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Conservation agriculture, organic farming and GM crops in Germany

Main focus: Eastern Germany

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I. Context of development of Conservation Agriculture and Organic Farming in Germany (Main focus: Eastern Germany)

General introduction

Germany is often considered a typical industrial country. Being the third largest industrial nation after the US and Japan, this is not completely wrong. The share of the agricultural sector of the total GDP is less than 1.5 %. The work force accounts for only 3.2 % of all employees. Compared to other EU countries, only Belgium, Luxembourg and Great Britain have even lower employment in agriculture.

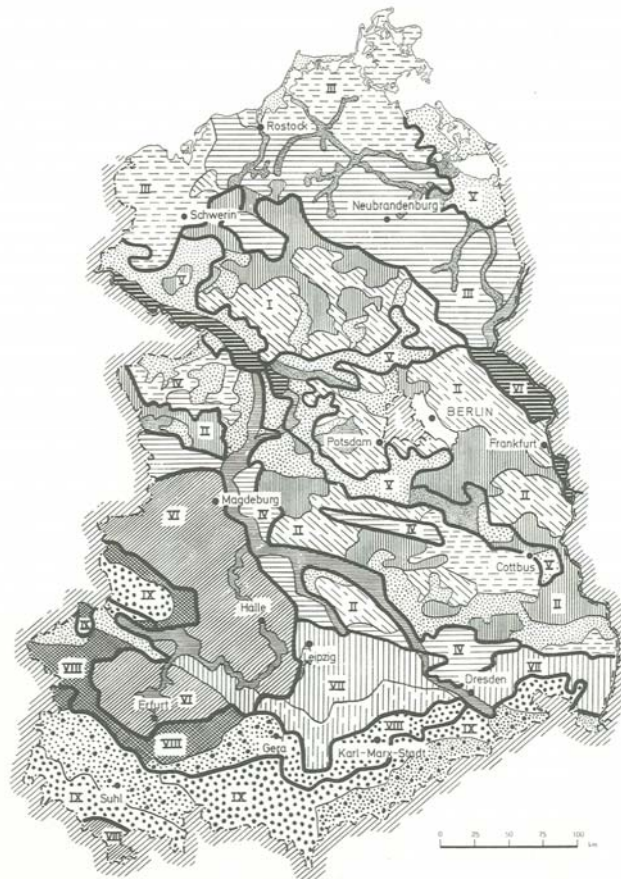


- I Young Moraine Region
- II Old Moraine Region
- III Loess Region
- IV Mountain and Hill Region

Figure 1. Map of the Soil Regions in the eastern part of Germany (former GDR)
Source: Lieberoth, 1982

25 % of the population lives in rural areas. Approximately 55 % of the territory is agriculturally cultivated, and a further 30 % is used by forestry. The actual situation, however, differs considerably among the different regions. This is due to various physical conditions, historical roots as well as recent transformation processes that can be observed in many former rural areas. Of special importance was the political separation of Germany with two contrasting economic systems between 1949 and 1990.

