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Landesamt für Landwirtschaft und Ländlichen Raum

Comparison of the soil moisture exhaustion of a loess soil in a lysimeter and in a field

Steffi Knoblauch

Cause and aim of the presentation

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- Long-term series of measurements of the soil water balance are important in order to recognize the effects of climatic conditions, vegetation and intensity of soil use
- Lysimeters are containers that are closed at the bottom and at the sides.
- If the depth is not sufficient, the influence of increasing drought on the site's soil water supply will not be properly reflected.
- In order to find out to what extent the soil water dynamics of the soil of the lysimeters correspond to those of the soil in the field, the soil moisture was determined at both sites in parallel.
- In the following, an evaluation of these measurement series is carried out for the period from 2010 to 2019.

Methods

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Neutron probe for measuring soil moisture

- weekly during the growing season
- in 20 cm depth increments up to a depth of 240 cm (15, 30, 50, 70, 90, 110, … 230 cm)
- one access tube per lysimeter in two lysimeter of a variant = two replicates
- two access tubes per measuring point in the field = two replicates

Methods

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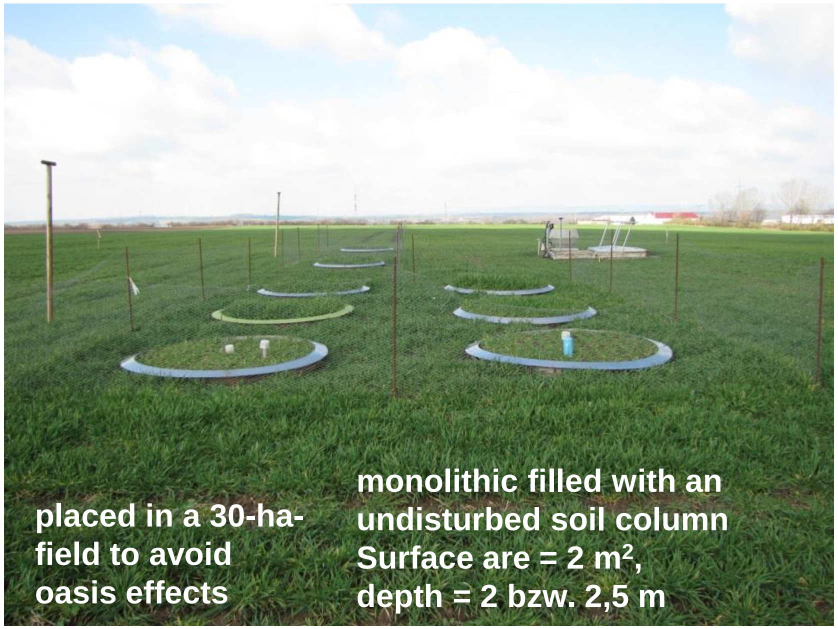

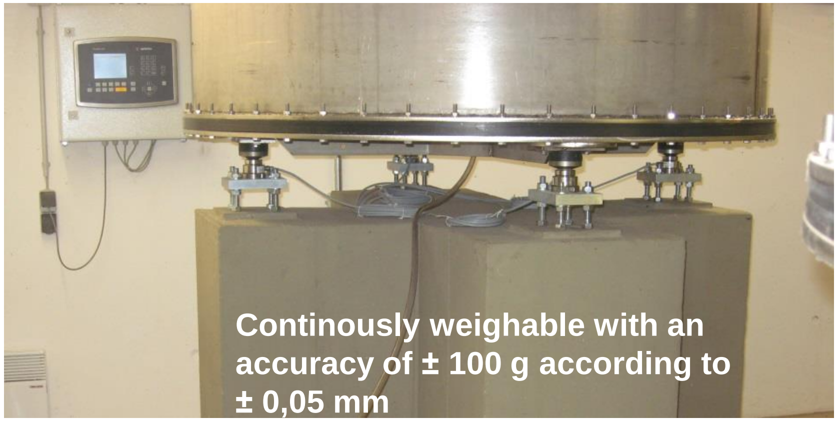

Lysimeter Buttelstedt for measuring soil water balance, evapotranspiration, evaporation, seepage rate and nutrient leaching

two lysimeter cellars, each of them with eight weighable lysimeters

Soil water collection with suction cups (loess) and gravimetric via a filter consisting of sandy and silty quartz

Measurement of soil moisture using a neutron probe, one access tube per lysimeter in two lysimeters of a variant

