The 11th European IFSA Symposium:
Farming systems facing global challenges: Capacities and strategies
Berlin, Germany

Information about Field Trip 1

Large-scale crop production on sandy soils

Berlin, April 2014

The 11th European IFSA Symposium:
Farming systems facing global challenges: Capacities and strategies

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Contents

Preface

Welcome to Berlin. It is our pleasure to invite you on a trip which takes us to an area surrounding Berlin; it is typical for land use and agricultural production in the Federal State of Brandenburg. The destination of the field trip is the region of Teltow-Fläming about 50 km South of Berlin. We will introduce you to the natural conditions of agricultural production representative not only for the region but also for a wide range of agricultural sites in the Eastern part of Central Europe.

Due to glacial genesis, soils show large heterogeneity here. The trip focuses on sandy soils determining the agricultural productivity of the Brandenburg region to a large extent. The trip joins field experimentation with agricultural practice. It offers the opportunity to discuss aspects of resource efficiency, optimal soil management and climate change adaptation on sites which are highly threatened by nutrient losses, water shortage and annual yield fluctuations.

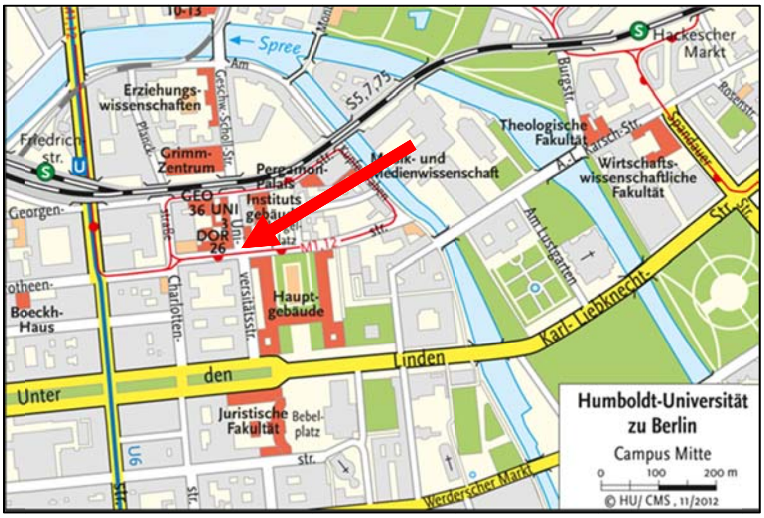
During the first part of the trip we will present the long term agricultural field experiments in Thyrow, run by Humboldt-Universität zu Berlin. The experiments demonstrate the potentials and limitations of agricultural productivity of sandy soils, further they show the potential for CO_2-sequestration and greenhouse gas emissions. During the second part we will visit the Cooperative Farm Trebbin. Farming on an area of more than 4000 ha it belongs to the largest agricultural companies of the region. Here you can discuss farm philosophy and strategies which enable the adaptation to political decisions, market fluctuations, and short and long term changes of natural environment.

So we hope you get an impression of the varying natural conditions and land use potential, as well as the options for agriculture in the Brandenburg region. We are looking forward to interesting discussions and a nice day.

View over the lowlands of Nuthe-Notte-Niederung near Trebbin. On clear days you can see the Berlin television tower to the right on the horizon

