Euroopa Maaelu Arengu Põllumajandusfond: Euroopa investeeringud maapiirkondadesse

Focusing on heterogeneity of arable land: experience on Bavarian sites and some thoughts for better yields and quality

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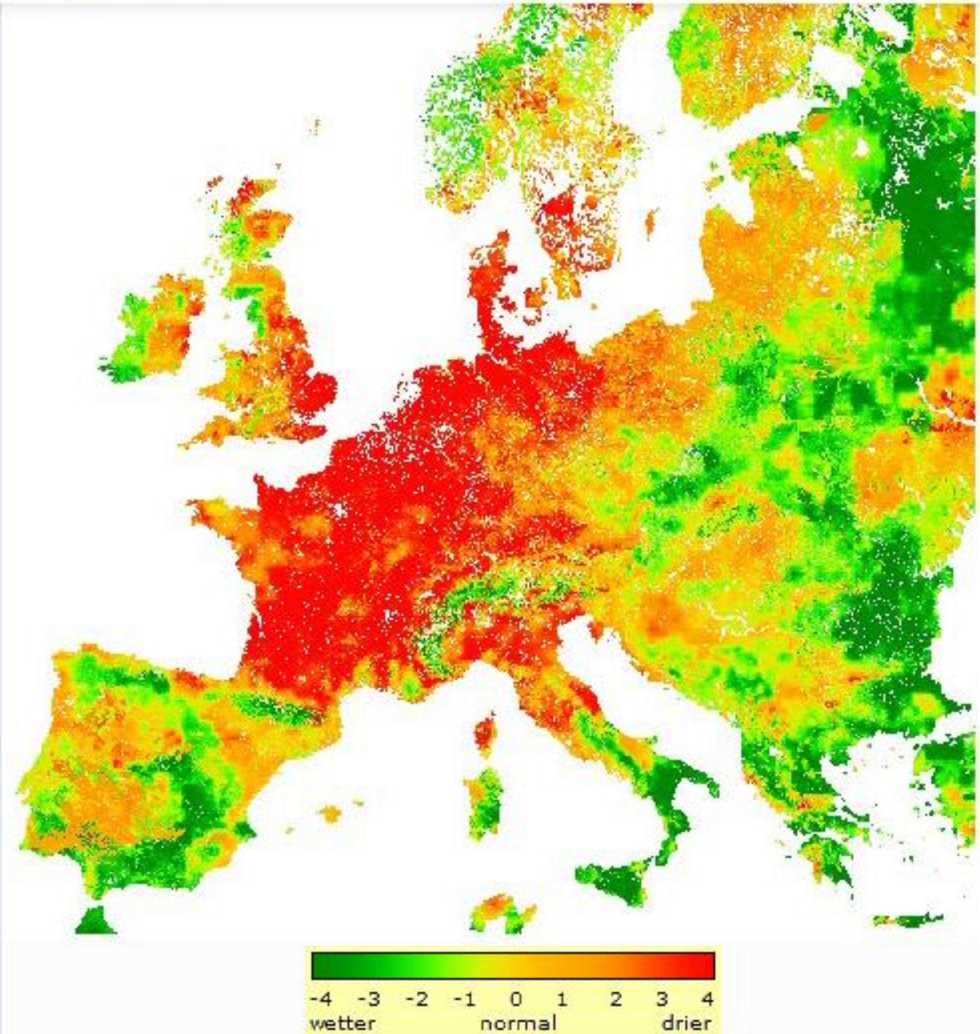
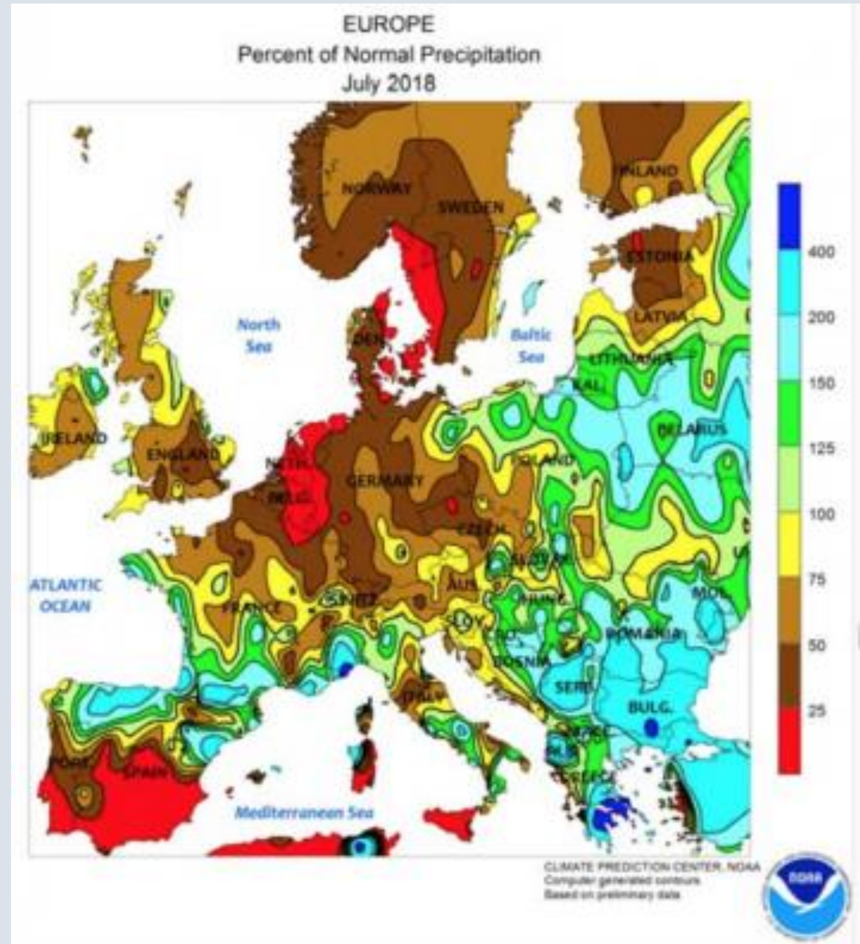