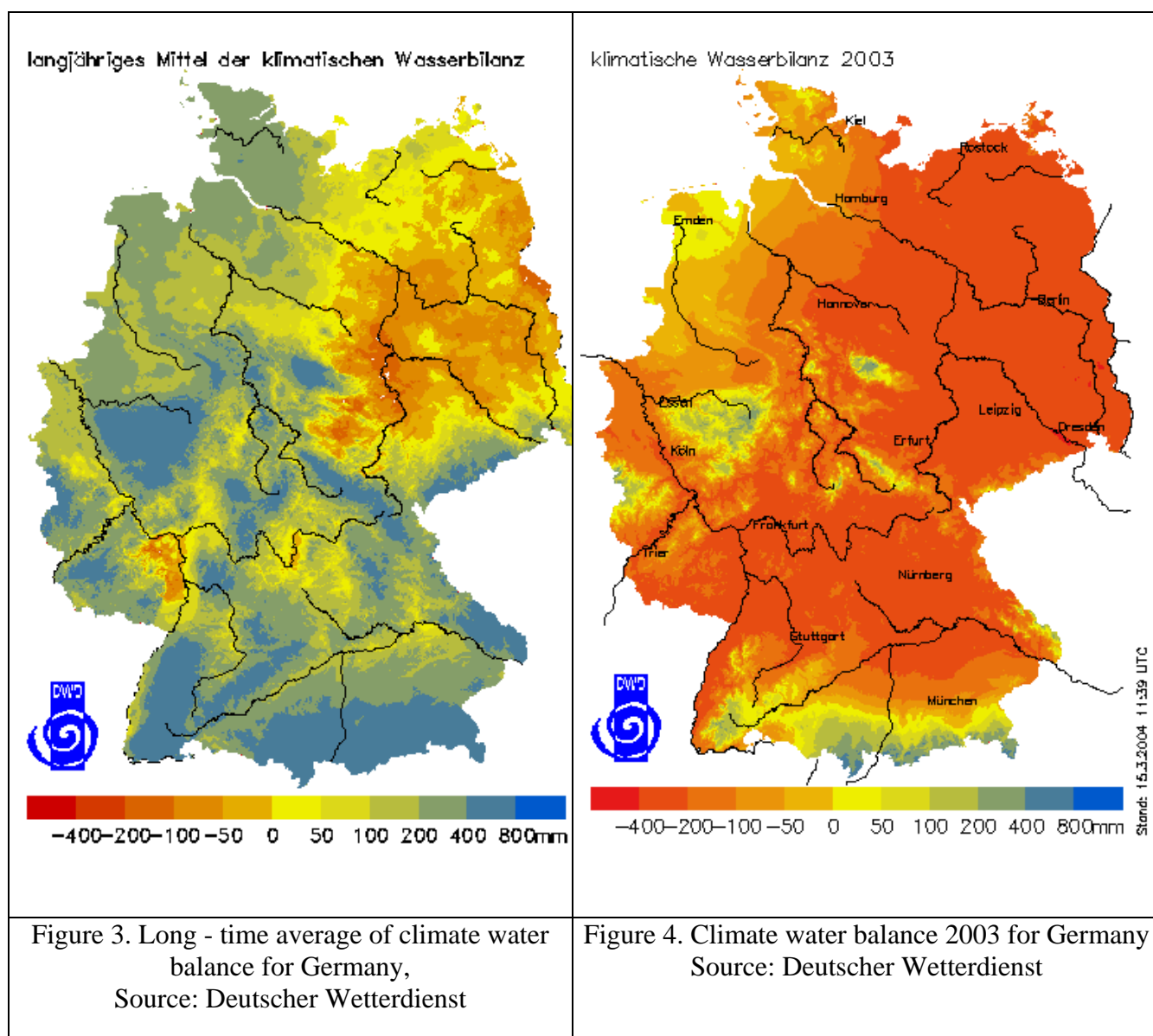
As for the site conditions, there are differences mainly in soils and climate. Major soil differences exist between regions of young moraine, old moraine, of loess as well as hill (Fig.1 and 2).



- I Sandy agricultural areas in northeast Germany
- II Sandy agricultural areas in middle and east Germany
- III Loamy agricultural areas in north and northeast Germany
- IV Loamy agricultural areas in middle and east Germany
- V Grassland areas in the lowland
- VI Agricultural areas in the Magdeburger Boerde, the Thuringian Basin and the Oderbruch region
- VII Agricultural areas in the hill region of Saxony
- VIII Foreland of the low mountain ranges
- IX Grassland areas of the Highlands

Figure 2. MAP of the Land use regions of the east Part of Germany (former GDR)
 Climate water balances show differences between eastern and western Germany (Fig.3)
 An extreme water balance situation was in the year 2003 (Fig.4).

Source: Lieberoth, 1982



Agriculture and Farms

Beside the soil, the climate and the site differences, one reason for regional discrepancies in German agriculture is the size structure of farms. In 1997, the average size of a farm was 32.1 ha (Table 1).

Table 1. Farm size classes (2001/2003). Source: BMVEL, 2004

Farm size classes ha agricultural area	2001	2003	Change per year in %
	Number of farms Thousand		
2 – 10	143.7	132.5	- 4.0
10 – 20	84.0	77.7	- 3.8
20 – 30	44.4	40.1	- 4.9
30 – 40	33.5	31.1	- 3.6
40 – 50	24.8	23.6	- 2.4
50 – 75	36.9	36.3	- 0.9
75 – 100	18.2	18.8	+ 1.7
100 – 200	17.9	19.5	+ 4.4
> 200	8.4	9.0	+3.3
Total	411.8	388.5	- 2.9
Farms <2 ha with a special status	37.1	32.6	- 6.3
Total	448.9	421.1	- 3.1

However, this number does not say very much about the regional variety. In western Germany, the average holding accounts for only 24.7 ha, whereas the average size in eastern Germany is 201.7 ha. Statistically, the largest farms exist in Western Pommerania, with 272.2 ha per holding, compared to only 17.9 ha in Baden-Wuerttemberg.