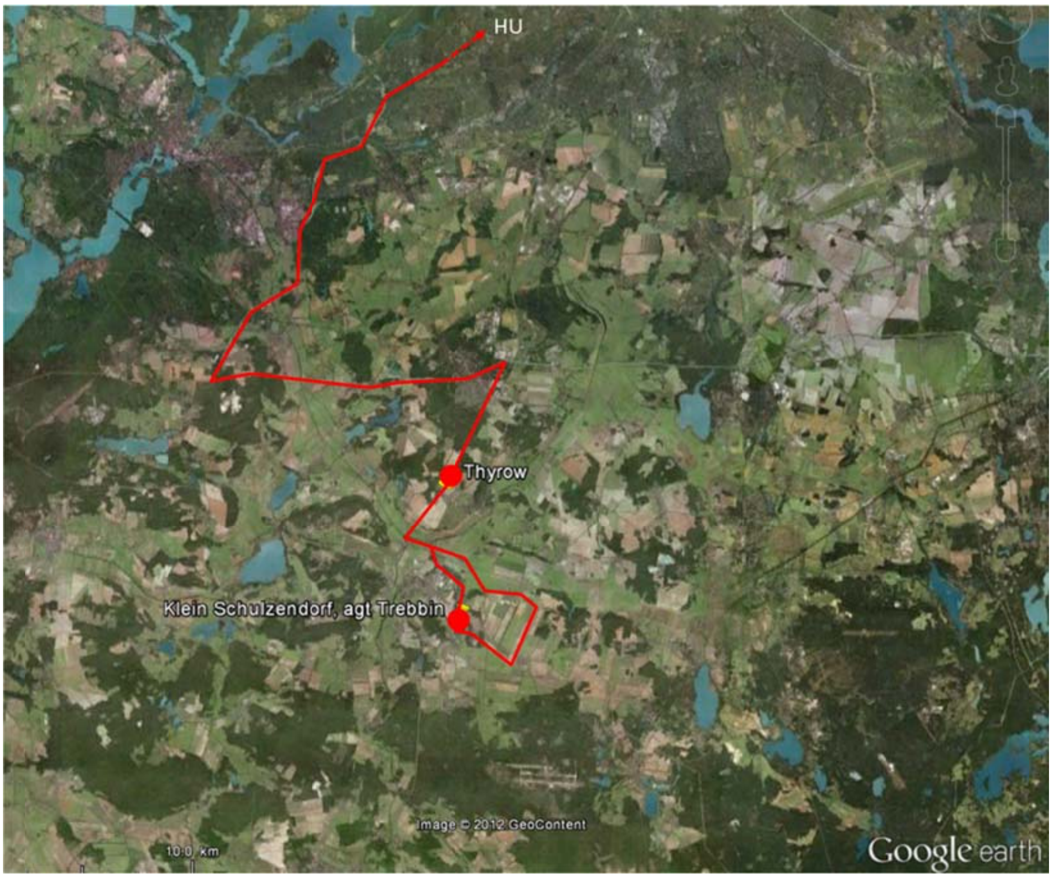
Time table and program

07:45	**Registration at the start point**
08:00	**Start**
09:00 – 11:30	**Visit of the Agricultural Research and Teaching Station in Thyrow**
09:15	Welcome
09:30	Introduction to climate and soil conditions
10:15	Presentation of long term field experiments
	Soil fertility experiment: impact of mineral-organic fertilisation at different N-levels (D6)
	Nutrient deficiency experiment (D41)
	Nutrient deficiency under winter rye monoculture (D42)
	Continues fertilisation and irrigation experiment (D1)
12: 00 – 16:30	**Visit of Agricultural Cooperative Trebbin**
12:00	Visit of the biogas plant
13:00	Lunch
13:30	Presentation of the company by the management director
14:00	Tour around the company
16:30	**Return to Berlin**
18:00	**Arrival in Berlin, *Dorotheenstraße 24***



Start *Dorotheenstraße 24* at the rear of the main building of Humboldt-Universität

Route of the field trip



The image shows the land use pattern along the route. In glacial landscapes the land use follows the geomorphology: crop land (brown areas) on sandy-loamy sites of ground moraines; grassland (light green) on groundwater influenced sites in the lowlands of the old glaciofluvial valleys; forestry (dark green) on areas unsuitable for crop production, that are dry areas in the lowlands and channels on ground moraines formed by melting water and filled up with poor sands.

Introduction to the site conditions, land use and agricultural production of the region

Based on geomorphology and climate, Germany's landscapes can be divided into three major natural regions: the North German Plain, the Central Uplands and the Alp Mountain Region.

Brandenburg is located in the Northeast German Plain, which can be distinguished from the Northwest German Plain by its more continental climate.

Climate

Climate is mostly constant throughout the Northeast German Plain because of only small differences in elevation. It can be classified as temperate oceanic (Köppen Geiger Climate Classification) but it is increasingly influenced by continental circulation in northeast direction. Northeast Germany, Brandenburg in particular belongs to the driest regions of Germany (Tab. 1). A seasonal water deficit of about -50 to -125 mm occurs mainly during the spring and the early summer (DWD, 2011) and threatens the crop during its critical stage of intensive growth. Strong and long winter periods as well as low precipitation during the summer shorten the growing period of agricultural crops and limit agricultural production (Schultzke & Kaule, 2001).

Tab.1: Agro-climatic regions of Germany (Schultzke, 2005)

Agro-climatic region	Temperature (°C)	Annual precipitation (mm)	Sun shine duration (h)
West of Ems und Lower Rhine (Ic)	9.1 (7.7 – 9.9)	795.0 (688.2 – 1042.1)	1517.5 (1390.3 – 1789.0)
Northwest Germany Lowland (IIa)	8.6 (8.4 – 8.9)	720.0 (593.6 – 767.4)	1638.3 (1455.0 – 1670.7)
Northeast Germany Lowland (IIb)	**8.4** **(8.0 – 8.9)**	**536.1** **(472.4 – 576.6)**	**1618.6** **(1459.1 – 1727.2)**
Central uplands (IIc)	8.1 (6.5 – 9.5)	818.3 (648.6 – 999.9)	1609.0 (1544.0 – 1847.0)
Southwest Germany und Upper Rhine (IV)	9.2 (8.9 - 9.6)	717.5 (696.8 – 762.8)	1735.8 (1706.8 – 1816.0)

Northeast Germany is one of the areas where a worsening of natural conditions for crop production will be expected due to climate change. Therefore farmers *may look for alternative, non-agricultural activities* (UBA, 2011).

Geomorphology and land use

Due to the relatively uniform climate land use pattern is primarily a result of the geomorphology linked to a certain water regime and soil association (see image page 5).

Northern Germany's surface is made up of unconsolidated sediments from the ice ages. The glaciation in northern Germany resulted in a typical sequence of landscape forms in northeast-southwest direction (ground moraines, end moraines, outwash plains, broad glaciofluviatil valleys, dunes). End moraines, outwash plains and dunes are exclusively used for forestry because of their poor sandy sediments, extreme water shortage and high erosion risk. Ground moraines and the lowlands of glaciofluvial valleys are the preferred sites for agricultural production.

Ground moraines were formed under glacial ice and are plateaus which rise up above the common land level to about 50 – 80 m. The relief is usually gently undulating with slopes of < 2 % to 10 %, thus not limiting arable crop production. The sites are mostly well drained and the biomass production is rain-fed. Drain water from ground moraines influences nutrient regime of the surrounding lowlands, but it is also pathway of pollutant input.