Soils across the heart of western and northern Europe are far drier than usual, as indicated in this graphic showing conditions on 10 May 2011. The anomalies are calculated by comparing daily soil moisture data from the European Commission to a 15-year record. (Image courtesy European Droug

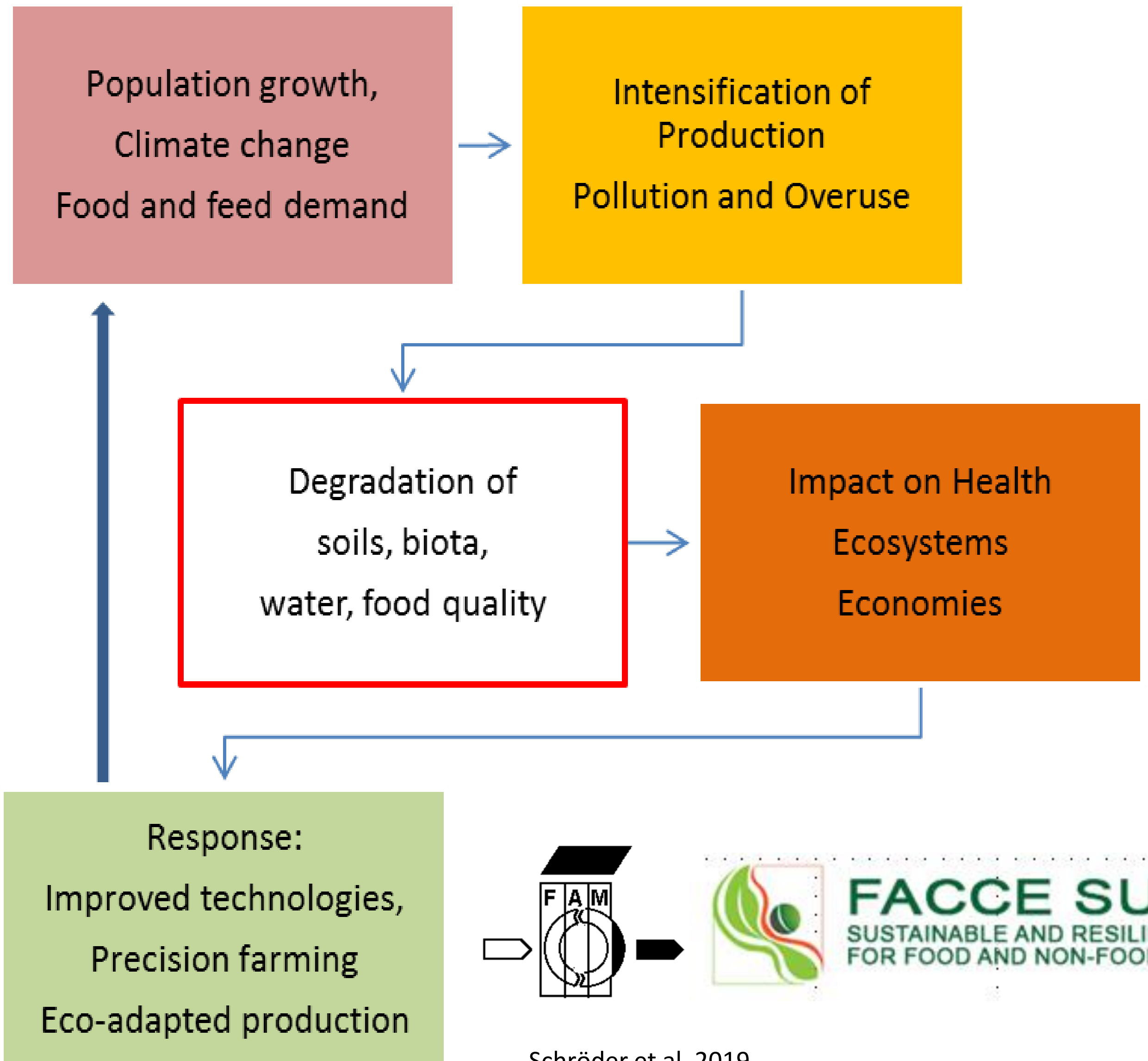
REUTERS

SUSTAINABILITY

Only 60 Years of Farming Left If Soil Degradation Continues

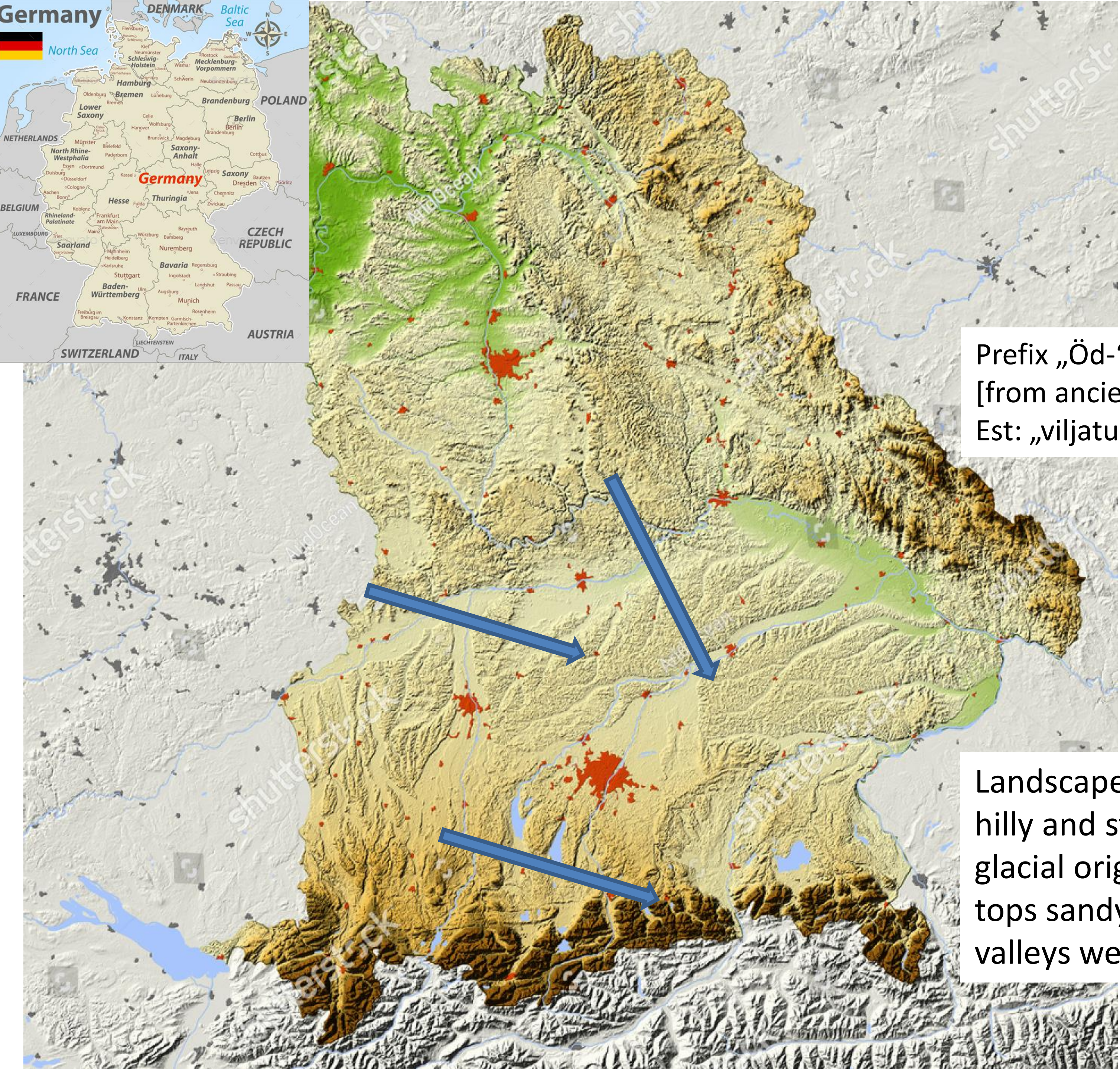