These regional differences exist mainly for historic reasons. In eastern Germany, the roots of large estates go back to the landownership in medieval times. Even today numerous castles reveal the past. Even more substantial was the period of socialist agricultural policy after the Second World War, when due to socialistic land reforms the average size of the so-called Agricultural Production co-operatives (Landwirtschaftliche Produktionsgenossenschaften, LPG) increased to more than 5,000 ha. The evolution of inheritance laws influenced the size of farms in another way. The ‘real distribution’ (which means the split of the farm among all heirs) led to a strong fragmentation of agricultural property, especially in southwest Germany.

Another important characteristic of recent transformation processes is the strong decrease of both employment and the number of farms. In 1950, some four million people were employed in agriculture. In 2003, this number had declined to 193,179. Almost 2 million farms were counted in 1949, of which only 421,100 were left in 2003. Although between 1981 and 1997, a decrease of 300,000 farms could be observed, the average size of a holding did grow constantly, since many of the farms purchased were rented or used in some other way. In the western Laender, almost 69.2 % of the cultivated area is rented. In the eastern Laender, the share is even higher (85 %). Nevertheless, one major characteristic of German agriculture has not changed: the majority of farms are family businesses. Moreover, 59 % of all farms are smallholdings which means that the major income is earned outside agriculture.

In the former GDR, the traditional field patterns have basically been destroyed by socialist land reforms. Huge, continuous collective properties were established, ones that sometimes contained whole communities. Even after unification, these patterns have not been

abolished completely, although one of the endeavours of the ‘Agriculture Adjustment Law’ of 1990 was to dissolve the former co-operatives and the privatisation of agricultural land. The law also provided a legal framework for former members of the co-operative, for the reorganisation of the co-operatives into new legal forms as well as for the reimbursement of land, equipment and other contributions of the former members (Eckart 1998: 379). This law was repealed on December 12, 1991.

Not only have size structures altered, but the conditions of land use have changed considerably as well. Primarily, a horizontal simplification of the farm occurred which led to a reduction of the product variety to only a few product branches. Furthermore, land use changed due to agricultural policies and measures on a national and supranational scale (e.g. in the context of the EU agricultural policy). Regardless of regional differences, cultivated land is predominant over the total area in Germany (11.8 million ha out of 17.2 million ha total agricultural land). On 65 % of the cultivated land, grain is the most important crop with an increasing trend. Root crops, on the contrary, especially potatoes, are constantly losing their share, even though the sugar beet is still an important cash crop in the rich agricultural areas of Germany (e. g. Loess-Regions, “Bördelandschaften”). One quarter of the production of sugar beets is grown in Lower Saxony.

Conservation Agriculture

The evolution of Conservation Agriculture has been slower in EU countries than in other parts of the world, especially when talking about direct drilling. Different reasons can be found to explain this slower development: less need to take risks, lack of technology, lack of transfer of technology, lack of institutional support. Reasons named against the implementation of conservation tillage in Germany, are the high risk and to less agronomical experiences. Numerous examples of farmers practicing conservation tillage on a long term basis show that the system can be managed and successfully accomplished with agronomical know-how. In Germany, the distribution of conservation tillage has considerably increased in the past 10 years. Farmers consequently ploughing their fields every year meanwhile constitute a minority. Unfortunately, in Germany no comprehensive statistics exist on the distribution of conservation tillage, but presumably 20-25 % (about 2,375,000 ha) arable land is under conservation tillage. The majority of the farmers dispense with the plough after rape or grain legumes and, when conditions are favorable, also after silage maize, sugar beet, or potatoes. However extensive regional differences exist. Whilst for example in many arable areas in eastern Germany and Lower Saxonia the area of land under conservation tillage is distinctly greater, areas with structures dominated by small farms as in southern and western Germany or in the north sea fens conservation tillage is represented far less.

Furthermore, the farm size has a major influence on the application of conservation tillage. Above all, large-scale farms calculate with the economic benefit in labour and fuel reductions and the financial benefit of full capacity machinery use. These factors have an influence on the decision toward conservation tillage. Especially farms with 100 to 500 ha and farms with more than 500 ha arable land increasingly apply conservation tillage methods.