Ground moraines are primarily made up of glacial till being a favourable parent material for agricultural soils. Glacial till is characterised by a sandy loamy texture, low to medium carbonate content and a balanced mineral composition, however, modified under extreme climatic conditions at the end of the ice age. Usually, the top 50 - 70 cm were depleted of almost all clay resulting in a textural transition at this depth from sandy to loamy. Carbonates are washed out to a depth below 150 cm where they are without significance for annual crops. The ground moraines are often dissected by channels formed by melting water filled up with poor glaciofluvial sands or are covered by aeolian sands. Such sites are considered to be marginal for any agricultural production and are used by forestry. Shifts in land use over time, however, show that there have been historical periods where even very unfertile, dry sites have been used as cropland. Cropping of poor sites has been caused strong wind and water erosion from the past to the present (Fig. 1)

Fig. 1: Wind erosion on poor sandy sites during a dry spring (2011)

The typical arable soils of ground moraines are Albic Luvisols. Due to the typically low clay and humus content of the topsoil (< 5% and < 2% resp.) the soils are without structure and are threatened by wind erosion, soil compaction, acidification and nutrient losses. Soil productivity depends on the thickness of the sandy layer covering the deeper loam. The deeper the loam the higher is the risk of water deficit mainly during the early growing stages. Different thickness of sandy layers causes small-scale soil heterogeneity and high spatial yield variability at ground moraine sites.

Lowlands of broad, level glaciofluvial valleys are found at an elevation of 30 to 50 m above sea level. The glacial melt water deposited fine to medium textured poor sands. Soils of the lowlands are widely influenced by groundwater. The lowlands are characterised by high soil diversity. Reasons are the spatial variation of the groundwater table, differences in micro-relief and the heterogeneous younger sedimentation. Sandy Gleysols dominate. They are used for arable crop production. Associated organic soils (Histosols) are typical grassland sites (Fig. 2). Dry sites are under forestry.

Fig. 2: Wet areas constrain the management of grassland (above). During long rainy periods in summer 2011 water has dammed up in the plains and the ground water table was near the surface (below).

Large areas of primary organic soils on the wet sites were converted to agricultural use through extended drainage ditches. Some of the drainage ditches date back to the 17th century, but the current system of drainage in northeast Germany is a result of the widespread amelioration 40 years ago. Within a few years, the increase of arable land area was contrasted by the decrease in fertility of the organic soils. The drainage has led to irreversible changes in soil quality, e.g. degradation of physical properties, the differentiation of the micro-relief ongoing with an increasing share of dry sites with lower productivity and higher exposition to wind erosion.

The impact of water management as well as of climate changes with corresponding changes of water regime in the whole landscape is of large-scale due to the small differences in elevation within the lowlands. In addition, fluctuations of groundwater table cannot be predicted because of the heterogeneous conditions in the underground. An optimal water management is a challenge but the precondition of sustainable and efficient land use of these lowlands.

In summary, the land uses ‘forest’ and ‘arable land’ compete on the well-drained sites of ground moraines, while in the moist lower areas grassland and arable land are the dominant land uses. Brandenburg belongs to the federal states richest in forests. Forests cover 35% of the area, Agriculture 49%, 78% of which is arable land and 22% grassland. Horticulture, field vegetable crop production in particular is without significance because of unfavourable climate conditions. Its percentage on agricultural land area is continuously decreasing (< 0.9%) being strengthened by the competition of energy crops (MIL, 2012).

The trip route crosses the Teltow, a ground moraine plateau (acreage of 675 km^2) after we have left Berlin in south direction. Passing the highway we look to the lowlands of Nuthe-Notte-Niederung (acreage of 516 km^2) surrounding the Teltow plateau. The tour continues alternating on ground moraine plateaux and through the lowlands and shows the fast change of arable land, forestry and grassland typical for this landscape.

Fig. 3: In the lowlands near Trebbin. Wind turbines can serve agrarian enterprises as an additional source of income.

Soils of the region

Ground morains

Albic Luvisol from sand overlaying loam and deep glacial till
(37-43 soil points)

Arenosol from sand
(16-22 soil points)

Lowlands

Mollic Gleysol from sand
(30-36 soil points)

Histosol from peat overlaying sand

Soil productivity and Agricultural production

In Germany, a *Soil Assessment Rating System (Bodenschätzung*) is used to classify the productivity of agricultural land. This system, based on natural site characteristics, was originally developed for taxation of farms but it has been become of increasing interest for evaluation of soil functions in general. It describes economic yield possible for given natural site conditions, if methods of best practice are applied, relative to the most favourable site conditions. Soils are divided into classes according to soil texture, soil condition and origin of parent material, for grassland water table and climate are also taken into consideration. The best soils, getting 100 points are Chernozems formed from loamy loess.

The vast majority of agricultural land has weak to moderate productivity with a rating range from < 30 to 50 points in Brandenburg. Around 9% are among the least productive marginal sites. Areas where most of the soils are in classes > 50 only occur only on 15% of agricultural land (LBGR 2007 in Heinrich & Hierold, 2009). The low soil productivity of the majority of soils is exacerbated by frequent spells of drought.

For production organisation sites are aggregated and regionalised according to the boundary of production possibilities. This boundary is defined by the crops which earn highest yields under given natural environment even when methods of best practice are applied. For arable crops five land cultivation areas *(Landbaugebiete)* are specified (tab. 2). Most sites of about 55% are suitable for rye production. An overview about average yields and cultivated areas in Brandenburg is given in table 3.

