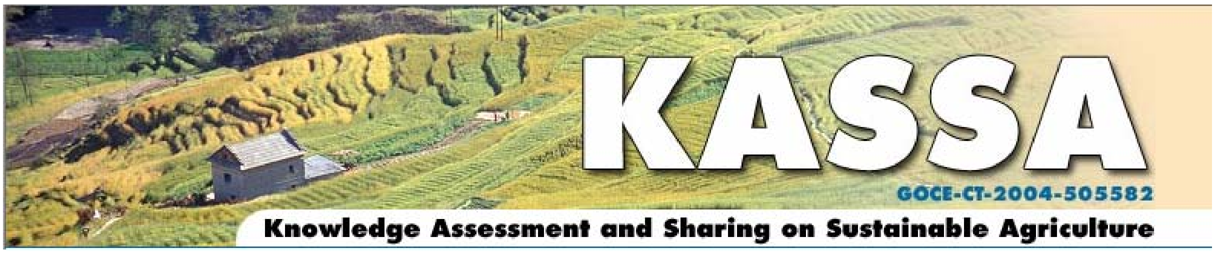

Knowledge assessment and sharing on sustainable agriculture

Main results, gaps in knowledge and challenges in the European platform

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Disclaimer

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The KASSA Consortium assembled 28 contractors from 18 countries.
KASSA has been implemented through four regional "platforms": Europe, the Mediterranean, Asia and Latin America.
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Partners of the European platform:

2- INRA, France;
5- FNACS, France;
6- KVL, Denmark;
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THE EUROPEAN PLATFORM

European agroecosystems

Information on temperate climate agroecosystems was obtained for the following countries: Czech Republic, Denmark, Estonia, France, Germany, Norway, Ukraine and the United Kingdom. The agricultural activities most frequently mentioned were winter wheat, winter barley, maize, sugar beet, rapeseed, potatoes and – for the United Kingdom in particular – livestock production. Water for agriculture was not normally perceived as a limiting factor, because precipitation (rain and snowfall) is generally adequate and well-distributed – unlike most other regions covered by KASSA.

Ecological and environmental issues vary across the countries for which information was gathered. Soil erosion was a ubiquitous concern, largely through water erosion but also – in the Czech Republic and the Ukraine –through wind erosion. Soil crusting was noted as a problem in loamy soils of northern Europe, and poor drainage and "pebble rising" (soil inversion bringing deeply buried stones to the surface) in parts of France and the Ukraine. Other issues include biodiversity and how it is affected by agriculture; soil organic matter content; the carbon cycle and greenhouse gas emissions; the leaching of nutrients (especially nitrogen); and the processes whereby pesticides, heavy metals and organic materials may become air and water pollutants. Understandably, water pollution concerns (especially pesticides and nitrate) tend to be greatest in those areas where rainfall is high, evaporation low, water tables elevated, and where sizeable levels of inputs are used in agriculture.

Economic and social issues for temperate northern European agroecosystems include the need to reduce production costs, improve competitiveness, comply with evolving Common Agricultural Policy regulations and policies, preserve cultural landscapes, and insure the supply to consumers of safe, high-quality, nutritious food products.

Conservation Agriculture in the European agroecosystems

Table1. Number of farms, average farm size, extension of reduced tillage and no-tillage for various countries

Country	General		Reduced tillage		No tillage	
	No of farms	ha/farm	Area (ha) (date)	% of the agricultural used area	Area (ha) (date)	% of the agricultural used area
Czech Republic			750 000 -2005	18%	150 000 -2005	3.5%
Denmark	48 750	53	150 000 -2004	6.8%	~ 0 -2004	
Estonia	36 859	22	160 000	16%	10 000	1%
France	600 000	70	1 373 800 -2001	4.6%	50 000 -2001	0.2%
Germany	420 697	44	3 400 000 -2004	20%	510 000 -2004	3.0%
Norway	55 697	19	158 000 -2004	15%	6 000 -2004	0.6%
Ukraine	53 000	800	9 400 000 -2005	24%	50 000 -2005	0.1%
United Kingdom	304 800	69	1 416 000 -2000	7.7%	24 000 -2000	0.1%

In these systems, there has been until now low adoption of conservation agriculture in the broad, comprehensive sense of no-till combined with surface cover but adoption of minimum tillage is spreading in all the countries of the platform (table 1).

