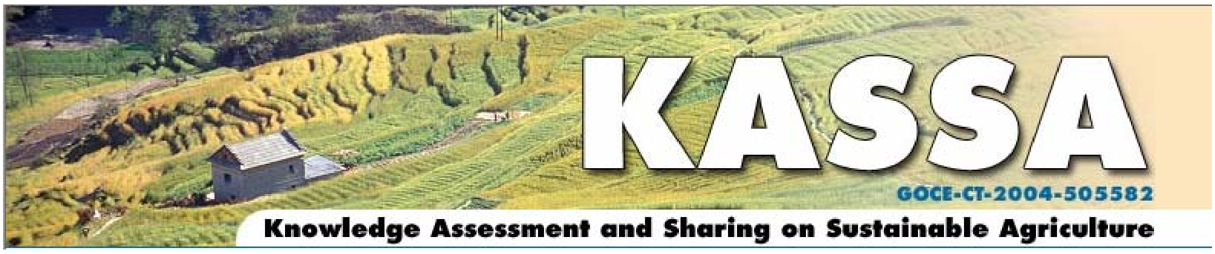

Deliverable 1.1 – Appendix A10

Conservation agriculture, organic farming and GM crops in Czech Republic

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ACKNOWLEDGMENTS

The research reported here has been carried out in the context of KASSA project (Knowledge Assessment and Sharing on Sustainable Agriculture) a European Commission – funded project (DG-Research - Contract no. GOCE-CT-2004-505582) under the FP6 programme: "*Integrating and strengthening the European Research Area*"; Thematic priority "Sustainable Development, Global Change and Ecosystems", Sub-priority "Global Change and ecosystems".

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KASSA has been coordinated by CIRAD.
It worked between 1 September 2004 and 28 February 2006.
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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13- EAU, Estonia;
14- VURV, Czech Republic;
15- NSC-ISSAR, Ukraine.

Scientific advice has been provided by:

Michel Griffon (CIRAD, France);
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This document is the workpackage 1.1 report of the partner VURV, Czech Republic

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A) Context – overall characteristics of agriculture in the Czech Republic

Soils and land use

Total area of the Czech Republic is 7886 thousands hectares. More than a half of it is agricultural land, about 33 % is covered by forests, water bodies form about 2 %, and about 1.8 % is covered by buildings and communications. The rest is mountainous and other areas. According to the recently published "Green report of the Ministry of Agriculture 2003", the estimates of the agricultural land area in the Czech Republic have been relatively stabilised over the last 15 years as shows Tab. 1. The arable land area decreased by about 170 th. ha (which is about 5%) over the same period. This area was partly transferred to grasslands, but mainly it has been left set aside. Because this occurred in marginal regions, in which the proportion of arable land to the agricultural land was too high (75%), this development has not been considered as a negative.

In a long-term, however, a lot of the agricultural and arable land has been withdrawn of the agricultural use, as shows Tab. 2. Since 1920, 16% of the agricultural land and even 20% of the arable land has been withdrawn from the agricultural use.

Tab. 1: Agricultural land area in the Czech Republic (th.ha)

Year	1989	1999	2000	2001	2002	2003
Agricultural land (th.ha)	4296	4282	4280	4277	4273	4269
Arable land (th.ha)	3232	3096	3082	3075	3068	3062
Proportion of arable to agriculture land area in %	75,23	72,3	72,01	71,89	71,80	71,73
Set aside (th.ha)		58,3	70,8	112,8	83,15	177,0

Source. Green Report 2003 of the Ministry of Agriculture, Czech Republic

Tab.2: Changes in the agricultural and arable land area in the Czech Republic since 1920 (th.ha)

Year	Agricultural land	Arable land
1920	5094	3814
1930	4999	3836
1938	4989	3835
1948	4744	3490
1958	4613	3387
1968	4481	3328
1978	4412	3316
1988	4307	3242
1998	4284	3101
2003	4269	3062

Source: History and presence of agriculture. Czech Statistical Office, 1998, Green Report

2003 of the Ministry of Agriculture, Czech Republic

Soil survey

A comprehensive soil survey was implemented during sixties and seventies. Besides of a number of soil physical and chemical characteristics, all agricultural soils were assigned to the taxonomical classification units. The main classification units, their area and proportion of the agricultural soils are presented in Tab. 3.