Tab. 2: Land cultivation areas for arable crop production and percentage of arable land area (MIL, 2010; Zimmer, 2013)

Type	Crops for profitable production with methods of best practice	soil points	% of arable land
I	wheat, sugar beet	>45	16
II	barley, wheat, sugar beet	36-45	25
III	rye, potatoes, partly barley, canola, wheat	29-35	21
IV	rye, potatoes, partly maize	23-28	20
V	marginal sites, suitable for rye, lupine, serradella	<28	15

Tab. 3: Areas and yields for the main crops in Brandenburg (MIL, 2012: *Agrarbericht 2011/2012*)

Crop	Area (1,000 ha)	% of arable land in Brandenburg*	Yield (2006 - 10) (100 kg ha^{-1})
Winter Rye	193.9	18.8	39.4
Maize for silage + CCM (30% DM)	164.4	15.9	320.2
Winter wheat	151.6	14.7	60.4
Canola	118.4	11.5	35.5
Winter Barley	65.9	6.4	53.6
Triticale	42.4	4.1	56.1
Maize + CCM	25.7	2.5	47.9
Summer barley	11.2	1.1	30.7
Potatoes	9.4	0.9	313
Sugar beet	8.3	0.8	528

* Arable land area in Brandenburg, 2010: 1.031,9 T ha

Research and Teaching Station in Thyrow

Introduction

The Research and Teaching Station is one of the central institutions of the Department of Crop and Animal Sciences at Humboldt-Universität zu Berlin, providing the common needs for research and educational purposes. It is divided into two units, greenhouse research and agricultural field experimentation. The latter comprises two experimental sites. One is located on campus Berlin-Dahlem close the lecture rooms and the facilities of the Department of Crop and Animal Sciences. The second lies in the Federal State of Brandenburg around 30 km South of Berlin in Thyrow.

The sites represent typical arable sites of the younger glacial drift areas of central Europe, in particular the ground moraine sites of low to medium soil fertility. Both sites have a long research tradition. They were established at the former Royal Agricultural College in 1923 and 1936 resp. From the beginning the special interest has been focused on the sandy soil management leading to an extensive programme of long-term agricultural field experiments.

The Thyrow experimentation station belongs to the network of the International Phenological Gardens (IPG) and is equipped with a modern weather observation station (http://ipg.hu-berlin.de/.

Fig. 4: View on the expreimentation station in Thyrow.

Site characteristics

The Thyrow experimentation station is located in the South of the Teltow ground moraine plateau. Dry climate and poor soil fertility can be considered as representative for marginal agricultural sites of the Brandenburg region.

Main climatic constraints are drought periods during the spring. The minimum average precipitation of 30 mm occurs in April (Fig. 5). During the summer the precipitation is higher with a considerable variability. The maximum average precipitation of 62 mm occurs in July. High rainfall negatively influences the maturity and harvest of grain crops; however, fodder crops and silage maize can utilise this precipitation for high biomass production. The annual precipitation is on average 509.8 mm, the annual mean temperature 9.2 °C.

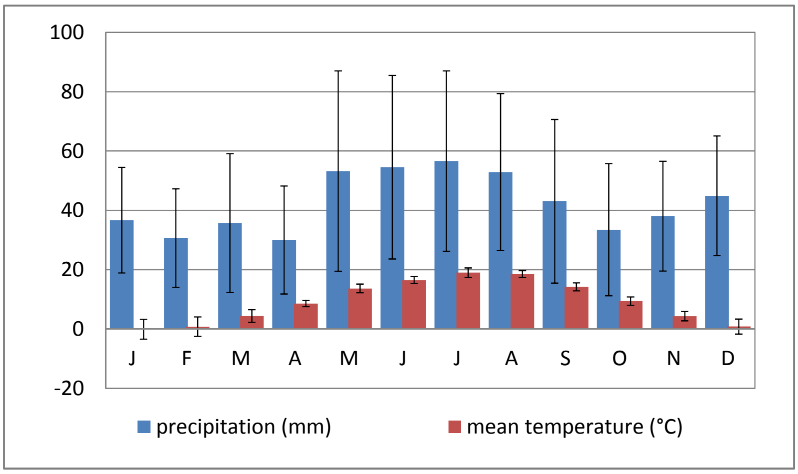


Fig. 5 : Monthly precipitation and mean temperature in Thyrow (Reference period 1981-2010, long-term average and SD)

In the area of experimental fields the relief is nearly level (slope < 1%, Fig. 4). Albic Luvisols with deep layers of cover sands (see following page) alternate with poor Arenosols. Both soils are of low soil productivity assessed with 25-33 points. Whereas the top soil properties are nearly uniform great differences mainly in soil texture occur in the subsoil. This is caused by the undulating depth of the loamy layer below the overlaying (between 65 and > 100 cm, Fig. 6) and is responsible for the small-scale soil heterogeneity typically for ground moraine sites, as described before. Depending on the subsoil properties the field capacity for plant available water amounts from 44 mm to 90 mm and can be considered as low in general.

Tab. 4: Soil properties at site Thyrow

Parameter	Topsoil 0-30 cm	Subsoil 30-60 cm
Clay (%)	< 5	< 5 - 20
Silt (%)	10 - 14	10 - 27
Sand (%)	> 80	50 - > 80
bulk density (g cm^{-3})	1.6	1.7
C_{org} (%)	0.4 - 0.8	< 0.02
CEC (cmol kg^{-1})	< 5	< 5 - 11
plant available field capacity (mm)	24	20 - 66