There are big differences in terms of definition and programs of conservation agriculture between the eastern federal states. Here some examples:

Organic Farming

The rate of unemployment is very high in the rural areas. In this situation, many farmers are searching for alternatives. One possible niche market is ecological agriculture or organic farming. At the end of 2003, there were 16,476 organic-production holdings in Germany farming 734,027 ha of land in accordance with the EU Regulation on Organic Agriculture. They account for 3.9% of all holdings, managing around 4.3 % of the total utilized agricultural area (BMVEL 2004b). The number of the processing enterprises as well as the farmed area in the organic sector continued to grow.

The development of organic farming in Germany was initiated by Rudolf Steiner as early as 1924 (Demeter label). From the end of the 1960s producer associations for organic farming were founded (Bioland label). Common basic standards for the individual operation organisations have already been developed in 1984. Organic farming has been promoted by state funding through the EU extensification programme from 1989 onwards and later EU-Regulations 2078/92 and 1957/1999.

In eastern Germany organic farming spread quickly after the German reunification in 1990. In the days of the German Democratic Republic, organic farming was not encouraged. The primary objective in agriculture had been to maximize the production in order to become independent regarding agricultural products. Nevertheless, a very small number of farms in eastern Germany had practised organic farming methods (SOEL 2002).

Table 2: Development of Organic Farming in Germany from 1994 until 2003
Source: NITZSCHE, O.; KRÜCK, S.T. ; SCHMIDT, W. ; RICHTER, W: (2001)

Year	Number of organic farms	% of all farms	Organic land area in ha	% of all agricultural land
1994	5 866	1.0	272 139	1.6
1995	6 641	1.2	309 487	1.8
1996	7 353	1.4	354 171	2.1
1997	8 184	1.6	389 693	2.3
1998	9 209	1.8	416 518	2.4
1999	10 400	2.4	452 279	2.6
2000	12 740	2.9	546 023	3.2
2001	14 702	3.3	634 998	3.7
2002	15 626	3.6	696 978	4.1
2003	16 476	3.9	734 027	4.3

Concerning the land use, grassland, legume based leys, the production of vegetables and fruit as well as sheep and goats have a higher importance in organic farming compared to

conventional farming in Germany. On the other hand comparatively little pig and poultry meat are produced.

The percentage of sales of organic foods in the total turnover of foods in Germany increased from 1.2% in 1997 to 2.4% in 2003. Organic farming will increase in importance in the near future, due to the growing market and the change in public awareness in favour of sustainable agriculture. The Federal Government aims to achieve a 20% share of organically farmed land in Germany in the medium to long term. In order to reach this goal, a set of measures was introduced in 2001 by the German government. These include the improved support of organic agriculture, the implementation of the federal programme for organic agriculture (BOEL) as well as the introduction of a national organic seal.

Outlook

Despite these positive trends, German agriculture is confronted with strong competition in the EU as well as on a global scale that will cause further transformation. In the context of over-production and high subsidies this question will gain more importance. 'Holiday on farms' is also an opportunity for several farms in attractive settings to increase or complement income. Depending on the overall economic circumstances in the different regions of Germany and Europe, agriculture will continue to change within the next years. One reason is the so-called Agenda 2010 of the EU that proposes a fundamental reform of the agriculture policy regarding market conditions and the development of rural areas. Considering the related economic and social problems, the future agricultural sector will remain a great challenge for the EU.

II. Conditions of obtaining results

Analysis of Conservation Agriculture in the New Laender

At first it was possible to compare short overview reports of the 5 New Laender Saxony, Saxony-Anhalt, Thuringia, Brandenburg and Mecklenburg-Vorpommern.

Saxony and Saxony-Anhalt

The highest part of agricultural areas is located in the loess and hill regions of southeastern Germany.

In Saxony there is the most developed system of conservation agriculture combined with an efficient supporting program, effective advice and demonstration farms. The main item is conservation tillage and mulch seeding. In 2002/2003, after a ten year period of the environmentally friendly farming program, the mulch seeded area reached nearly 195.000 ha and covered 26.9 % of the arable land in Saxony (Table 2). Currently, in some regions conservation tillage methods are applied to various crops on over 50 % of the arable land. This shows that the strategy to reach a voluntary uptake of soil protecting agriculture on a large scale by information, demonstration and incentives is very successful in Saxony.