Sites of the soil moisture measurements

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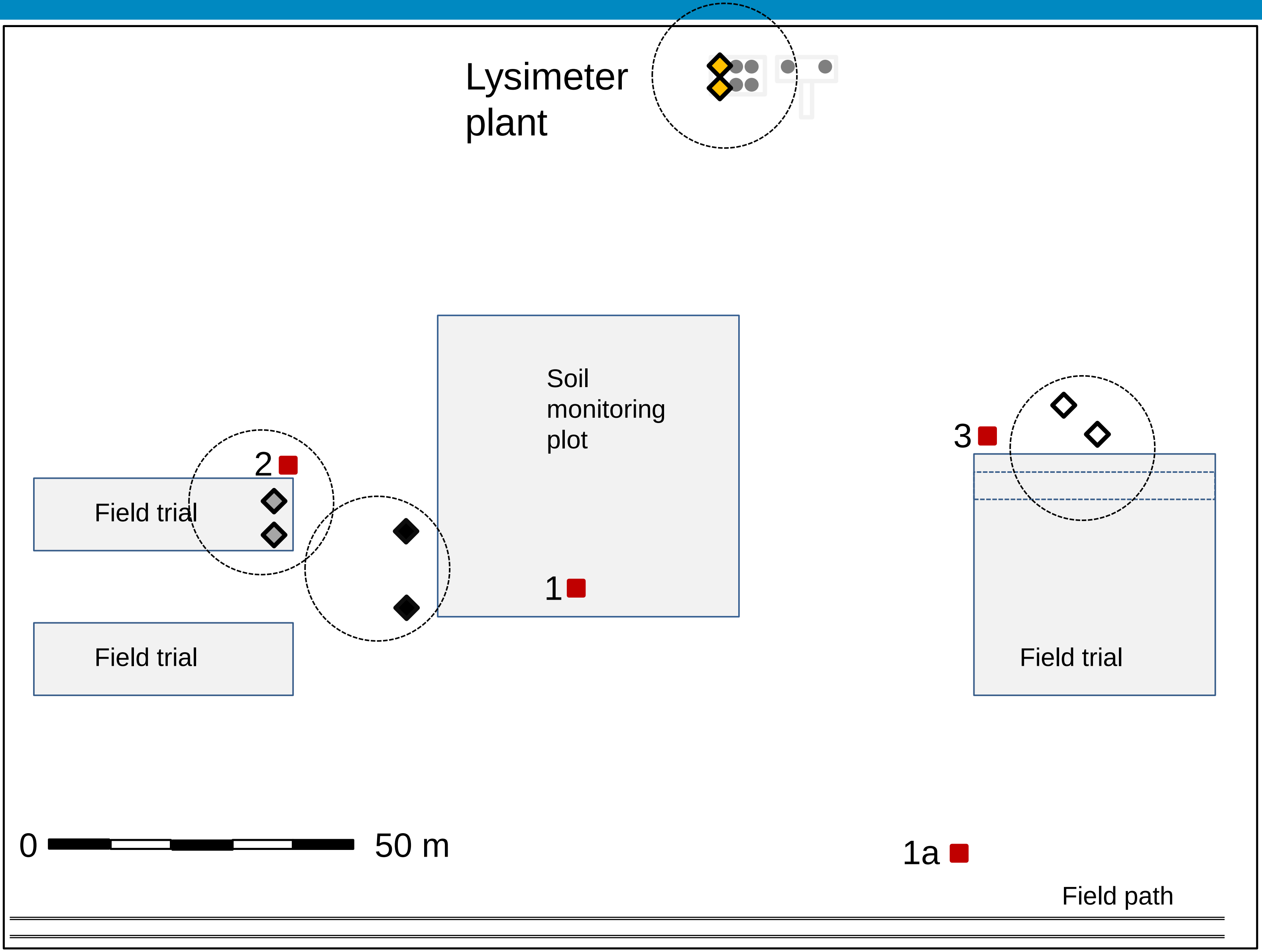