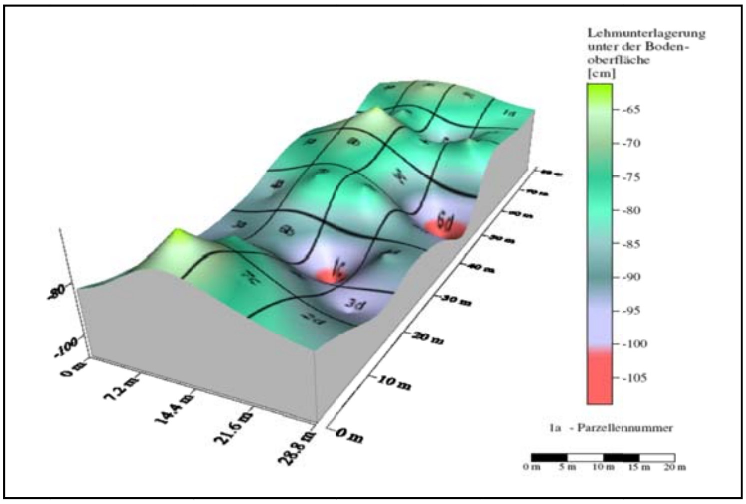
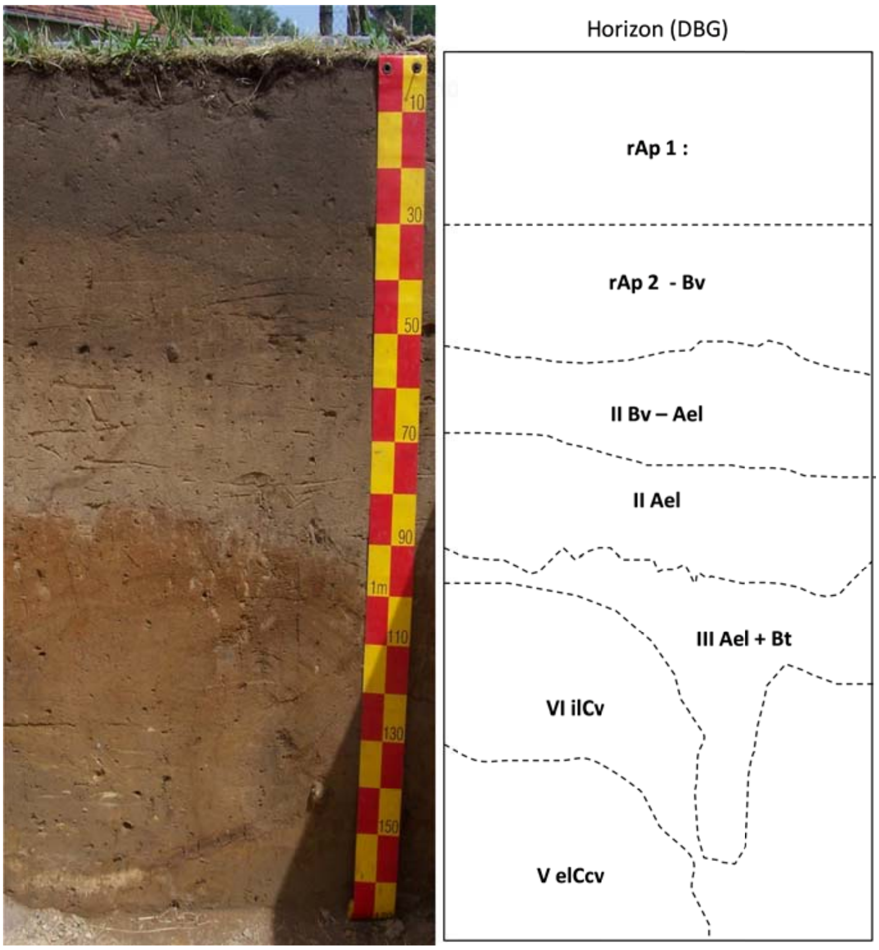


Fig. 6: Variation of the textural change from sand to loam at the site of the Nutrient deficiency experiment (Vogel, 2006)

Soil Profil

Albic Luvisol from periglacial sand overlaying periglacial loam and glacial till



Profil description

Horizon (DBG)	Depth (cm)	Parent material	Description	Diagnostic properties (WRB)
rAp1	0 - 15	redeposited natural material	10YR4/3, loamy sand, very low humus content (OC < 0,6%)	
rAp2 - Bv	15 - 30		10YR4/4, 10YR4/6, medium to fine sand, very low discontinuous humus content (OC < 0,6%), increased bulk density	
II Bv - Ael	30 - 50	periglacial sand	10YR5/4, 10YR6/4, loamy sand, very low discontinuous humus content	
II Ael	50 - 95	periglacial loam	10YR6/4, loamy sand	albic
III Ael + Bt	<90-130		10YR6/4, 5YR5/8, 7.5YR5/8, loamy sand and sandy loam, clay films	argic, cutanic
IV ilCv	<130-155	glaciofluvial sand	10YR5/6, 10YR5/8, loamy sand	
V elCcv	>200	glacial till	10YR5/4, 10YR5/6, loamy sand, high carbonate content (< 15%), carbonate veins and pseudomycelia (> 5%), lamellae structure	

Analytical data

Horizon No.	Horizon (DBG[1])	Average thickness	Sand	Silt	Clay	Bulk density	Soil moisture per 15.12.2010
		cm		% fine earth		g cm^{-3}	% Vol
1	rAp1	30	87.7	10.1	3.3	1.62	7.7
2	rAp2 - Bv	20	90.3	6.5	3.2	1.67	10.5
3	II Bv - Ael	30	83.3	14.3	2.4	1.67	17.2
4	II Ael	12	80.9	16.3	2.8	1.70	17.8
6	III Ael+Bt	23	72.8	15.0	14.4	1.79	24.4
7	IV ilCv	27	75.8	15.0	9.3	1.79	19.2
8	V elCcv	> 58	72.7	19.3	8.1	1.80	17.1

Horizon No.	Horizon (DBG)	Carbonate	pH		C_{org}	N_{total}	C:N	P sorption capacity	CEC_{pot}
		%	(H_2O)	($CaCl_2$)	%			mmol kg^{-1}	cmol$_c$ kg^{-1}
1	rAp1	-	5.8	5.1	0.52	0.035	15	19.1	4.1
2	rAp2 - Bv	-	6.3	5.5	0.21	0.013	16	14.4	2.0
3	II Bv - Ael	-	6.5	5.1	0.09	0.006	-	8.2	1.7
4	II Ael	-	5.9	4.6	0.05	0.004	-	5.5	1.2
6	III Ael+Bt	-	6.1	4.7	0.13	0.015	-	21.1	4.4
7	IV ilCv	-	6.6	5.3	0.09	0.012	-	11.7	4.5
8	V elCcv	8.5	8.1	7.4	-	0.006	-	6.2	3.6

[1] Deutsche Bodenkundliche Gesellschaft (2005): Bodenkundliche Kartieranleitung.