Table 3: Development of mulch seeded area due to the program for environmentally friendly farming methods in Saxony from 1993/94 to 2002/2003

Source: NITZSCHE, O.; KRÜCK, S.T. ; SCHMIDT, W. ; RICHTER, W: (2001)

Year	Mulch seeded area [ha]	Proportion of total arable land in Saxony* [%]
1993/1994	1.638	0,2
1994/1995	26.176	3,6
1995/1996	44.585	6,3
1996/1997	57.716	7,9
1997/1998	75.970	10,4
1998/1999	78.910	10,8
1999/2000	104.672	14,4
2000/2001	151.832	20,9
2001/2002	176.693	24,2
2002/2003	194.519	26,8
2003/2004	230.943	31,9

*: equivalent to 725.000 ha

Nothing affects the acceptance of a cropping system by farmers more than the yield. Based on a large number of on-farm field trials it was possible to show that no yield depressions occurred after conversion toward conservation tillage (Table 3).

Table 4: Yields of different crops cultivated with plough and conservation tillage (cultivator, active-driven tine-harrow) in a long term experiment from 1998 to 2003 in the Saxon loess hill region.

Year	Sugar-beet [t/ha]			Winter-wheat [t/ha]			Winter-barley [t/ha]		
	plough	cultivator/ chisel plough	active- driven tine- harrow	plough	cultivator/ chisel plough	active- driven tine- harrow	plough	cultivator/ chisel plough	active- driven tine- harrow
1998	61,2	64,7	71,7	7,2	7,3	6,8	4,6	4,6	4,8
1999	55,7	59,1	66,1	8,5	8,5	8,6	5,1	6,4	6,3
2000	72,0	68,5	74,4	7,7	6,9	7,3	7,0	7,6	6,7
2001	65,7	62,0	58,0	8,2	9,1	9,0	9,0	9,0	9,7
2002	63,7	68,1	67,0	6,6	7,0	7,0	5,1	5,5	5,6
2003	51,6	54,7	51,4	6,0	6,0	5,9	5,0	5,8	5,7
average yield	61,7	62,9	64,8	7,4	7,5	7,4	6,0	6,5	6,5

Conservation tillage is a new strategy to cultivate arable land in Germany. Until now, ploughing of arable land is common practice. For a broad implementation of conservation tillage it is necessary to provide as much support as possible to farmers wishing to introduce this new method. In Saxony strategies for conservation tillage are developed to solve production challenges. Large field-scale trials are performed on-farm together with farmers to gain results and conclusions that can be directly put into practice. Technical and management problems are identified and lead to the main research questions (Table 4). The experiments consider different soil and climate conditions, management systems and a wide range of crops. This type of research – in contrast to small-scale research plots - not only persuades farmers but also offers the possibility to demonstrate the benefits of conservation tillage for the environment.

Table 4: Main management problems and research fields in conjunction with conservation tillage, based on the experiences in Saxony.

<ul style="list-style-type: none"> • Yield safety and product quality • Management of straw and crop residues • Seedbed preparation (as prerequisite for successful mulch seeding) • Successful mulch seeding/direct seeding when high amounts of plant residues occur • Weed and disease control • Control of slugs and mice

Thuringia

The highest part of the agricultural areas is located in the Thuringia lowland and the hill region of southern Germany. The main item of conservation agriculture is the program KULAP (Support program for agriculture well adapted for environment, conservation of the cultural landscape, nature conservation and control management). It is a program for ca. 200.000 ha. The following measurements are integrated: abdication of herbicides, more extensive crops, integrated and controlled plant production, extensivation of grassland and pastures, conversion of arable land into grassland, edge strip program, long-term set-a-side program, special program for biotope consolidation.

The propagation of conservation tillage is marginal, caused by heavy soils, high level of precipitation, high part of grassland.

Brandenburg.

The agricultural areas are located in the old and young moraine regions. Semiarid climate with a water deficit and unstable sandy soils are limiting factors for conservation tillage. The main item of conservation agriculture is the program KULAP (Support program for agriculture well adapted for environment, conservation of the cultural landscape, nature conservation and control management). Extensive grassland management and especially on floodplains, controlled integrated horticulture, perennial leguminous intercropping in former mining areas and conversion of arable land into grassland. Calculation of area under agreements result in total 200.000 ha.

In special and stable farms conservation and reduced tillage (no zero tillage) become more and more accepted. The tillage operations within crop rotations were reduced. The motivation is the save of 15 –20 l oil /ha, compared with ploughing, the save of costs for man power and the save of time and soil water. But the extension is restricted and no important compared with Saxony. The risks of special weeds, water concurrence and unstable yield level is higher compared with the loess region.