Measuring points of the neutron probe

Soil profiles

1, 1a, 2, 3,

Change in soil water supply measured with the neutron probe and the lysimeter

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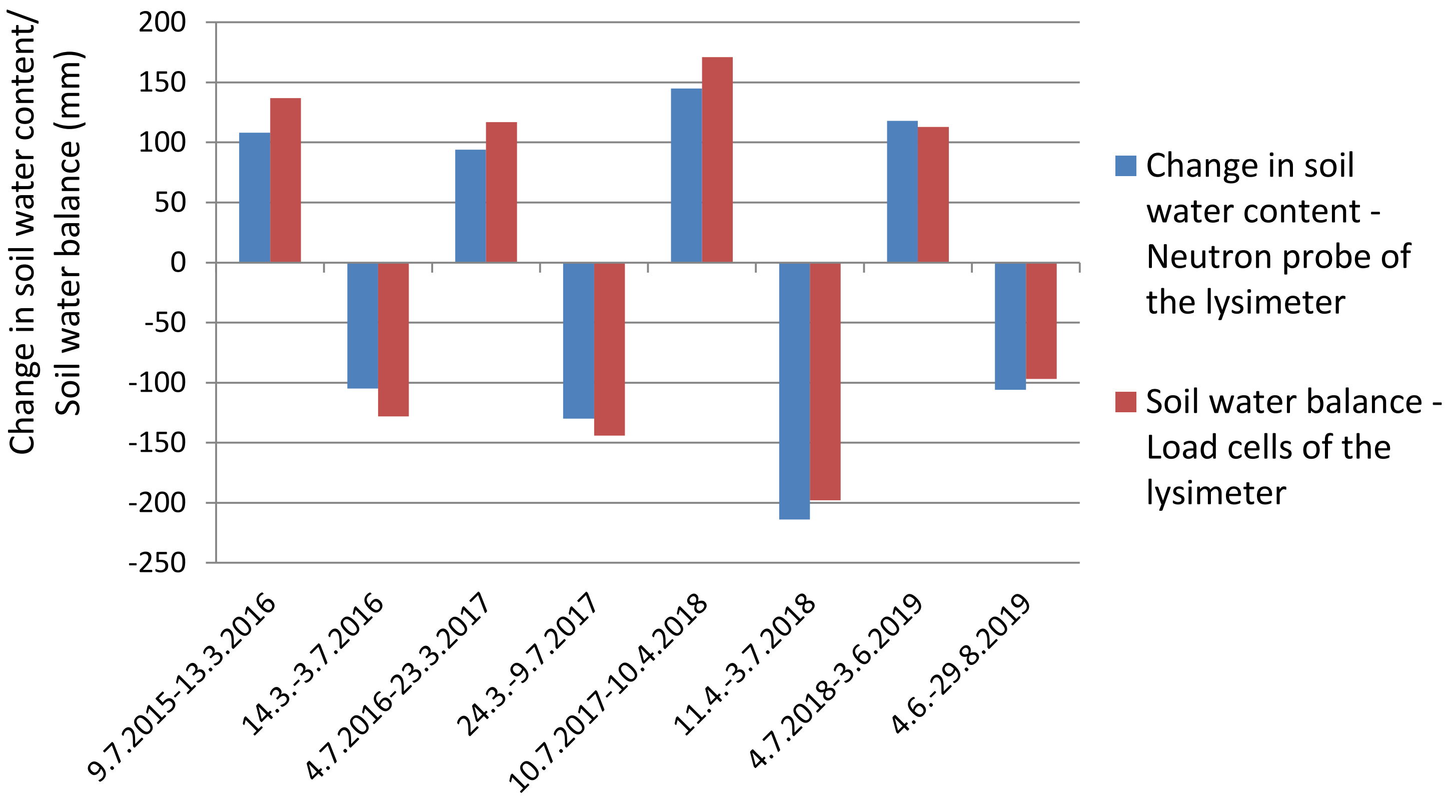


- during winter half-year (after harvest to start of vegetation) the increase is underestimated by the neutron probe by **-0.07 mm/d**
- during growing season (start of vegetation to harvest) the decrease is overestimated or underestimated by **+/- 0.15 mm/d** .
- This shows the suitability of the neutron probe for measuring soil moisture.