Table 3: Acreage and proportion of the main taxonomical classification units within agricultural soils

Classification unit (FAO)	Arable soil area (th.ha)	Percentage (%)
Chernozems	348,3	11,3
Haplic Luvisols	391,4	12,7
Albic Luvisols	157,2	5,1
Stagnosols	206,5	6,7
Rendzina	114,0	3,7
Cambisols	1386,9	45,0
Arenosols	37,0	1,2
Spodo-dystric Cambisols	47,8	1,6
Fluvisols	181,8	5,9
Phaeozems	55,5	1,8
Gleysols	135,6	4,4

Source: Novak P., Personal communication, derived from the Soil survey.

Cultivated crops on arable soils

The acreage of the main crops on arable soils is presented in Tab. 3. Cereals have been the main crop on arable soils in the Czech Republic during the last 80 years and certainly also earlier. The acreage of cereals amount slightly more than 50% of arable soils and its proportion practically did not change over this time period. Similarly, the acreage of legumes did not change much. On the other hand, the acreage of root crops and fodder crops on arable soils decreased and the acreage of oil crops increased, substantially.

Table 3: Area of the main crops on arable soils (th. ha).

Year	Cereals	Root crops	Legumes	Oil crops	Fodder crops
1920	2017	565	113	6	875
1988	1655	232	58	115	1092
1989	1662	242	58	121	1079
1990	1640	229	56	130	1099
1991	1612	233	71	162	1065
1992	1583	236	90	166	1032
1993	1606	212	94	192	961
1994	1654	168	71	249	886
1995	1576	171	60	325	872
1996	1581	190	55	277	864
1997	1686	168	50	270	786
1998	1678	158	57	350	722
1999	1587	131	58	468	734
2000	1648	131	47	409	718
2001	1624	132			
2002	1562	115			

Sources: History and presence of agriculture. Czech Statistical Office, 1998, Green Report of the Ministry of Agriculture Czech Republic, 2003

Organic and mineral fertilisation

Organic manures supply can be estimated from the number of the farm animals and/or calculated to cattle units. Tab. 4 shows the comparison of the average number of farm animals and cattle units per 1 ha agricultural land in 1990 and 2000 to illustrate the drop down of the cattle units per ha during this period. Evidently, the drop down of the cattle units per ha by about 50% diminished the farmyard manure production at approximately the same rate.

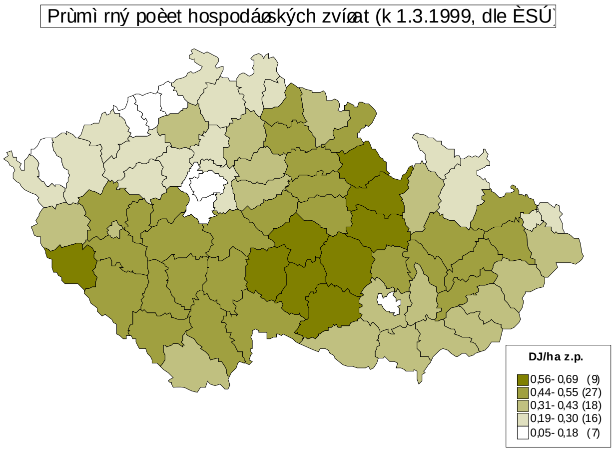
Table 4: Livestock numbers in the Czech Republic (th.heads)

Years	1985	1990	1995	1998	2003
Cattle	3 603	3 506	2 028	1 690	1 474
Pigs	4 299	4 790	3 866	3 995	3 363
Poultry	31 898	31 981	26 688	29 010	26 873

Source: Czech Statistical Office

Such data specified for individual districts are also available in the annual reports of the Czech Statistical Office. Fig. 1 shows the differences in the geographical distribution of the farm animals (cattle units per ha agricultural land) in individual districts in 1999 from which it is apparent that the distribution of the farm animals is rather uneven (Fig. 1).

Fig. 1: Geographical distribution of the farm animals (cattle units per ha agricultural land) in individual districts in 1999



Source:Czech Statistical Office Report, 2000

Mineral fertilisation dropped down after 1989, due to the overproduction and basic transformation of the agriculture. During the nineties it stabilised at a relatively low level about 80 to 90 kg.ha^{-1}.a^{-1}, as shows Tab. 5. The decrease in mineral fertilisation touched mainly P and K fertilisation. Mineral N fertilisation level is about 60 to 70 kgN.ha^{-1}.a^{-1}. Lack of mineral P and K fertilisation has already caused the drop down of the available P and K content in soils.