Mecklenburg-Vorpommern

The agricultural areas located in the young moraine region. The climate is influenced by the Baltic Sea and the soils are loamy and sandy-loamy soils. The extension of conservation and reduced tillage is higher compared with Brandenburg. The crop yields level was indifferent (1995 –2002) (Table 5)

Table 5: Comparison of conventional and conservation tillage of different crops (dt/ha)

Source: NEUBAUER. W. (2003)

crops	number of harvests	Soil tillage		
		conventional with plough (30 cm deep)	conservation tillage with chisel	
			deep (25 cm)	flat (15 cm)
Winter wheat	11	104	101	101
Winter barley	4	84	78	83
Sugar beet	6	726	732	705
Winter rape	2	36	40	38
Potatoes	2	391	379	414
Clover grass (dry matter)	2	65	66	64
Corn	1	163	160	161

Favourably was the reduction of costs in farm experiments in Mecklenburg-Vorpommern. The averaged cost saving was 45 €/ha machine costs and 0,73 working hour/ha (table 6)

Table 6: Reduction of costs and working hours by conservation tillage in experiments (1995 –2002)

Source: NEUBAUER. W. (2003)

crops	years	Variable machine costs	Working hours	Labour costs
		€/ha	Wh/ha	€/ha
Winter wheat	11	15,17	0,55	7,09
Winter barley	4	14,56	0,55	7,09
Sugar beet	6	21,70	1,11	14,43
Winter rape	2	21,74	0,84	10,92
Potatoes	2	16,25	0,60	7,80
Clover grass (dry matter)	2	12,91	0,58	7,48
Corn	1	22,24	0,92	11,90
avarage		17,79	0,73	9,53

Analysis of Organic Farming research projects in the New Laender

In Eastern Germany, there have been various, recent research activities on Organic Farming (OF). Research in the New Laender during the last five years has been carried out by different research institutes (universities and research institutes of the Federal Republic of Germany) as well as federal and regional agricultural and environmental agencies and offices.

General research in OF has been carried out regarding the development of fauna, flora and soils as well as yield estimates after conversion to OF. Guidelines for farmers for independent on-farm experiments and models which consider specifics of OF have been developed by ZALF e.V. in Brandenburg.

Organic cropping systems have been researched on one hand with multiple objectives and on the other hand for particular questions of crop rotations and cultivation of specific crops. Multiple objectives regarding cropping systems include issues of biomass production and yields, water and nitrogen balances, soil fertility as well as economical aspects. Crop rotations have been investigated in field experiments in varying regional contexts. Specific crops under investigation included winter wheat, summer wheat, maize, spelt and durum, and also field bean and peas.

Specific questions regarding nutrient and humus balances have received intensive attention in research related to OF. Aspects of the use of fertilizer and manure in OF are, for example, investigated in depth in Saxony by the regional agricultural office. Another researched point of focus in this context is symbiotic fixated legume nitrogen and its effective use.

Plant protection and pest control certainly are two more fields central to research on OF. The Federal Biological Research Centre for Agriculture and Forestry (BBA) has published an extensive compilation of research reports on pest management in OF in 2002. Specific research on diseases of potatoes and lupines was recently done in Berlin, Saxony and Thuringia. Regarding weed control in OF different extension service material for farmers has been published by regional agricultural offices.

An important research project on biodiversity in OF is presently undertaken on the “Nature Conservation Farm Brodowin” in Brandenburg.

Besides these ecological aspects, also socio-economic issues are being investigated. These studies are mostly undertaken on a national rather than a regional scale.

III - First information about GMO

Growing of GM crops is an emerging tendency in the agriculture of Germany. This holds in particular for Maize. Maize is the most powerful forage crop in our region. Planting of Bt maize could help to solve problems with the European corn borer arising within the last years. On the other hand, many organic and conventional farmers try to protect their maize harvest from the contamination of grains of GM maize and form associations (“Zones free of Genetic Technologies”).

Knowledge on large-area GM planting in Germany is rare. Against this background, research activities outgoing from independent organizations are urgently required.

The Leibniz-Centre for Agricultural Landscape and Land Use Research (ZALF) e. V. Muencheberg is involved in work on risk management of GMOs (especially maize, potato and rape).

Important topics are:

- impact of transgenic potatoes on the soil and plant-associated microflora
- survival of GM crops during the winter time
- distribution of pollen by wind
- translocation of GMO or parts of them in the soil or by water

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