Generating three centimeters of top soil takes 1,000 years, and if current rates of degradation continue all of the world's top soil could be gone within 60 years, a senior UN official said

Adapting the pressure-state –response scheme to our problem



FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Schröder et al. 2019



Study sites:

-Scheyern
-Ödberg-Ostin
-Ödwiesen-Weichs

Prefix „Öd-“:
[from ancient German: „poor“]
Est: „viljatu“

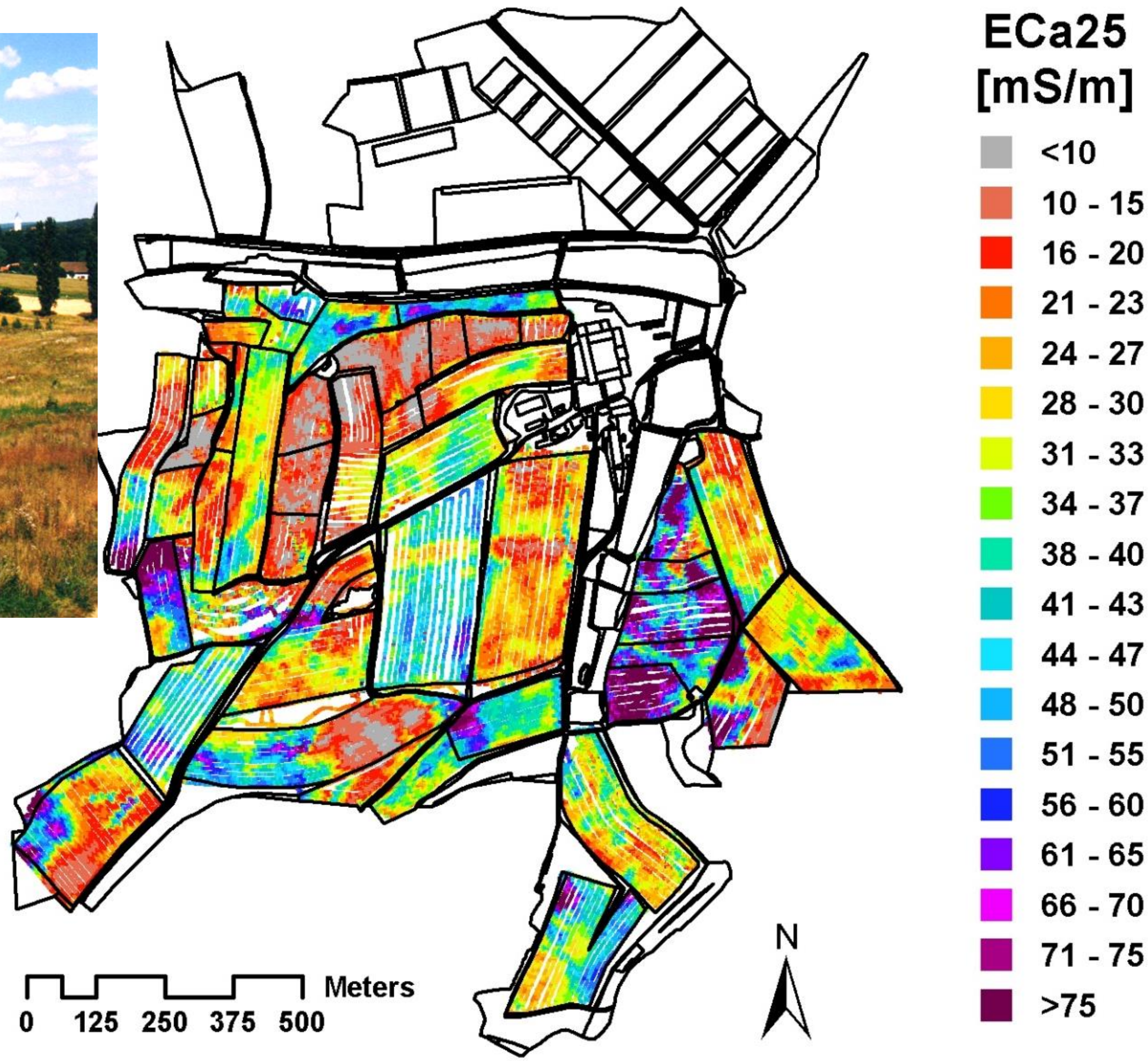
Landscape formed by ice age:
hilly and steep slopes,
glacial origin,
tops sandy, eroded,
valleys wet, loamy, colluvia