Many farmers propose a step-by-step implementation of reduced tillage and no-tillage leading to a large diversity in the practices used:

from minimum tillage for winter crops followed by full tillage for the subsequent spring crop, to direct seeding in permanent mulch.

Researches undertaken

Research on conservation agriculture for European agroecosystems has been more basic and strategic than adaptive. There has not been a strong research focus on participatory interaction with farmers to design conservation agriculture practices. Rather, research has compared the performance of different practices in contrasting soil and climate conditions, examined ways to reduce pollution derived from agriculture, fostered the development of organic farming practices, and assessed long-term consequences of technologies (e.g. on soil physics) through long-term stationary field experiments.

In **Czech Republic**, long-term field experiments have been implemented in conservation agriculture. During the last years, several trials/experiments have been realized in nine Research Institutes and Universities. The sites of experiments differ in climate conditions, soil types and altitude. Various types of soil tillage, crop rotation, and kinds of mulching were tested.

In **Denmark**, researches have focused mainly on organic farming, more widely used than conservation agriculture. However, during the last years, several trials/experiments on reduced tillage have been conducted in collaboration with farmers and the Danish Agricultural Advisory Centre.

In **Estonia**, the biological and ecological aspects of soil organic matter researches are of utmost importance. Since 1965 a large number of pedo-ecological investigations have been made in order to build up a national database on soil productivity as well as chemical properties and other characteristics of Estonian soils. Studies on plant-soil systems, fertilisation, and ecologically sound and sustainable use of soil cover should also be mentioned.

In **France**, published results mainly come from 12 experimental stations (Research Institutes, Technical Institutes) and 6 on farm studies even if many studies are carried out on farm by farmer associations, private companies and Chambers of Agriculture aiming to assist farmers in farming and cropping system management.

In **Germany**, number of institutions - at state or federal state level - and associations are working to improve knowledge in conservation agriculture and organic farming practices. Presented results in conservation agriculture (field experiments, on farm, laboratory) are mainly the outcomes of University research in locations representing different soil types and climatic conditions. In the new Länder, large field-scale trials have been performed on-farm with farmers for different management systems and a wide range of crops.

In **Norway**, five Research Institutes have conducted experiments both in organic farming and conservation agriculture, during several years. Main experiments have been performed on-field, on-farm and combined field and laboratory research, sometimes in long term trials (7 to 27 years).

In **Ukraine**, 45 short- or long-term experiments, amongst numerous works, have been collected and processed, including mainly reduced tillage and fertilization, but also organic agriculture.

In **United Kingdom**, domains in which research projects seem to be most numerous are strategies for the control of pathogens, pest species and weeds with minimum inputs; the maintenance of soil fertility without artificial input; the reestablishment of genetic robustness/appropriateness in crop and livestock varieties and breeds. Reduced and no-till do not seem to be an area of extensive interest to UK researchers certainly insofar as its application within the UK is concerned.

Main Results

For North European countries, cost reduction is the most important driving force for conservation agriculture. The main farmer interest appears to be in the labour saving and the reduction of production costs (or other means of improving the profitability of farm operations). Large farmers seem to be favoured. Estimates from several countries on fuel and labour costs for crop establishment using full tillage, reduced tillage, and no-till direct-sowing, give a further sense of the magnitude of cost-savings to be gained (table 2).

Table 2. Reduction in costs for conservation tillage and additional expenses for plant control compared to conventional plant production in different farms of the state Saxony with loess soils – Average 1994-2003				
Crop	**Reduction of costs at soil tillage (€ / ha)**	**Additional expenses at plant control (€ / ha)**		
		Herbicides	**Fungicides**	**Control of slugs / mice**
Winter wheat	100 - 120	+ 25	no	+ 20
Winter barley	100 - 120	+ 50 bis + 70	no	no
Winter rye	110	no	no	no
Triticale	110	+ 70	no	no
Spring barley	110	+ 70	no	no
Winter rape	100 - 120	+ 50 bis + 70	no	+ 20 bis + 40
Sugar beet	100	+ 50	no	no
Potatoes	250	no	no	no
Corn	100 - 150	+ 50	no	no
Grass for food	120	no	no	no
Grass for reproduction	120	no	no	no

Soil erosion and land degradation are mentioned as important potential drivers of conservation agriculture for temperate systems in Europe (water and wind erosion, soil crusting, pebble-raising). Erosion and run-off measurements indicate that no-till results in reduced erosion during the cropping period and during the intercrop, an effect which tends to increase and become stronger over time. Reduced water run-off during the intercrop, however, often occurs when a cover crop is used. Results on experimental stations showed that runoff was reduced by 4 times when a mustard intercrop was sown. On farms results confirm this observation: sowing a mustard intercrop permits to reduce runoff by 1.5 to 15 times from case to case. In some case, modifying the times of tillage is sufficient to reduce the risk of erosion, particularly in Northern Europe (Norway).