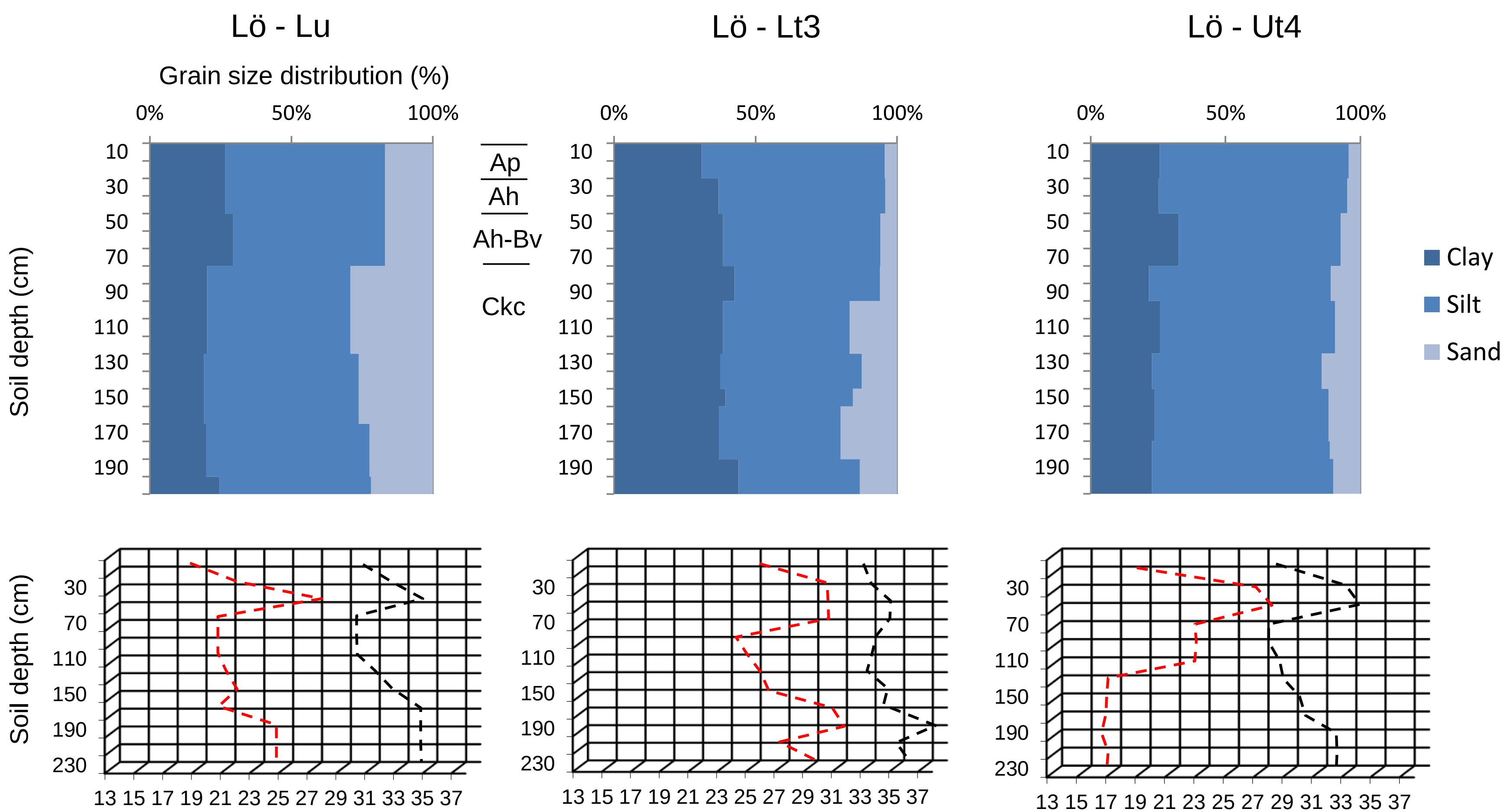
Soil characteristics

Haplic Phaeozem (Loess)

depth	horizon	grain size distribution	clay content	stone content	AWC¹ 0,3 bar	AWC² 0,3 bar	Corg
cm			%	%	Vol.%	mm	%
0…43	Ap/Ah	Lu	27	0	12	230	1,7/ 1,2
…65	Ah-Bv	Lu	29	0	7		0,8
…200	Ckc1…3	Lu	19…23	2…8	10		0,2…0,4

AWC¹…plant available water content in Vol.%, AWC²…plant available water capacity in effective rooting depth

Soil characteristics



Soil water content at the permanent wilting point - - - and at the field capacity (0,3 bar) - - - (Vol.%)

Climate and Weather

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- Climate

	Longtime Precipitation (mm/a)	Longtime Air temperature (°C)
1981 bis 2010	535	9,0

- Weather in 2010 to 2019

Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Precipitation	% of the longtime average	114	78	90	105	94	86	93	107	72	81
Air Temperature	°C of the longtime average	-1,7	+0,2	-0,2	-0,8	+0,9	+0,7	+0,3	+0,3	+1,0	+1,0

Plants, Seepage rate and Soil water deficit (Lysimeter trial)

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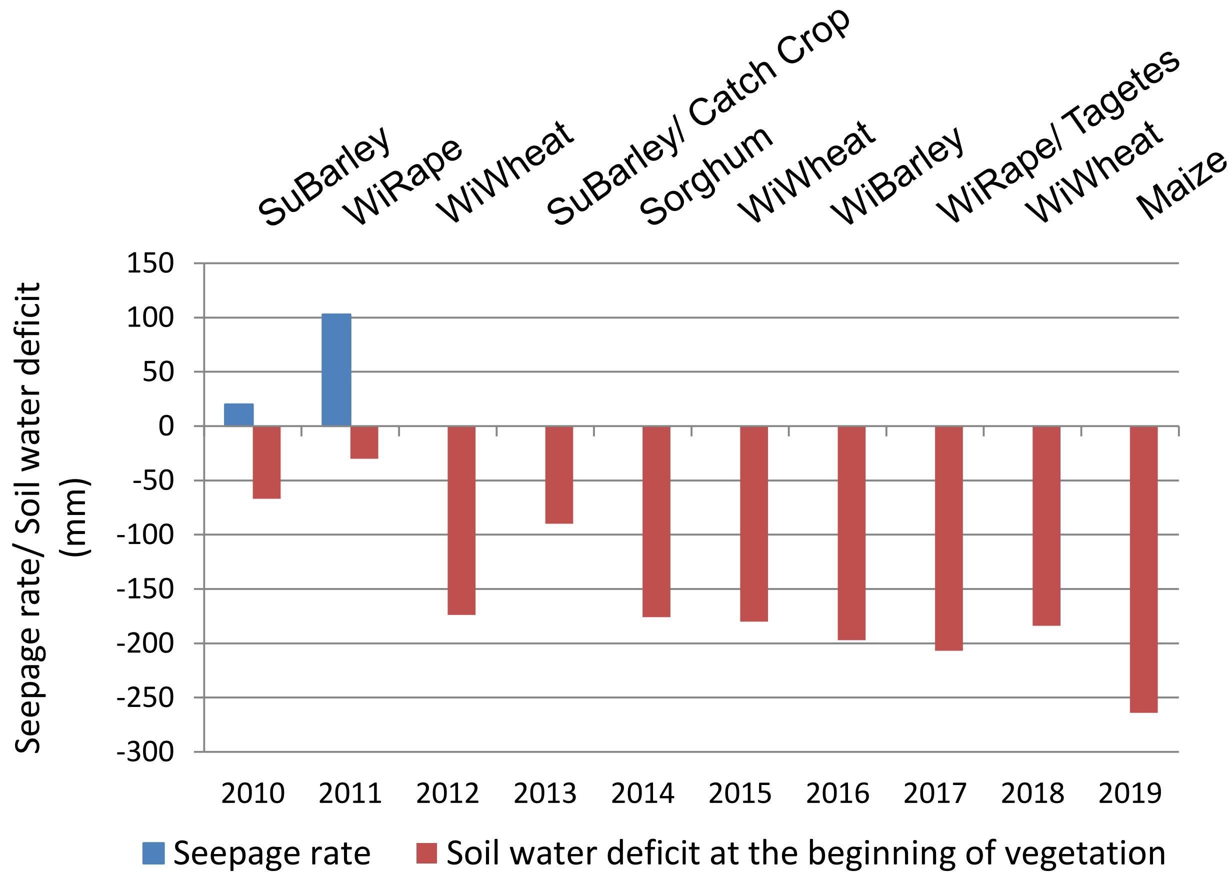

After above-average precipitation in 2010, the soil water supply is almost completely filled by spring 2011 and seepage water escapes. This no longer happens in the following eight years.