Ödberg-Weichs, P. Schröder

Ödwiesen-Ostin, P. Schröder

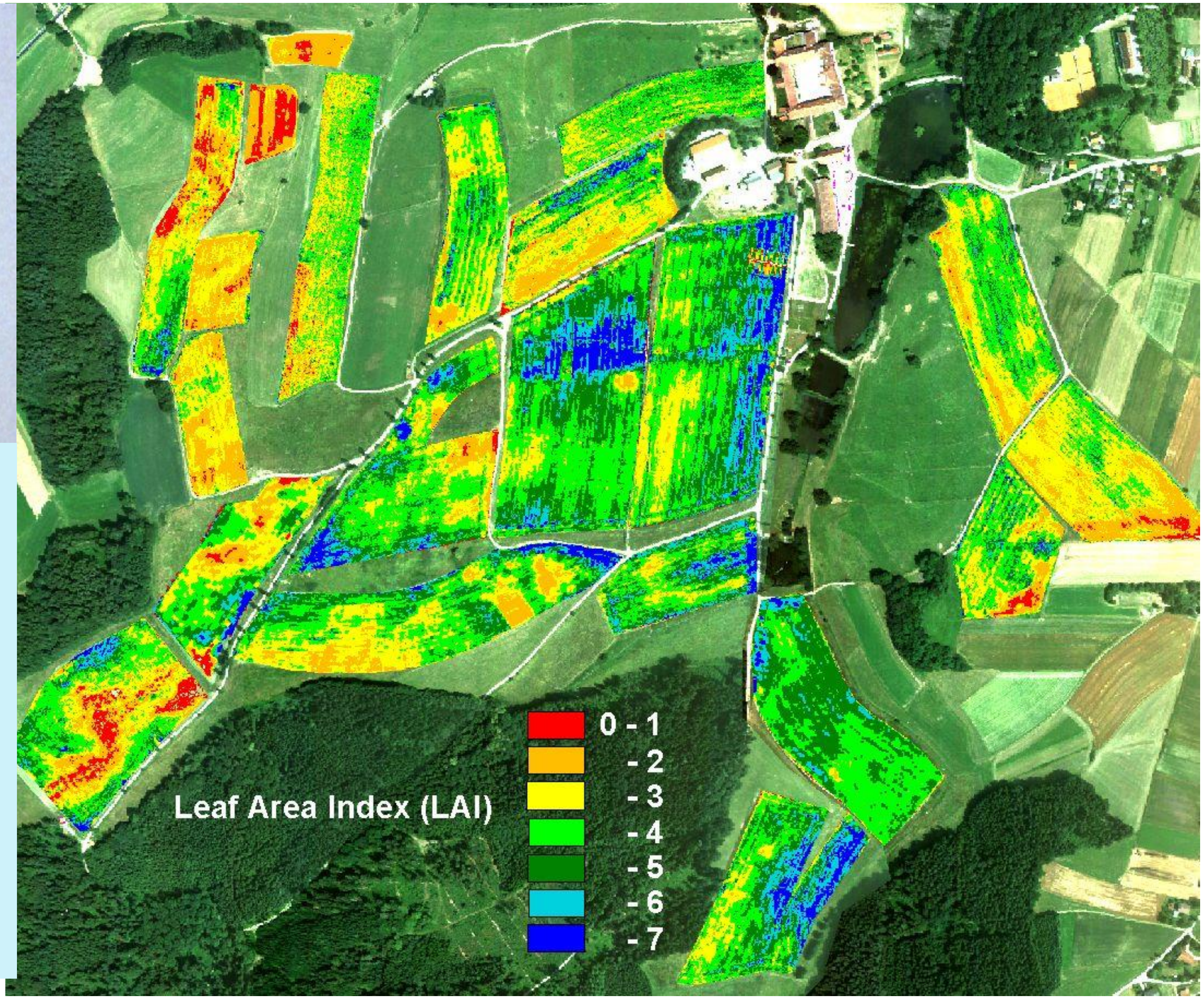
Scheyern, G. Gerl

Field capacity in heterogeneous landscapes



Remote sensing

- Optical scanner in plane
- Determining leaf area index,measure of plant dry weight
- huge spacial variability
- Hypothesis 1: „Plant status mirrors soil condition“
- Hypothesis 2: adapted plants give better yields