It appears that conservation agriculture is best suited to medium textured soil and well drained clay, and clay loam soils. Chernozem soils in Ukraine are ideal for these practices.

Generally, larger farmers find conservation agriculture technologies more attractive (e.g., larger farmers with larger field sizes in the UK are said to face greater risks from wind and rain-induced erosion). In such cases, differences in size of farm holding, even within a country, can determine where conservation agriculture can be adopted.

Nitrate and phosphate losses may occur in no-tilled soils when significant macrospore flow relocates the nutrients into subsurface soil. However, the results of several studies indicate a significant decrease of nutrient (N, P, K) losses under reduced tillage due to the infiltrating water by-passing the soil matrix, the lower mineralization rate and the catch crops promoted by conservation agriculture which are of great interest to decrease leaching risk.

Very little is known on the fate of pesticides under reduced tillage situations, though it is broadly observed that reduced tillage may lead to an increased use of herbicides for weed control. However, this increase is not compulsory in reduced tillage: several experiences and studies stress the importance of adapted crop rotations and cover crops to control weed in such systems. The results obtained in Germany clearly show that transfer of pesticides is related to the distribution of soil organic matter: as soil organic matter-SOM is enriched in the upper horizon of soils under reduced tillage, pesticides susceptible to sorption on organic matter accumulate near the surface and show less availability to depth transfer. Pesticides are generally faster broken down in soils under reduced tillage due to the higher microbial activity. Moreover, losses of agrochemicals via the lateral path may be clearly reduced under no-till conditions. Higher sorption rates of heavy metals under no-till were detected in German studies by different extractabilities especially of Zn and Cd. This suggests that the availability of those heavy metals for transport is reduced under no-till or reduced-tillage, which benefit from the supply of organic Carbon from plant residues left on the surface.

Gaps in knowledge

Abandoning ploughing is not just to be seen as a change of the tillage system: it induces thorough changes in the functioning of the cropping system leading to the necessity to revise the whole management process. Therefore, the need of knowledge generation and dissemination about functioning, management and impacts of conservation agriculture is crucial, but there is little scientific information available. The following topics were especially emphasized:

- Profitability and economic viability of conservation agriculture;

- Site specific suitability for conservation agriculture – appropriate local and regional policy;
- Indicators of soil fertility and quality in conservation agriculture for assessment; monitoring and decision support systems;
- Impacts of reduced/no- tillage and cover crops on soil-plant processes, soil life and its consequences for sustainable management: integrated weed and pest management, soil organic matter and soil physics, nutrient management and soil fertility, water balance, integrated crop rotations…;
- Impacts of conservation agriculture on the environment and human health: biodiversity, Carbon sequestration, pollution and contamination (fate of pesticides and other pollutants)…;
- Sociological aspects and rural development: work place, identity, networks, education…

Challenges

Conservation agriculture is definitely not a technological package; it is an innovation process. This process is already ongoing in Europe because it meets two main farmers' expectations: labour saving and costs reduction. According to farmers' point of view, conservation agriculture leads to take risks too: economic, technical and sociological risks. The risk/benefit assessment is site specific, which indeed leads farmers to adopt a step-by-step implementation and then to diversify the practices used. The impacts of conservation agriculture on the environment and the human health are closely related to these practises and may be positive or negative. Hence, the main challenge for conservation agriculture in Europe is: how to make this process sustainable?

This indisputably calls for an appropriate and significant research effort and for adapted research approaches taking into account the complexity of conservation agriculture systems and the diversity of European agricultural contexts. It calls also for an institutional and policy effort that may help the emergence of a system of governing able:

- To encourage effective partnership between all involved and potential actors and;
- To strengthen the innovation process through appropriate knowledge management and dissemination strategies.

This is crucial to improve/adapt/correct conservation agriculture technologies and, to assess and to anticipate their impacts and to enhance their management.