Change in soil water supply in the lysimeter and in the field during the growing season

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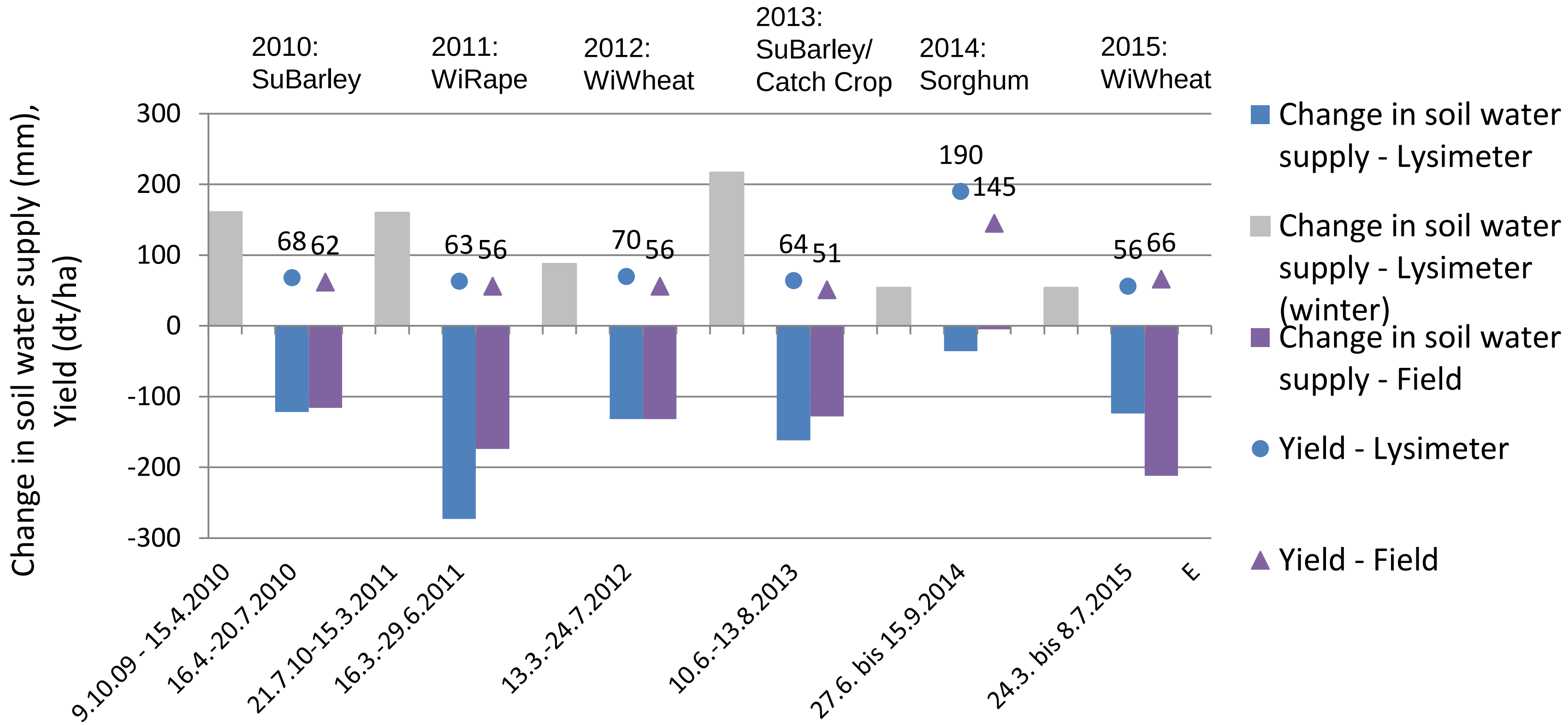


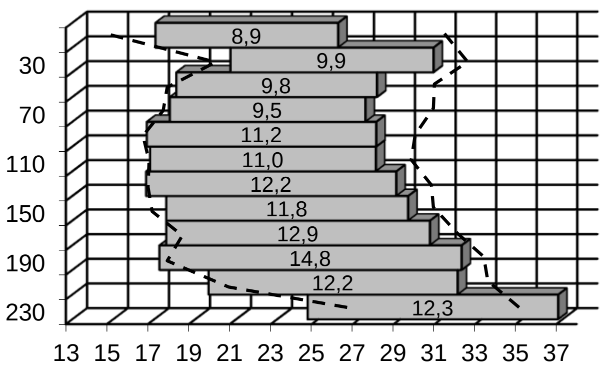
In most cases, soil moisture extraction on the lysimeter was slightly higher than in the field, with higher yields in each case, except in 2015.