Table 5: Average annual mineral nutrient supply (kg.ha^{-1}.a^{-1} agricultural land)

Year	N	P2O5	K2O	Total
1987	99	67	71	238
1988	99	68	67	234
1989	99	64	56	218
1990	90	57	51	197
1991	46	11	8	65
1992	48	11	7	66
1993	40	13	11	64
1994	58	10	13	81
1995	55	15	13	83
1996	61	12	8	81
1997	55	12	10	77
1998	53	13	7	73
1999	51	9	6	66
2000	59	11	6	76
2001	73	12	7	92
2002	72	12	8	92
2003	60	12	7	79

Source: Green Report of the Ministry of Agriculture Czech Republic, 2001, 2003)

Soil erosion

In the Czech Republic, water erosion is one of the most significant soil degradation processes, at present it affects over a third of all agricultural areas (42.0 %) , totalling 1 796 740 hectares. A part of Czech Republic (7.5 % of agricultural land) also suffers from wind erosion (319 691 hectares are at risk). The estimates for 2002 is presented in Tab. 6.

Table 6: Potential soil erosion in Czech Republic, 2002

Erosion	
Total area affected by water erosion	1.797 million ha
of which	
severe erosion (level 6),	0.595 million ha
medium erosion (level 5),	0.430 million ha
moderate erosion (level 4)	0.772 million ha
Total area affected by wind erosion	0.320 million ha
of which	
severe erosion (level 6),	0.012 million ha
medium erosion (level 5),	0.079 million ha
moderate erosion (level 4)	0.229 million ha

Source: Research Institute for Soil and Water Conservation, Praha – Zbraslav

Environmental constraints

Current legislation and the measures of the Czech government are aiming at improvement of the farming systems and fitting the farming systems to environmental concerns are mainly connected with the effect of agriculture on the water quality. Probably the most important basis in this connection is the Water Act approved by the Parliament in 2001 (No.254/2001) and the nitrate directive EU (91/676/EEC). The first Action Programme of nitrate directive in the Czech Republic has been elaborated and it has been already launched since the 1 January 2004 by governmental regulation No. 103/2003. The Action Programme includes measures regarding fertilizers and manure use and storage, regulation concerning crop rotation, and erosion control measures, mainly in vulnerable zones that have been defined within the action programme. Fig. 2 shows the vulnerable zones that cover as much as 36% of the total territory and 44% of the agricultural land area, and have thus a strong impact on the farming systems development in the country.

Fig. 2: Vulnerable zones designation in the Czech Republic

B) Conservation tillage

Prevailing tillage systems in the Czech Republic are still the conventional ones, including ploughing to 20-28 cm every year. However, the conservation tillage has been widely introduced and employed during the last decade. At the present, their proportion can be estimated to approximately 30%, which is about 900 thousand hectares which include about 450 th. ha minimum tillage, about 300 th. ha mulch tillage and about 150 th. ha of no tillage. The different systems of reduced tillage have been widely evaluated in field experiments and on the farm fields, as well.

During the last years, several trials/experiments on protection tillage and mulch have been realized in several research institutes and universities of the Czech Republic: Research Institute of Crop Production (www.vurv.cz), Research Institute of Agricultural Engineering (www.vuzt.cz), Czech University of Agriculture (www.czu.cz), University of South Bohemia (www.jcu.cz), Mendel University of Agriculture and Forestry (www.mzlu.cz), Institute of Microbiology, Academy of Sciences of the Czech Republic (www.biomed.cas.cz/mbu/mbu.html), Potato Research Institute (www.vubhb.cz), Research Institute for Fodder Crops (www.vupt.cz), AGROEKO Ltd (www.agroeko-zamberk.cz). Results and findings from these experiments are published in several scientific journals and proceedings and they are written in English or have English summaries.

The sites of experiments differ in climate conditions, soil types and altitude. Various types of soil tillage were tested:

- conventional tillage mouldboard ploughing to a depth 0.2 m usual seed bed preparation, sowing (control variant)
- sowing by drill machine John Deere 750 into no tilled soil without mulch
- no tillage using straw as mulch
- shallow tillage, sowing of catch crop, frost-killing of catch crop biomass, sowing of spring crops
- straw harvest + green manuring (white mustard)
- straw incorporation
- straw incorporation + green manuring
- straw burning
- disc tiller skimming
- chissel tiller loosening

Crop rotations differed in these experiments, the prevailing crop rotations were as follows:

- Winter wheat, spring barley, soybean or pea
- Lucerne, Lucerne, winter wheat, silage maize, corn, spring barley
- Winter wheat, pea, winter wheat, spring barley, corn, spring barley
- Seed maize, seed maize, winter wheat, winter wheat
- Red clover, winter wheat, potatoes, oats

Besides of the arable land, different kinds of mulching and different cutting regimes were tested on the grasslands, as well.