Long-term agricultural field experiments

Long-term agricultural field experiments (LTAE) belong to the main research methods to answer questions of sustainable agriculture. LTEAs are set up to detect accumulation effects of long-term management on slowly changing soil and plant parameters. The classical approach of LTAEs is a reliable estimation of productivity limits and potentials for given soil and climate conditions (management-site specific steady-state). They provide an excellent basis for understanding the short and long-term dynamics of the soil-plant system. Thus they are widely used for model development and validation, in particular for modelling of soil organic carbon changes. Further the LTAEs provide information about the stability of the soil-plant-system under short term and long-term changing environment (e.g. annual weather vs. climate change). Long term experiments usually lead to a great differentiation in soil status. Thus parameters sensitive for long term changes in soil status can be clearly identified which may be suitable for evaluation of the sustainable impact of a certain management.

The Humboldt-Universität zu Berlin runs 10 long term field experiments, including the *Long-Term Agrometeorological Field Experiment (Tab.5, p. 21)*. These experiments are 30 to 90 years old. A new experiment, designed in 2005 as long-term experiment, is the *Demonstration and Monitoring Field of Cropping Systems.*

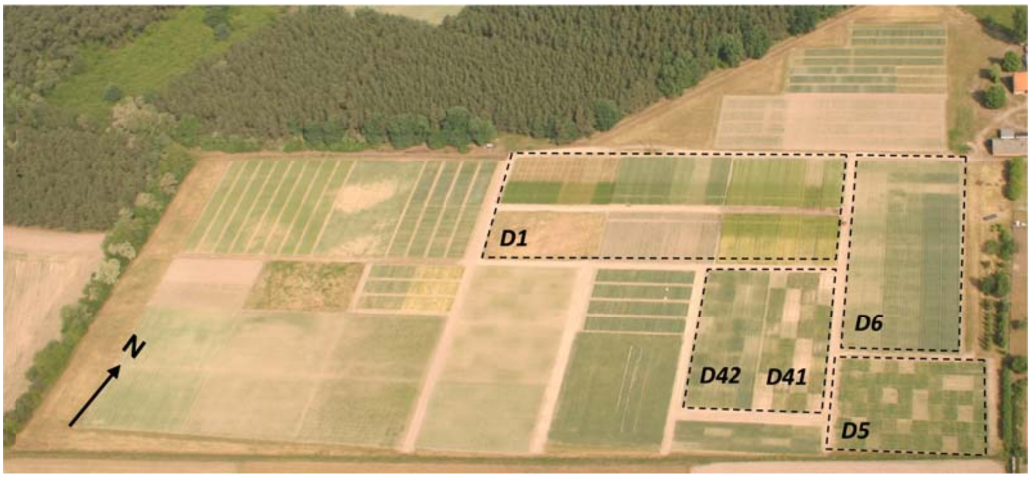


Fig. 7 : Long-term field experiments in Thyrow: D1 Continuous Fertilization and Irrigation Experiment, D41 Nutrient Deficiency Experiment, D42 Nutrient Deficiency Experiment with rye monoculture, D5 Experiment Crop Rotation and Straw Incorporation, D6 Long-Term Soil Fertility Experiment.

The *Static Nutrient Deficiency Experiment* (since 1937), the *Static Irrigation and Fertilisation Experiment* (since 1968) and the *Long-Term Soil Fertility Experiment* (since 1938) are among the most important long-term experiments in Thyrow. Due to a few special characteristics, these experiments are unique not just on a regional level. The oldest experiment, which has barely been changed since the founding of the experimental station, is the *Nutrient Deficiency Experiment*. This fertilisation experiment follows the tradition of the long-term experiments in Rothamsted (UK), Halle (Germany) and Bad Lauchstädt (Germany). The *Continuous Fertilization and Irrigation Experiment* is the only long-term experiment in which the long-term effect of irrigation on soil and plants is measured. The use of soil texture as an experimental variable through the addition of clay as a soil supplement in the *Long-Term Soil Fertility Experiment* is unique in Europe (Ellmer et al., 2000). In addition, the Series *Crop Rotation, N-fertilisation* and *Straw Incorporation* is particularly relevant in light of the current discussion around the competing demands for organic matter for soil fertility and biofuel production, in particular because of the rise in demand for biofuel straw.

The primary interest which initiated the establishment of the first field trials in the 1920s was to find out solutions to improve the fertility of dry sandy soils. The effect of specific organic fertilizers in combination with different levels of mineral fertilization, tillage depth and liming has to been proved in the early years. Later in the 1970s the studies were focused on maximizing the yields by increasing fertilization intensity and irrigation. After this period the objectives changed. Nutrient dynamics and balances and the resilience of the system against long term nutrient exploring have been of increasing importance as well as the interannual yield stability. Studies about soil organic matter have been of prior interest over the whole time. The Thyrow long term field trails belong to the few experiments with continuous soil carbon measurements over more than 40 years.