Layer-by-layer soil moisture extraction of the soil in the lysimeter and in the field

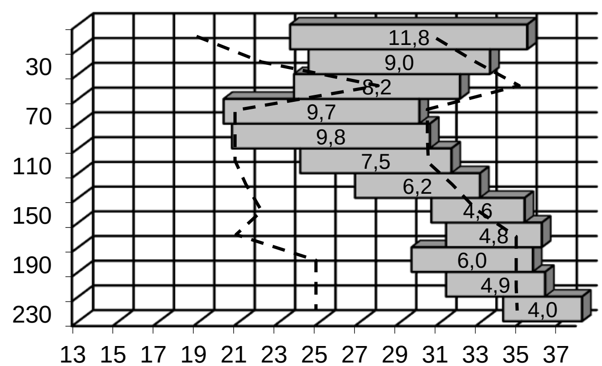
Lysimeter

Field

Winterrape 2011, lö-Lys, 63 dt/ha

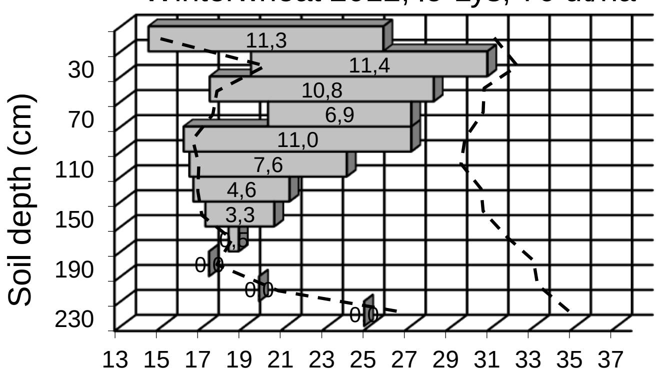


Winterrape 2011, lö-**Lu**, 56 dt/ha

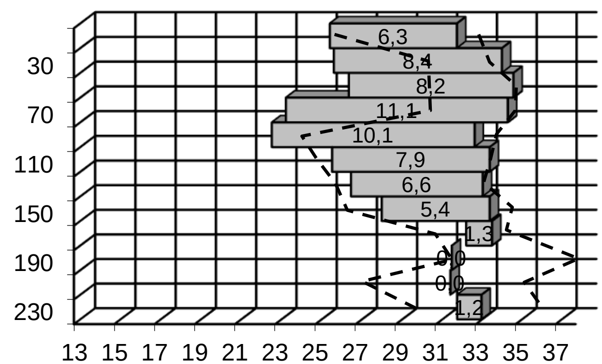


The differences in soil water extraction and yield seem to be mainly related to differences in the soil water characteristics of the loess soils in the lysimeter and in the field.

Winterwheat 2012, lö-Lys, 70 dt/ha



Winterwheat 2012, lö-**Lt3**, 56 dt/ha



Change in soil water supply in the lysimeter and in the field during the growing season

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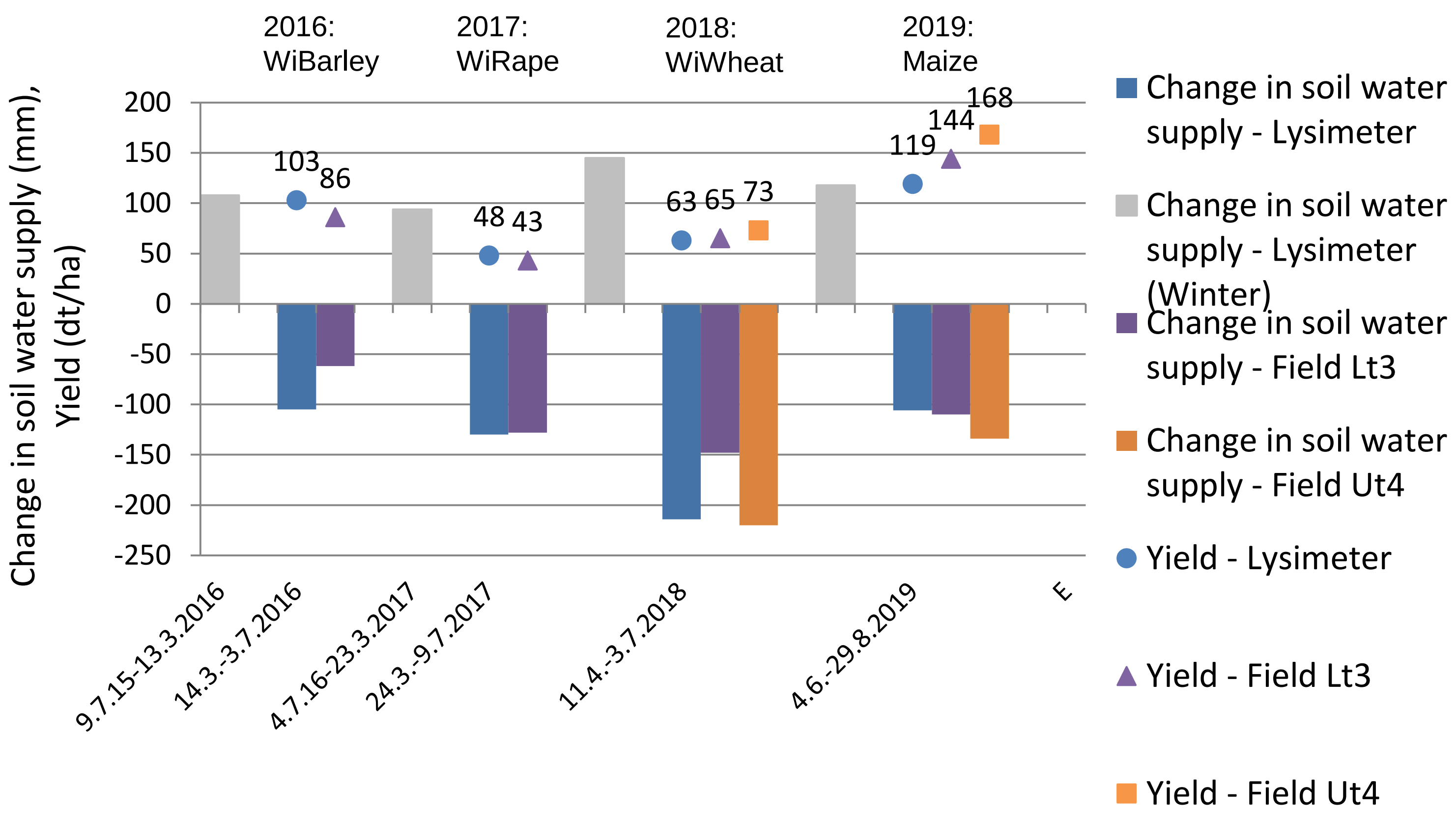

