizers to be used, for example, the optimum fertilizer for oilseed rape is 190 kg/ha, but only 130 kg/ha is allowed. This programme pays 5000 SKK/ha but is highly demanding.

They are able to achieve a wheat yield of 6 t/ha with 90-110- kg/ha of N and apply 35 t/ha of manure every 2.5 years. They would like to convert to liquid manure (slurry), but would need to introduce a means of storing this for six months.

Overall, they have to maintain a balancing act between commercial, student and EU demands!
Prior to our introduction to the University farms we had spent a short while in one of their winter wheat fields looking at the soil. This looked highly fertile and showed evidence of good structure within the field itself, but significantly better alongside where in addition to little tillage, there may have been some manure amendment.

Oponice had another little treat for us in terms of the produce from the 25 ha vineyard! Hidden away underground in this innocent little building were some truly memorable wines that we were invited to sample. Red, rosé and white were offered in abundance and were “seriously” enjoyed by all! Our thanks to all at the University farm for a most interesting and enjoyable visit.
Agro Divižia s.r.o., Selice

Introduction to the farm
We were introduced to the farm by Jan Zsak (Chairman) and Jozef Meszaros, the local manager.
In 1951 the farm was a 3800 ha co-op run on traditional lines with 28 different crops plus pigs, cattle and poultry. The first change came in 1991 when over 1000 of the people who had an interest in the farm had a meeting at the local football stadium at which it was decided that everything had to be put on a profitable footing. This plan became for them the “Holy Grail” and a budget of 230M SKK was set aside for rebuilding the company, being achieved with an overspend of just 30M SKK.
Poultry production ceased and management of the beef and dairy cattle was refocused to finish up with a 650 cow dairy herd and 550 head of beef cattle. Each of the dairy cows was producing 2860 litres of milk annually in 1991, but this has now risen to 8000 litres, giving an annual herd output of some 5 Million litres.
Agro Divižia was the first company in Slovakia to use soil conservation tillage, which they introduced in 1993 and in just one year reduced their 28 crops to just four. However, wheat, barley, maize and lucerne have now been augmented with sugar beet, oilseed rape and sunflowers. All grain crops are grown for human consumption and until 2000 were sold off the farm as flour using an imported US grain milling plant. However, these crops are now sold as seed.
In terms of farm ownership, they have embarked on buying out the many owners and have secured 60% of the land which now extends to 5,500 ha. This is managed at three centres separated by 40 km, making materials handling an important factor.
Annual rainfall at the farm is around 630 mm, of which 74 mm falls in May, 81 mm in June, 30 mm in July and 95 mm in September.
Average crop yields are:
- Wheat 4.3 – 5.6 t/ha
- Barley ditto
- Maize 6 – 10 t/ha although 5 t/ha in 2007 due to flooding and insect attack
- Sugar beet 60 t/ha (representing the best yielding farm in SK in 2007)

For seed production they have their own laboratories for cleaning, separation and quality control and they bag and export most of their production.

Machinery Department
They presently have around 17 tractors which are replaced on a 5-7 year cycle. They have Kinze and Great Plains drills for no-till and stubble cultivators are used to incorporate liquid fertilizer (slurry).
As with any other business, they are increasingly using information technologies and, recognising that they don’t have the time or expertise themselves, collaborate closely with Nitra University to bring new technologies into practice. In 2004 they introduced Precision Farming in association with Ladislav Nozdrovický (Nitra), but have now taken this a step further by setting up AMS, an agricultural management system company that manages and oversees the machinery, precision farming systems and agronomic and
information services. Everything is now checked in detail, including water management, yields and inputs. They want to know how to get the best from their soils with minimum input but equally recognise that they need to comply with EU legislation, for which they need an evidence-based system.