FAM - Research Station Scheyern

Grassed water way: infiltration

Reducing water and soil loss from the field

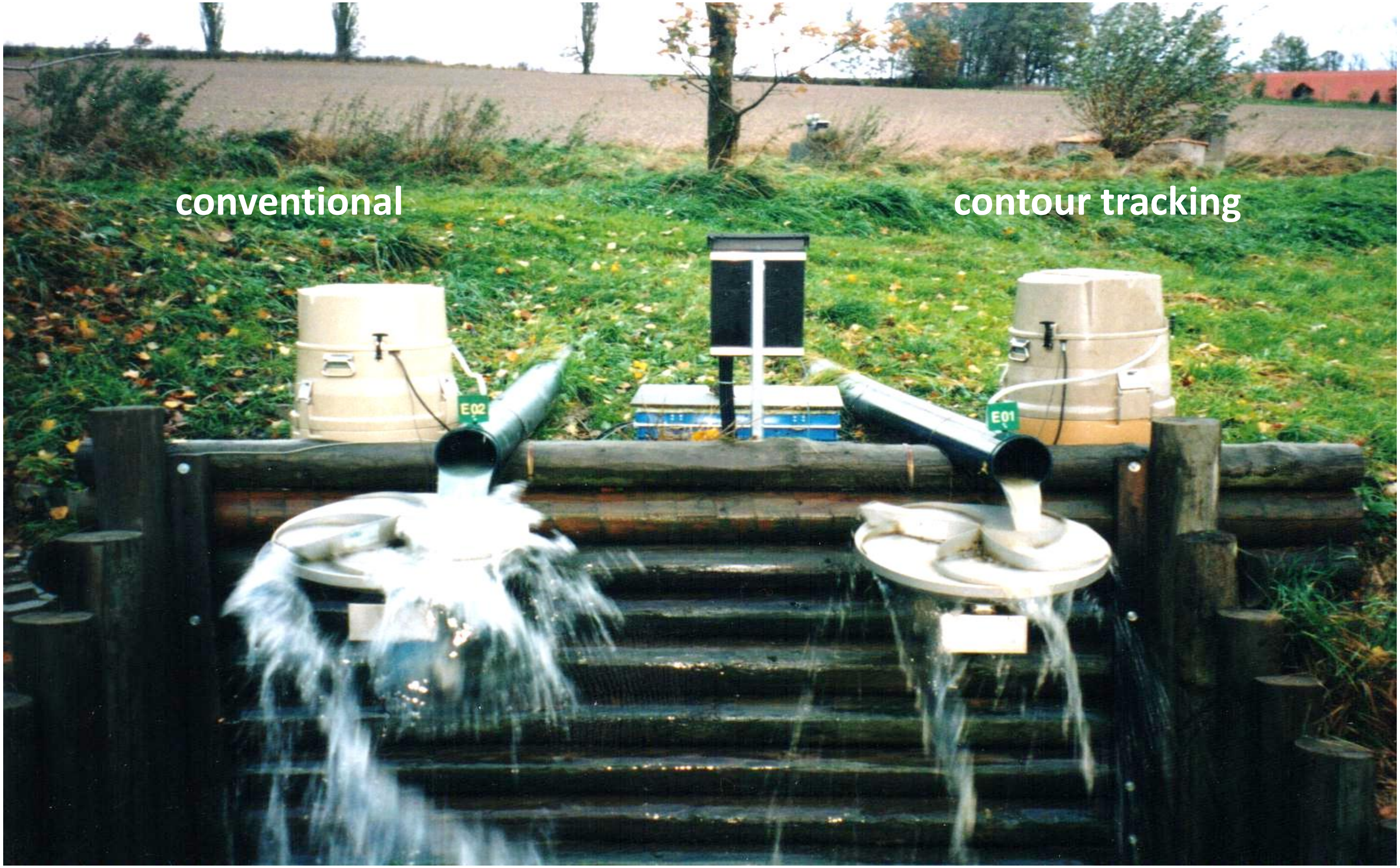
Scheyern, G. Gerl

FAM - Research Station Scheyern

Stop erosion by contour farming

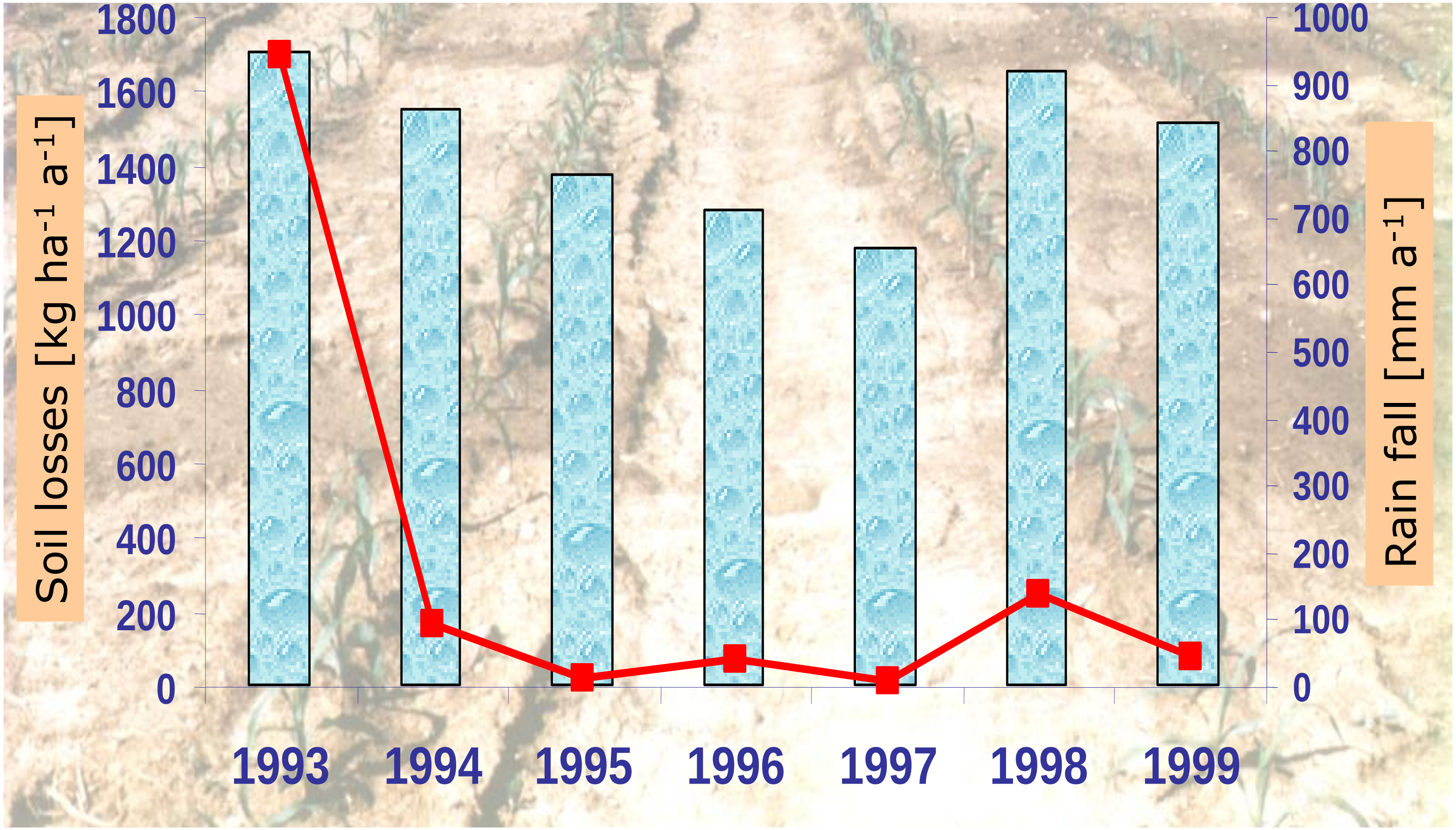
Scheyern, G. Gerl

Monitor surface runoff

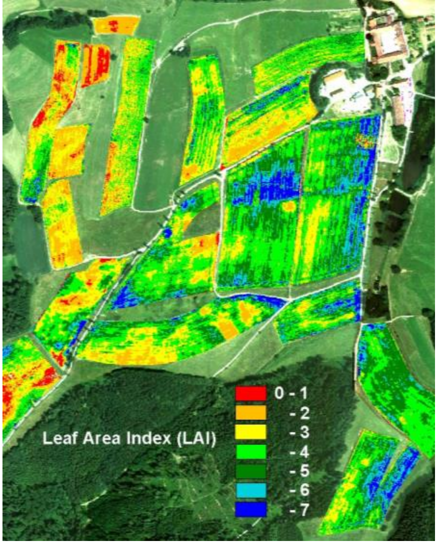


Scheyern, G. Gerl