Results of experiments

Different kinds of conservation tillage has been often entitled “protection tillage” in the published papers. We will keep to the author´s terminology in the following articles in order to prevent confusion (the precise description of the tillage technology has to be checked in the original papers).

Effects on the crop yields

Winter wheat, spring barley and soybean can achieve comparable or higher grain production under protection tillage technology as in conventional tillage systems on light sandy soils (Javůrek and Vach, 2002). The protection tillage system is more successful than the conventional tillage system in drier conditions on light sandy soils. Grain yields of spring barley were on an average 15.9 % higher in the protection tillage variant than in the conventional one. The highest yield was found in the variants of direct drilling (122.2 %) followed by the variants of shallow tillage and incorporated post harvest residues (115.7 %) and by the variants with catch crops (109.9 %). On the medium heavy Chernozem and in drier climate conditions, the grain yields of spring barley were 15.9 % higher (on an average) in protection tillage variants than in conventional ones.

On the contrary the average grain yields of spring barley were lover on the protection tillage variants as compared to the conventional tillage variants on the heavier Chernozems in the years of standard (medium) precipitations. The difference between the yields at the conventional and protection tillage variants was 23% (Javůrek and Vach, 2004). The tillage systems had no effect on the yield of maize and winter wheat in heavier soils (Čupa, 2000).

Protection tillage with direct drilling had a favourable effect on soybean grain yields (Javůrek and Vach, 1999). The highest yield of winter wheat was achieved after direct drilling into the Lucerne treated by Roundup. Shallow cultivation by disks, shallow ploughing (0.15 m) and ploughing (0.22 m) have shown decreasing level of the yields of the winter wheat. The winter wheat after pea reached higher yields in comparison to winter wheat after Lucerne but the effect of different soil cultivation was not significant (Procházková et al., 2002).

Effect of fertilisation and catch crops

Mineral nitrogen fertilization enhanced the yield formation more than the conventional tillage. Protection tillage seemed to be more mineral fertilisation dependent than the conventional one. Catch crops could be support the yield formation by means of better time distribution and a higher effectivity of nitrogen nutrition (Javůrek and Vach, 2002). The selection of the catch crops for mulching positively influenced grain yields of the next crops in protection tillage system (Vach and Javůrek, 2003).

Weeds

The total amount of weeds in reduced tillage systems is increased but the species diversity of weed decreased (Mikulka, 1999). In the no tillage technology, there is higher need of herbicides especially against perennial weeds.

Irrigation

The effect of irrigation was in the conventional and protection tillage was studied in a field experiment established a light soil in Tisice. Irrigation increased the yield of spring barley and winter wheat by 13% and 19 %, respectively. The yield of soybean increased 11% to 23% in the irrigated plots. The effect of the irrigation was higher on the protection tillage variants than on the conventional variants (Javůrek and Vach, 2002).

Mulching

In 32 years long-term field experiments in which various straw application were used the highest yields were reached in the variants with straw burning and with green manuring. Variants with straw incorporation into the soil have reached lower yields and the difference increased during the last decades (Procházková, 2003).

Grassland mulching and set aside was studied in the experiment on meadow: mulching once a year in September (MS) and plots without management (U). Both treatments resulted in increase of Veronica chamaedrys and Galium album and in the disappearance of light sensitive Trifolium repens. T. repens increased in two cut, two cut without removal of the biomass and in three times mulch treatments. The lowest species diversity was recorded under MS and U treatment at the end the experiment. Mulching once a year in July altered the vegetation in a different way than the MS treatment (Geisler, 2004).

The effect on the soil properties

The effect of the conventional and protection tillage was studied in a 30 years long-term field experiment. The main soil organic matter characteristics (total organic C content, C of humic substances, hot water soluble C content, and Q4/6) decreased slowly and steadily from surface to deeper layers in no-tillage variants. In the tilled variant these values were almost constant from surface to 0.3 m. Then the values fell steeply to a relatively low level. The results have shown that the long-term use of no-tillage system led to an increase in the total content of organic matter in the soil, and to a better distribution of the soil organic matter in the soil profile, including subsoil than in tilled control (Horáček et al., 2001).