At present a wide spectrum of crop sequences and 13 arable crops are cultivated in Thyrow and Berlin-Dahlem. Given the characteristic site conditions at Thyrow, the following maximum yields (long-term mean of a treatment) were reached in long-term experiments:

Winter rye	5,5 t ha^{-1}
Winter barley	4,5 t ha^{-1}
Summer barley	3,5 t ha^{-1}
Potatoes (Tuber FM)	32,5 t ha^{-1}
Silage maize (DM)	14,6 t ha-^{1}

Irrigation only becomes effective with well-balanced organic-mineral fertilization, yielding 14% more winter rye and 16% more winter barley. Slightly increased clay contents (8.2% compared to 4.5%) lead to 17 - 108% higher yields in silage maize, 23 - 51% in potatoes, and 4 - 60% in winter rye. Maximum yield loss is observed in the treatment without liming (pH 4-4.5), followed by treatments without N and without K, whereas long term P deficit have led to the minimal decrease of about 5-10% over a time period of 75 years.

On the trip the experiments D1, D41, D42 and D6 will be presented. Data about factor levels, crop sequence and fertilisation are given by the following tables (pp. 19 – 21).

Further Information:

MLUV, Ministerium für Ländliche Entwicklung, Umwelt und Verbraucherschutz , Hrsg. (2009): Dauerfeldversuche in Brandenburg und Berlin. Schriftenreihe des Landesamtes für Verbraucherschutz, Landwirtschaft und Flurneuordnung, Reihe Landwirtschaft, Band 10, Heft IV. S. 15, 22-49.

Chmielewski F.M., Köhn, W. (1999): The long-term agrometeorological field experiment at Berlin-Dahlem, Germany. Agricultural and Forest Meteorology. 96. 39-48.

http://www.agrar.hu-berlin.de/fakultaet/einrichtungen/freiland/

http://www.agrar.hu-berlin.de/apb

http://www.agrar.hu-berlin.de/agrarmet

Factor levels, crop sequence and fertilisation in the presented experiments

(Organic fertilisation: FM in t ha^{-1}; Mineral fertilisation: nutrients in kg ha^{-1})

D1: Fertilisation and Irrigation Experiment

Factor levels

Factor		**Level**	
A	Irrigation	a1	without irrigation
		a2	irrigation as required
B	Mineral N / straw incorporation	b1	straw incorporation + PK
		b2	straw incorporation + N1PK
		b3	straw incorporation + N2PK
		b4	N2PK

Crop rotation and fertilisation

Fertilisation		Crop sequence (with field rotation)					Annual mean
		Field 1 **Grass**	Field 2 **Potatoes**	Field 3 **Winter Wheat**	Field 5 **Canola**	Field 6 **Winter rye**	
Organic	Straw	harvested rye straw	0	0	harvested wheat straw	0	
Mineral	N0	0	0	0	0	0	0
	N1	60+30+30	60	60	50+60	60	82
	N2	120+60+60	120	120	50+120	120	154
	P	17.5	17.5	17.5	17.5	17.5	17.5
	K	100	100	100	100	100	24
Liming				as required			

D41: Nutrient Deficiency Experiment

Factor levels

Factor	**Level**	
A	a1	without fertilisation, without lime
	a2	farm yard manure, without lime
	a3	NPK + farm yard manure + lime
	a4	NPK + lime
	a5	NPK, without lime
	a6	NP+ lime
	a7	NK + lime
	a8	PK + lime

Crop rotation and fertilisation

Fertilisation		Crop sequence				Annual mean
		Potatoes	**Spring barley**	**Silage Maize**	**Spring barley**	
Organic	farm yard manure	30	0	30	0	15
Mineral	N	90	60	90	60	75
	P	24	24	24	24	24
	K	100	100	100	100	100
Liming			as required			

D42: Nutrient deficiency in rye monoculture

Factor levels

Factor	Level	
A	a1	without fertilisation, without lime
	a2	PK + farm yard manure + lime
	a3	N1PK + farm yard manure + lime
	a4	N2PK+ lime
	a5	N1PK + lime
	a6	N1P + lime
	a7	N1K + lime
	a8	N1PK without lime

Fertilisation

Fertilisation		Mono culture **Winter rye**
Organic	farm yard manure	15
Mineral	N1	60
	N2	120
	P	24
	K	100
Liming		as required

D6: Impact of different organic and mineral N fertilisation on soil fertility

Factor levels

Factor		Level	
A	Mineral N-fertilisation	a1	N0
		a2	N1
		a3	N2
B	Organic fertilisation	b1	farm yard manure
		b3	PK
		b4	PK + farm yard manure 1
		b5	PK + farm yard manure 2
		b6	PK + green manure
		b7	PK + farm yard manure 1 + green manure
		b8	PK + Straw incorporation with extra N + green manure
		b9	PK + Straw incorporation with extra N
		b10	PK + Straw incorporation without extra N
		b11	PK + manure 1 + clay soil application (2 times)
		standard as b9	

Crop sequence and fertilisation

Fertilisation		Crop sequence **Silage Maize**	**Winter rye**	annual mean
Organic	farm yard manure 1	20	0	10
	farm yard manure 2	40	0	20
	green manure	harvested catch crop	0	
	straw	harvested winter rye straw	0	
Mineral	N0	0	0	0
	N1	60	60	60
	N2	60	80+40	90
	P	24	24	24
	K	100	100	24
Liming		as required		