To do this they have a close monitoring system. Each task undertaken by each member of staff must be controlled with the minimum of administrative input but in a way that avoids mistakes. To do this, everyone uses an information system (iSat AP) that has been designed by a student (Branislav Zidek) in collaboration with the farm. iSat AP has been adapted from other commercial systems and provides complete documentation for all farm operations. This includes which machines were used, yield variability using a GIS mapping system and sampling of soil organic matter and electrical conductivity using GPS (in collaboration with Nitra). Variable rate fertilizer application is also practised and site-specific tillage, such as subsoiling. Satellite guidance is provided by John Deere’s Autotrac operating with Starfire 2 (SF2), using both curve and straight tracking. Branislav has been responsible for designing and introducing IT on the farm and is considered to be one of its most valuable employees. He has introduced a central computer server and the internet is used to connect all the systems together. Each vehicle is fitted with a “D-box” that transmits speed and position data via a GPRS system back to the farm and together with an appropriate software programme, updates vehicle position in near real time. The system can be extended to include fuel consumption and seed rate for example. All the data are recorded continuously for later analysis if required. This allows work rates to be calculated on a field by field basis and average and maximum speeds to be computed. Overall, this provides an important aspect of traceability.

The farm now wants to introduce CTF, but have a problem with “employed” drivers who are nervous of new technology and techniques. To overcome this they have introduced a “life long learning” scheme to provide them with training and confidence.

Visit to see machinery and field conditions
We then made our way from the farm offices to see some of their machinery and a field recently prepared for maize. The machinery was impressive, both in terms of its modernity and size. The first thing to see in the stackyard was an 18 m wide Czech Strom Swifter cultivator pulled by an 8 wheel drive John Deere. The Swifter also seemed to be equipped with a liquid fertilizer tank but its means of distribution was not obvious.
Harvesters were John Deere STS with 6 m and 9 m cutting tables and a 12 row for maize. There were also 8 m cultivators but all drills were 6 m, including a 12 row maize planter. The sprayer was a 30 m John Deere self-propelled with a track width of around 3 m. The soil in the field we inspected looked very fertile, but there was unmistakable compaction across the site as evidenced by differences in ease of digging and the soil structure exposed and illustrated below. Having recently been cultivated in what appeared to be moist conditions, this was not surprising. Equally of course, with the wide equipment, traffic intensity would be significantly less than on many farms.

Differences in soil condition below the cultivated surface of the field above at Selice. The two leftmost photos show compaction in the topsoil and lower layers, whereas that on the right is generally well structured, probably having avoided any seedbed compaction.
Conclusions and actions from the workshop

The objective of bringing together researchers from across Europe was well met by the workshop, with delegates and contributions from nine countries. Equally successful was the research session that aimed to elicit some concrete plans. These included:

- Common research and measurement methodologies should be targeted.
- Gaps in CTF research should be and were identified.
- There should be transparency in planning and ongoing CTF research.
- Implementation plans and results from practising farms should be made available via the CTF website.
- There should be collaboration with publications and good dissemination of knowledge in different languages.

Although these goals had been outlined, considerable further effort and cooperation would be needed to make them a reality. To this end, Tim Chamen agreed to compile a spreadsheet that would be a first step in this process. The sheet would provide a reasonably concise means of entering all ongoing and planned research in the CTF arena. Primarily, this would be progressed under the ISTRO CTF working group, but when available, all participants were asked to complete the form for their own plans and projects.

As far as the potential for CTF in Slovakia is concerned, this appeared to be at least as great as elsewhere, particularly in view of the productive soils, which were widespread. The photo below shows typical field conditions in the area, with many wheel tracks showing up as dark lines across the field.

The benefits of traffic control in Slovakia would seem to be as great as in any other country in the world!
Endnote
An informal meeting of some of the participants brought out a few more ideas, which included:

- European soil tillage contest (3 year project, not quite sure where this came from or where it was targeted – perhaps others in the meeting will recall!?)
- Articles on the CTF website should be translated into different languages
- There was good support for the idea of transparency for CTF research and that a spreadsheet would be one way of delivering this.
- Harper Adams college in the UK might be persuaded to carry out research on tyre tread design for use on permanent wheel tracks.
- New information should be made more visible on the CTF website
- Perhaps we should create a booklet along the lines of “CTF for dummies” to mirror similar publications brought out on a very wide range of subjects. It could perhaps contain 10 distinct lessons in the process of conversion.

This was an interesting and productive workshop, not least because of the social interaction that occurred. I provide some photos for those present to recall!