Protection tillage positively affected the incidence of micro-organisms and several microbial and enzyme activities, especially in the upper layer of the topsoil, as compared to the conventional tillage (Javůrek et al. 2003).

Reduced tillage also positively affected bulk density (volume weight) of the soil and its total porosity, maximal capillary capacity and minimal air capacity as compared to the conventional tillage (Čupa, 2000). Soil protection technologies eliminated the subsoil compaction without higher costs (Javůrek and Vach, 2002).

Soil loosening

Soil loosening by tiller Howard Paraplow (adjusted loosening depth 0.45 m) significantly changed the spatial arrangement soil mass - volume weight reduction, total porosity increase, i.e. index of the non-capilar pores, which is important for the exchange of soil atmospheric air and for favourable water infiltration into the soil (Hůla et al., 2002). Chissel tiller loosening positively influenced the soil volume weight, porosity and minimum air capacity.

Machinery and the incorporation of the post harvest residues

Machine set operations were monitored during skimming by disc tiller the disc tiller effect to post-harvest remainders was evaluated (Hůla et al., 2003). After the first skimming by disc tiller one third of the remainders remained on the soil surface (31.1 wt %). After the second one, almost one third of crop remainders was incorporated to the soil upper layer 0-50 mm (31.0 wt %). Other crop remainders (37.9 wt %) were incorporated to the soil layer of 50-100 mm. The pre-crop remainders distribution during skimming is an important indicator of this operation benefit for soil protection against water erosion and wind soil erosion.

During the shallow soil tillage after winter wheat the average Diesel fuel consumption at first skimming of the post harvest remainders was 7.98 l/ha (Hůla et al., 2003). Diesel fuel consumption during disc tiller skimming decreased with increasing of plots acreage and length of operational drives.

Conclusions

Successful use of protection soil tillage technologies depends on site properties, methods of soil treatment, work quality and ways of mulching, both with the post harvest residues and with the catch crop biomass. Crop yields on fields under protection tillage can be comparable or better than that under the conventional tillage system on light sandy soils and in drier climate. In no tillage technology there is higher need of mineral nitrogen fertilization and herbicides, especially those against perennial weeds. Soil protection tillage save costs and energy for crop production and it can prevent production failure of field crops if a rainfall deficit appears during the vegetation.

C) Organic farming

Organic farming, designed as "Ecological agriculture" has developed in the Czech Republic since 1990. While in 1990, there were 3 "ecological farms" their number increased to 810 by the end of 2003. Total area of ecological farming is 255 th. ha, which is about 6% of the total agricultural land area. Most of the area is on the permanent grasslands (232 th. ha, which is 91 %) and about 20 th. ha (about 7.7 %) is arable land. So called "other areas" encompassed 2.7 th. ha and permanent cultures (orchards, vineyards, hop-fields) about 1 th. ha.

In 2003, about 195 th. ha agricultural land was fully registered as „ecological farming" and about 60 th. ha was in so called „transition administration period". In the present time there are two unions that associate ecological farmers, producers and merchants with bio-products. The first one is PRO-BIO operating on 136 th. ha agricultural land and Libera, operating on about 27 th. ha agricultural land.

Ecological farming has been supported by the government. The highest increase in the area of the ecological farming taking place in 1997 – 2003 was fuelled by the subsidies provided by the government, in frame of the agricultural diversification programme (support of non-production functions of agriculture). The subsidies are provided per area (hectares) of agricultural land under ecological farming. In 2003, the total sum provided was about 231 milllions CZK, which is about 8 millions Euro. The subsidy is diversified, it amounts 1000 CZK.ha-1 for permanent grasslands, 2000 CZK.ha-1 for arable land and 3500 CZK.ha-1 for orchards, vineyards and hop-fields.

In 2003, the government spent 4 millions CZK for the administrative and control activities connected with the subsidies (via an appointed organisation KEZ).

The Action Plan for the development of ecological agriculture in the Czech Republic till 2010.

The Action plan was elaborated during 2003 in collaboration of ministries of agriculture and environment with a number of other partners, mainly unions of ecological farmers PROI-BIO and Libera, administrative and control organisation KEZ, agricultural universities and individual ecological farmers, producers and merchants. The Action plan was approved by the government and sent to the European Committee for Ecological Agriculture as an information.