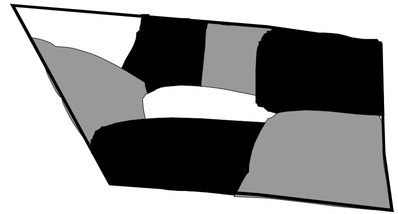
Suppress erosion by contour farming and reduced soil compaction

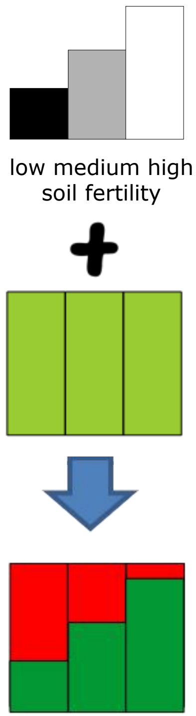


Coping with soil heterogeneity in field

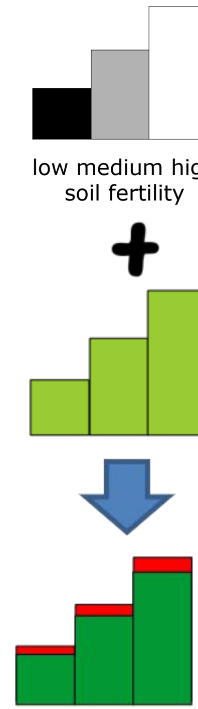


FORSCHUNGSVERBUND AGRARÖKOSYSTEME MÜNCHEN





Yield / loss

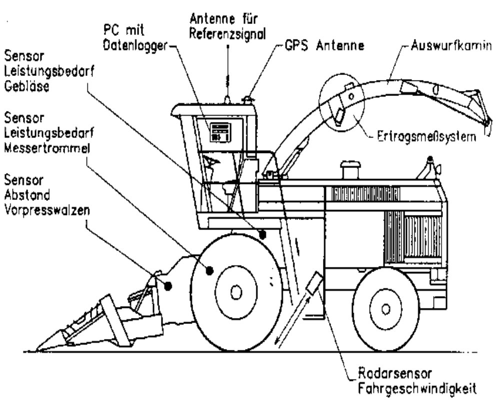


homogeneous

Management:
fertilizer, amendments, density

site adapted!