From 2018, a further measuring point (Lö-Ut4) will be added in the field.

Layer-by-layer soil moisture extraction on the lysimeter and in the field

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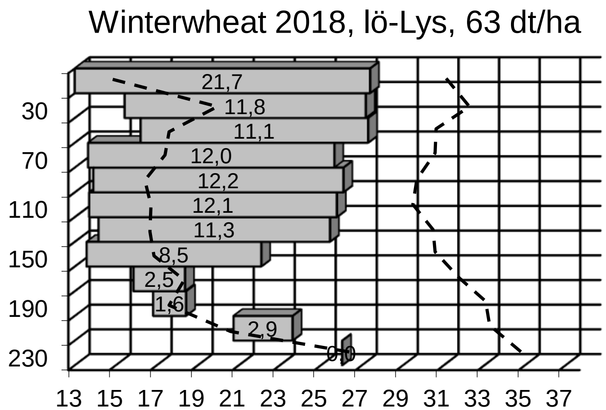
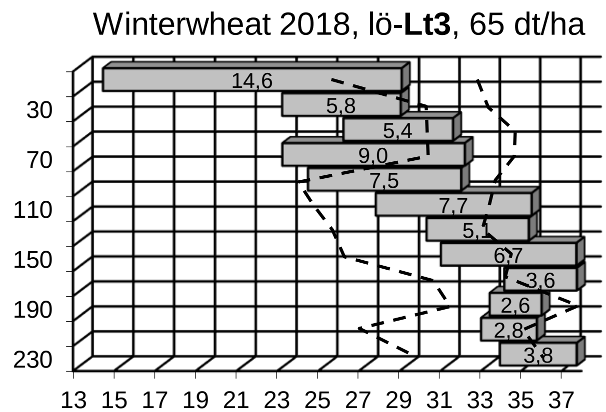
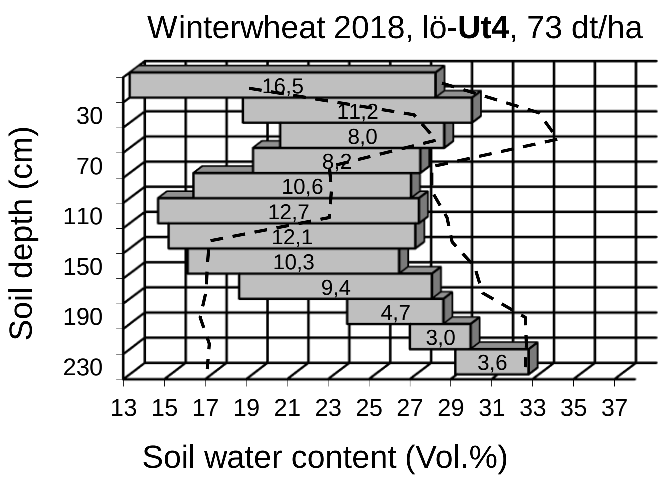
Lysimeter



Field





The soil water characteristics of the soil lö-Ut4 seem to be close to those of the lysimeter soil.

The lower yield on the lysimeters in 2018 and 2019 compared to the field monitoring sites is due to the lower soil water supply at the beginning of vegetation.