The main points of the Action programme are as follows:

- relationship of ecological agriculture to environment and animal welfare
- strengthening of the consumers confidence in bio-products, advertisement
- processing and marketing of the bio-products
- economical viability and enterprising
- research, education and extension
- political tools, political solutions

Market with the bio-products in the Czech Republic.

Bio-foodstuffs represent about 0.06 % of the total foodstuffs market in the present time, which has been considered as unsatisfactory. There are several reasons for this situation, for example, as a consequence of the dominance of the permanent grasslands in the ecological farming there is a high production of beef cattle. Due to the lack of bio- slaughterhouses, a considerable proportion of the beef cattle has been slaughtered and processed in non approved plants and, therefore, it cannot be marked as "bio-product".

Every new producer and/or merchant of the bio-products has to report to the Ministry of Agriculture. This duty pays for the new ecological farmers, as well. Each registered farmer, producer or merchant has been regularly controlled by the administrative and control organisation KEZ on basis of which this organisation provides a formal certificate "Certificate of the origin of the bio-product". The control and certification has been pursued according to the Act on Ecological Agriculture, No 242/2000 Coll.

Results of the long-term field experiments

As the concept of organic faming (ecological agriculture) is relatively new in the Czech Republic, there are no reliable experimental data regarding the effect of organic farming on the soil properties. It is well known that the soil processes (particularly soil organic matter transformations, mineralization and accumulation) are long lasting up to several decades. In this situation, the results of the long-term field experiments conducted in different soil and climate conditions in the Czech Republic can provide valuable information. Most of these experiments include variants without any organic or mineral fertilisation that have not received any organic or mineral fertilisation for up to 50 years. There are also variants that were only fertilised with organic manures (several kinds), without any mineral fertilisers and variants with only mineral or combined organic and mineral fertilisation.

Long-term field experiments in Prague-Ruzyně

a) Effect of organic and mineral fertilisation and of crop rotation on the crop yields.

The experiments were established in seven fields, in 1955. The fields differ in cultivated crops and crop rotations and they have comparable variants of organic and mineral fertilisation in four replicates. Period of evaluation was 12 and 16 years.

Both organic and mineral fertilisation increased production of the cultivated crops in all fields. The differences in the average dry matter yields were statistically significant. Both organic and mineral fertilisation enhanced significantly the N-uptake by the cultivated crops.

The effect of crop rotation on the yields of the main products could be evaluated. Nine years crop rotation with 22% of Lucerne has shown much higher productivity in the non fertilized variants as compared to the same variants in the field B, in which spring wheat and sugar beet has been growing alternatively.

The dry matter yields of sugar beet and mainly spring wheat (field B) declined in almost all variants of fertilisation over the evaluated time period. In spite of relatively high dry matter production, the declining yields indicated a lower sustainability of alternative cropping with sugar beet and spring wheat.

The effectivity of nitrogen input was the highest on field B, indicating that alternative cropping with sugar beet and spring wheat was more external N-input demanding and thus less sustainable than nine years crop rotation.

Organic fertilisation with farmyard manure contributed to the nutrient supply and simultaneously supported the crops indirectly by means of its effect on the soil quality.

b) Effect of organic and mineral fertilisation and of crop rotation on soil properties

Results of the dry matter yields of the main products in four variants of organic and mineral fertilisation in two long-term field experiments in Prague over 12 years time period have been evaluated in relation to ten chemical and biological characteristics determined over the last decade with the aim to estimate the contribution of the soil organic matter and the activities of soil micro-organisms to soil fertility. These included total organic C content, hot water soluble C content, microbial biomass C content, basal, reactive and potential respiration activity, ammonification activity and nitrification activity.

Organic and mineral fertilisation increased the crop yields and all the determined soil characteristics on Field IV (nine years crop rotation). Alternative growing of sugar beet and spring wheat on Field Bhas shown more remarkable differences between the fertilised and non fertilised variants. Not only in the crop yields but also in the soil properties.

Long-term field experiments in other soil and climate conditions

a) Effect of crop rotation organic and mineral fertilisation on the crop yields

The polyfactorial long-term field experiments have been founded in 1979 in several experimental stations located in different soil and climatic conditions, representing a climate and pedosequence of arable soils in the Czech Republic. Four of these experiments exist till the present time. Essentially, the same experimental design that includes different fertilisation with farmyard manure and/or with mineral fertilisers (N,P,K), liming and stand density, each in five levels with four replications, have been applied for all these experiments. Practically, the same eight year crop rotations were applied during the first and second rotations. A conventional tillage has been applied.