Partial area of field

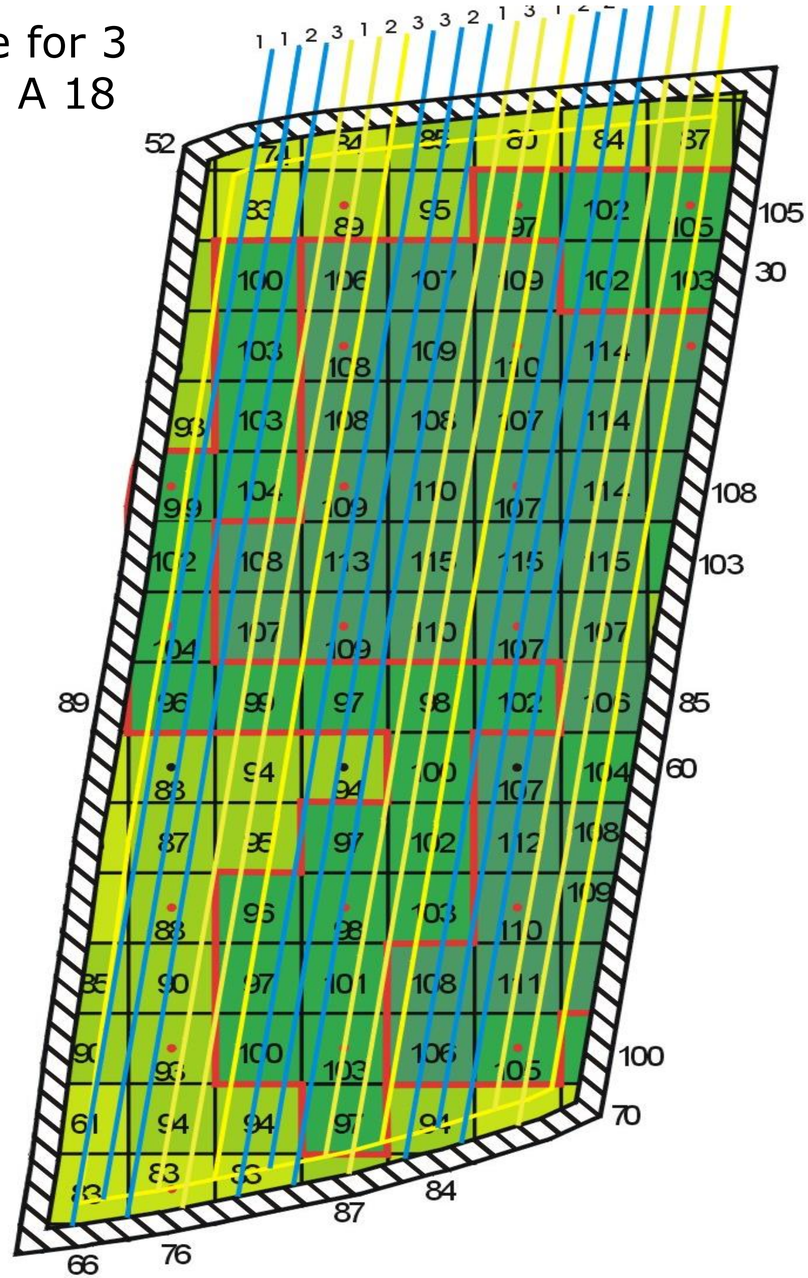


Yield structure for 3 years on field A 18

100 m

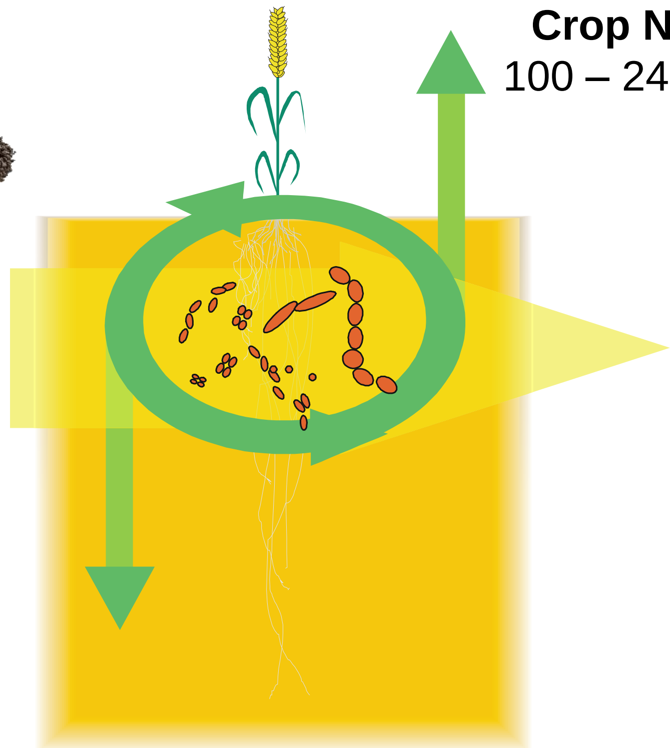
M 1 : 2000

1995 **winterwheat**
1996 **maize**
1997 **winterwheat**

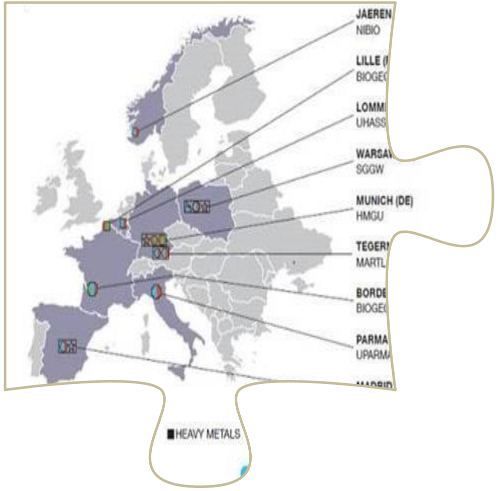


Yields < 85 % | 85 - 95 % | 96 - 105 % | 106 - 115 % | Yields > 115 %

Internal nutrient cycling has to be improved



Soil-Plant N-Loop and Immobilization by high C amendments reduce N-loss
Amendments increase water holding capacity



INTENSE

Central topic:
set aside marginal land

Conversion of grassland (1)

Broad bean (*Vicia faba* L.)

Step 1: Grassland (many species, weeds)

Step 2: Cultivation of *Vicia faba* L.