Additional consumption of soil water by the catch crop Tagetes on the lysimeter compared to shallow tillage

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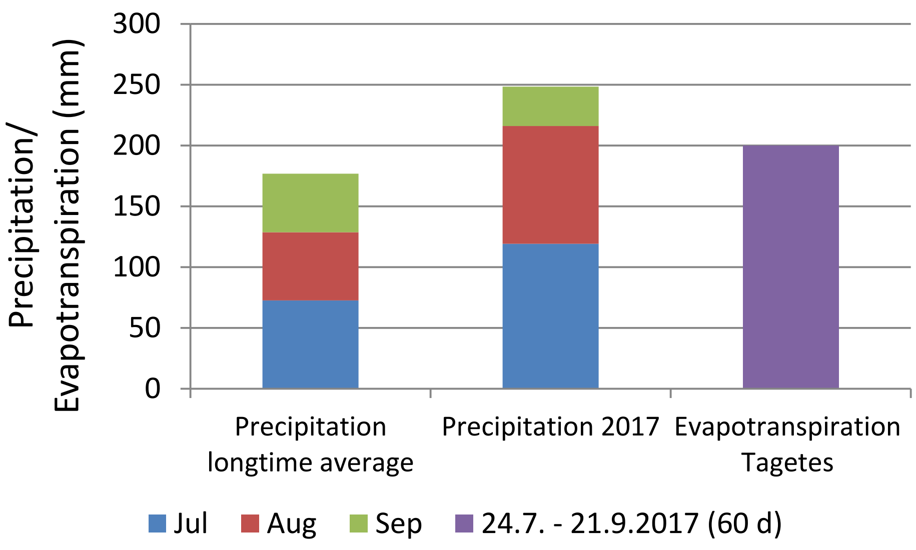
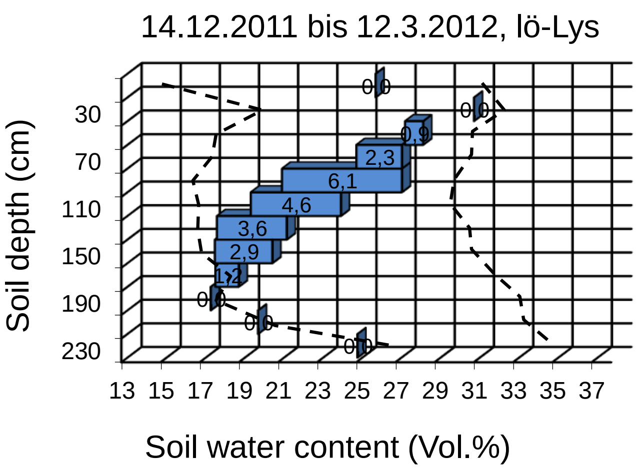


Precipitation longtime average in July/August	Precipitation 2017 in July/August	ET Tagetes 24.7.-21.9.2017 (60 d)	Evaporation shallow tillage 13.7.-17.8.2016	Additional consumption of soil water by Tagetes compared to shallow tillage	
mm/d	mm/d	mm/d	mm/d	mm/d	mm (60 d)
2,1	3,5	3,3	1,4	1,9	114

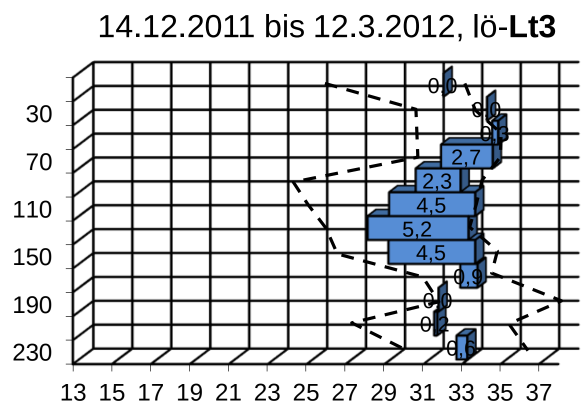
The cultivation of Tagetes on the lysimeters reduced the soil water supply for the following crop by about 114 mm.

Layer-by-layer soil moisture increase of the soil in the lysimeter and in the field during the winter-half year

Lysimeter



Field



A small capillary rise of 0.6 Vol.% at a depth of 220 to 240 cm occurred in the field, but not in the soil of the lysimeter. This question needs to be monitored further.

Summary

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- In most cases, soil water extraction on the lysimeter was slightly higher than in the field, associated with slightly higher yields.
- This is mainly due to differences in the soil water characteristics of the loess soil of the lysimeters and the surrounding field.
- The assumption of a homogeneous distribution of the grain size composition of the loess soil in the area could not be confirmed.

- In the last dry years 2018 and 2019, the yields and partly the soil water extraction on the lysimeter are lower than in the field. The reason for this is the cultivation of the catch crop only on the lysimeters. Due to this measure, the soil water supply was 114 mm lower in the following spring.

- Against the background of decreasing precipitation, the observation of soil water use in the field can be useful if the depth of the lysimeters is no longer sufficient to allow the effect of deeper rooting of the soil on the soil water balance to be seen.

- However, lysimeters have the decisive advantage of being able to precisely quantify the effect of vegetation and management measures (tillage, type and intensity of fertilisation, etc.) on the soil water supply.

Thank you for your attention