Dry matter yields, nutrient uptake by crops, nitrogen uptake by the main and second products and carbon and nitrogen balances have been evaluated in six selected variants of organic and mineral fertilisation over the time period 1996 to 2000.

Both organic and mineral fertilisation increased the average dry matter yields in the fertilised variants. This increase corresponded approximately to the nutrient supply. The efficiency of N supplied to the crops with the farmyard manure and/or mineral fertilisers was higher on the more productive Luvisols than on Cambisols. Carbon balance was positive in almost all sites, blocks and variants, however, the values of the carbon balance differ in individual sites. Nitrogen balance not including atmospheric N input (deposition and biological fixation) have been positive on all selected variants of organic and mineral fertilisation on Luvisols. A higher soil productivity and more favourable soil and climate conditions in these sites have contributed to the positive N balances even in the variants that have received relatively high doses of nitrogen in organic and mineral fertilisers. On Cambisols, a positive N balance has been found up to the average nitrogen dose of 90 kg N.ha-1.a. Higher N inputs caused negative N balances in these sites. The effect of mineral fertilisation on nitrogen balance was about 10 kg N.ha.-1.a better, on an average, than that of farm-yard manure, on all sites and most of the blocks.

b) Effect of crop rotation organic and mineral fertilisation on the soil properties

Both organic and mineral fertilisation increased the organic carbon content in soil in all sites and in all blocks. Single mineral NPK fertilisation increased organic C content in soil similarly to organic or combined organic and mineral fertilisation. Besides of the organic carbon and nitrogen contents in soil, hot water soluble carbon (Chwl), humic substances, e.g. humic and fulvic acids have been determined in soil samples taken in autumn each year from six selected variants of organic and mineral fertilisation. The results of the hot water soluble carbon content and of the humic and fulvic acids contents in soil samples have been evaluated. It was shown that humic substances are rather conservative and site specific soil properties that are not much affected by the cropping and fertilisation systems. Hot water soluble carbon, on the other hand, seems to be a dynamic part of the soil organic matter. The average hot water soluble carbon content in soil (Chwl) differed in the individual sites (different soil and climate conditions). The differences among individual blocks (effect of the cultivated crops) only exceptionally exceeded 10%. Mineral and mainly organic fertilisation increased the Chwl content in soil on all sites and blocks. Single farm yard manure fertilisation enhanced the Chwl content in soil more than mineral NPK fertilisation, however, the differences in the average values of all sites and blocks did not exceed 7%. An additional input of plant residues had no remarkable effect on the Chwl content in soil.

The extractable humic substances (humic and fulvic acids) carbon content in soil differ in individual sites, blocks and the selected variants of fertilisation. The average differences in the alkaline extract carbon content among individual variants of organic and mineral fertilisation varied between minus 10% and plus 15% as compared to the non-fertilised controls. Apparently, the higher proportion of the humic acids carbon was rather due to the soil properties and to the cultivated crops than to the organic and mineral fertilisation. Humic acids (HA) to fulvic acids (FA) ratio was predominantly a site characteristic, too.

Organic matter balance investigations in the Usti nad Orlici region.

Organic matter balance has been investigated in the Usti nad Orlici region (north east Bohemia) since 1979. Approximately, 80 th. ha agricultural land and about 50 th. ha of the arable land, that include different taxonomical soil units (Luvisols, Cambisols and Spodosols) different texture classes, and different climate regions has been investigated annually. It was estimated that the annual turnover of organic matter reached about 3.5 to 4.5 t.ha-1 , in the Czech Republic. About a half of it has been saturated with the crop residues. The rest of it, about 1.5 to 2.0 t.ha-1 annually, should be supplied with organic fertilisers. The long-term organic matter balance investigations in Usti nad Orlici region have shown that the effort given to the production, storage and application of organic fertilisers positively affects the level of the crop production and soil fertility.

D) GMO

As to GMO, basically no GM plants may be cultivated on a large scale. The Act on GMOs allows cultivation of these plants only in strictly controlled conditions, mainly for research purposes. According to personal communication the first GMO-maize, a cultivar that has already been approved for the EU) should be cultivated at a farm level in 2005.

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