Tab. 5: Long Term Field Experiments run by the Humboldt-Universität zu Berlin

Site	Exp_ID	Name	Start	Factors	Levels	Fields	Treat-ments	Repl.
Thy	D1	Static Irrigation and fertilisation experiment	1978	A: Irrigation B: Straw incorporation and/or mineral N fertilisation	2 4	5	8	2
Thy	D41	Static Nutrient deficiency experiment	1937	A: N, P or K deficiency, effect of farm yard manure and liming	8	1	8	4
Thy	D42/4	Nutrient deficiency in rye monoculture	1998	A: N, P or K deficiency, effect of farm yard manure and liming	8	1	8	4
Thy	D5	Series: Straw incorporation and mineral N fertilisation in different crop sequences	1976					
	D51	A) crop sequence with 50% cereals		A: Straw incorporation B: Mineral N fertilisation	2 4	1	8	2
	D52	B) crop sequence with 75% cereals		A: Straw incorporation B: Mineral N fertilisation	2 4	1	8	2
	D53	C) crop sequence with 100% cereals		A: Straw incorporation B: Mineral N fertilisation	2 4	1	8	2
Thy	D6	Static Soil Fertility Experiment	1975	A: Mineral N fertilisation B: Organic fertilisation (farm yard manure, straw, green manure) / soil texture	3 11	1	33	2
Thy	ABS	Arable Farming Systems	2005	Field demonstration				
		Three Field System		0		3	1	1
		Integrated Production		0		6	1	1
		Organic Farming		0		6	1	1
		Three Field System, improved		0		7	1	1
Dah	AMF	Long-Term Agrarmeteorological Field Experiment	1953	Impact of weather on eight crops		8	1	1
Dah	D3/3	Static Soil Use experiment	1923 1939 1967	A: tillage depth B: liming C: P fertilisation D: farm yard manure E: crop sequence (until 2013)	2 2 2 2 2	1	32	4
Dah	IOSDV	International Organic-Nitrogen-Long-Term-Fertilisation Trail	1984	A: organic fertilisation (farm yard manure or straw + green manure) B: Mineral N fertilisation	3 4 (2)	3	10	3

Cooperative Farm Trebbin

Introduction

In Germany the traditional legal form of farm organization is the sole proprietorship. However, there are significant differences between West and East Germany. Whereas family farms dominate in West Germany, cooperative farms and joint stock companies make up an important share in East Germany.

The East German agriculture is characterized by large-scale production structures. These structures have their origin in the domains of the late middle age. However, it was enforced after the Second World War when cooperatives were created with an average acreage of 4,528 ha in the former GDR (Stat. Ämter, 2010). During the transition process in the 1990s the majority of cooperatives were transferred into large scale successor organizations like *de novo* cooperatives and joint stock companies. At present the agricultural structure is characterized by farm sizes on average of 226 ha in East Germany compared with 55 ha in West Germany. In Brandenburg about 45% of the agricultural area in use is cultivated by 6,4% of the farms, each with an acreage of at least 1000 ha (MIL, 2012)). On average 1.8 labor units per hectare are employed.

Fig. Mean field size of about 20 ha and more is typical for large-scale farming in Brandenburg.

With regard to farming type specialization on grazing livestock prevails at German scale (43% of all farms) concentrated in more humid regions of West Germany and of the Central Uplands. Specialized field crop farms (25%) are situated mainly in favoured regions. Mixed crop-livestock farms (15%) are of lower significance, but made up 25% in the Brandenburg state.

The share of ecological farms differs widely depending on funding conditions, natural conditions and on missing agrarian alternatives (Stat. Ämter, 2010). In Brandenburg the percentage of ecological farms of about 12% is relatively high compared with 6% German wide.

Company's portrait

The Cooperative Farm Trebbin, AGT (Agrargenossenschaft Trebbin eG), with acreage of 4,100 ha, is among the largest farms in Brandenburg. It was established as de novo cooperative in 1990 after the merging of five farm cooperatives formed in the former GDR. Since then the farm has operated as mixed crop-livestock farm. Beside the agricultural production a modern agricultural service enterprise and a 1.85 MW (megawatt) biogas plant belong to the cooperative.

AGT is located about 60 km southwest of Berlin in a typical glacially formed landscape. The area under cultivation comprises a broad range of different habitats from swamps and ground water influenced sites, via extremely low-yielding dry and sandy soils to relatively good loamy soils. On average, the agricultural productivity of soils farmed by AGT is rather low (Soil Assessment Rating: average of agricultural land 23 points, of grassland 27 points). Sites influenced by ground water are drained, and parts of the mineral soils are irrigated.

The varying sites are cultivated differentially. Altogether, AGT cultivates 2,872 ha of arable land (70% of the land use size) and 1,268 ha of grassland (30% of the land use size). The most important crops are grain (42% of the area), there of predominantly winter rye, winter barley and triticale, as well as silage maize (30%) and canola (14%). Grain and canola are the main market crops; fodder crops (gras, maize, lucerne) are used as grass-maize-silage and lucerne silage for feeding the dairy livestock. Additionally, grass-maize silage is used as substrate for biogas production.

The livestock amounts to 2,100 animals, which corresponds to 0.47 heads ha^{-1} land use area. Dairy cows make up 20% of the livestock with a yearly production rate of more than 10,000 kg milk (4.03% fat, 3.45% protein). The accruing slurry together with maize and grass silage is used in the biogas plant. The remaining digestate is the major component of the organic fertilization, therefore significant amounts of nutrients remain on-site, and in the intra-farm nutrient cycle.

Overall, due to the farm size and diverse cultivation, AGT is characterised by relatively high yield stability, a profitable combination of animal and plant production, and an effective operation of the biogas plant.

Further Information: www.agt-eg.de

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