Social gatherings were equally important to the success of the workshop
Our accommodation in Nitra, The Agroinstitut (left) and view from it

### Participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation/Country</th>
<th>E-mail address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladislav Nozdrovický</td>
<td>Slovak University of Agriculture in Nitra, Slovakia</td>
<td><a href="mailto:Ladislav.Nozdrovicky@uniag.sk">Ladislav.Nozdrovicky@uniag.sk</a></td>
</tr>
<tr>
<td>Vladimir Rataj</td>
<td>Slovak University of Agriculture in Nitra, Slovakia</td>
<td><a href="mailto:Vladimir.Rataj@uniag.sk">Vladimir.Rataj@uniag.sk</a></td>
</tr>
<tr>
<td>Jana Havrankova</td>
<td>Slovak University of Agriculture in Nitra, Slovakia</td>
<td><a href="mailto:Jana.Havrankova@uniag.sk">Jana.Havrankova@uniag.sk</a></td>
</tr>
<tr>
<td>Milan Králik</td>
<td>Agrio, Slovakia</td>
<td><a href="mailto:konatel@agrio.sk">konatel@agrio.sk</a></td>
</tr>
<tr>
<td>Dimitrios Pateras</td>
<td>Technological Educational Institute of Larissa, Greece</td>
<td><a href="mailto:Pateras@teilar.gr">Pateras@teilar.gr</a></td>
</tr>
<tr>
<td>Laura Alakukku</td>
<td>Dept Agrotechnology, Finland</td>
<td><a href="mailto:Laura.Alakukku@helsinki.fi">Laura.Alakukku@helsinki.fi</a></td>
</tr>
<tr>
<td>Trulan Mircea</td>
<td>Romania</td>
<td><a href="mailto:BoelHansenJorgen@yahoo.com">BoelHansenJorgen@yahoo.com</a></td>
</tr>
<tr>
<td>Jørgen Boel Hansen</td>
<td>Romania</td>
<td><a href="mailto:BoelHansenJorgen@yahoo.com">BoelHansenJorgen@yahoo.com</a></td>
</tr>
<tr>
<td>Thomas Anken</td>
<td>Tänikon, Switzerland</td>
<td><a href="mailto:Thomas.Anken@art.admin.ch">Thomas.Anken@art.admin.ch</a></td>
</tr>
<tr>
<td>Martin Holpp</td>
<td>Tänikon, Switzerland</td>
<td><a href="mailto:Martin.Holpp@art.admin.ch">Martin.Holpp@art.admin.ch</a></td>
</tr>
<tr>
<td>Markus Demmel</td>
<td>LFL, Bavaria</td>
<td><a href="mailto:Markus.Demmel@LFL.Bayern.de">Markus.Demmel@LFL.Bayern.de</a></td>
</tr>
<tr>
<td>Pavel Milata</td>
<td>Leading Farmers, CZ</td>
<td><a href="mailto:Pavel.Milata@lfc.cz">Pavel.Milata@lfc.cz</a></td>
</tr>
<tr>
<td>Robert Brandhuber</td>
<td>LFL, Bavaria</td>
<td><a href="mailto:Robert.Brandhuber@LFL.Bayern.de">Robert.Brandhuber@LFL.Bayern.de</a></td>
</tr>
<tr>
<td>Chris Chamen</td>
<td>CTF Europe, UK</td>
<td><a href="mailto:Tim.Chamen@btclick.com">Tim.Chamen@btclick.com</a></td>
</tr>
<tr>
<td>Hans Henrik Pedersen</td>
<td>AgroTech, Denmark</td>
<td><a href="mailto:HHP@landscentret.dk">HHP@landscentret.dk</a></td>
</tr>
<tr>
<td>Jiří Mašek</td>
<td>Czech University of Life Sciences, CZ</td>
<td><a href="mailto:MasekJ@tf.czu.cz">MasekJ@tf.czu.cz</a></td>
</tr>
<tr>
<td>Josef Húla</td>
<td>Research Institute of Agricultural Engineering, CZ</td>
<td><a href="mailto:Hula@tf.czu.cz">Hula@tf.czu.cz</a></td>
</tr>
<tr>
<td>Milan Kroulik</td>
<td>Czech University of Life Sciences, CZ</td>
<td><a href="mailto:kroulik@tf.czu.cz">kroulik@tf.czu.cz</a></td>
</tr>
<tr>
<td>Tim Chamen</td>
<td>CTF Europe, UK</td>
<td><a href="mailto:Tim@ctfeurope.eu">Tim@ctfeurope.eu</a></td>
</tr>
</tbody>
</table>