Step 3: Crop land (ploughing of plant residues)

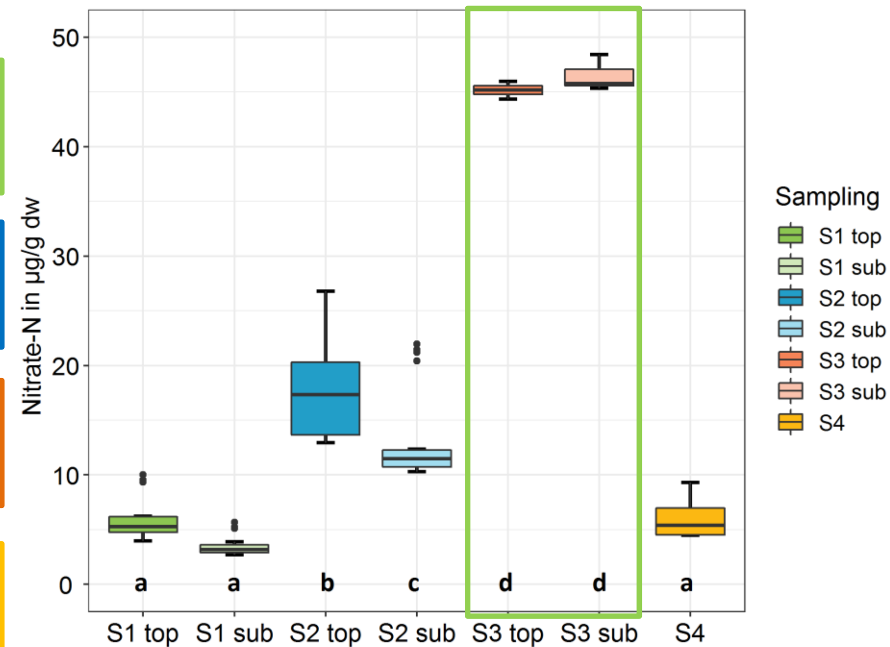
Control

S1: Initial grassland

S2: *Vicia faba* L.

S3: Plant residues

S4: Control grassland



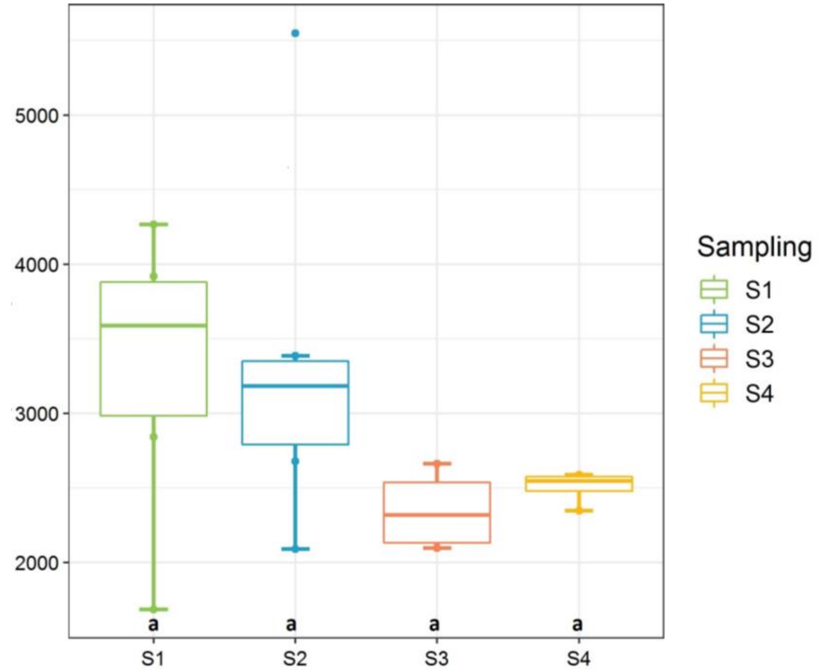
Nitrate-N [µg N g^{-1} *dw] at* 4 sampling times in 0-10cm and 10-30cm

-> Increased Nitrate-N: mineralization, N_2 fixation of *V. faba* L. and green manure incorporation

from 4 µg N g^{-1} *dw* to almost 50 µg N g^{-1} *dw* **-> 150 kg N/ha**

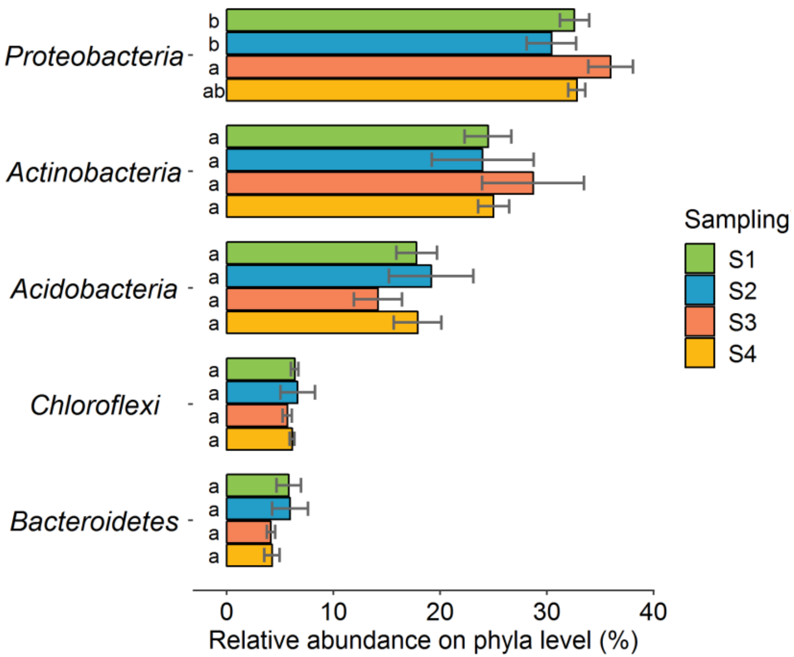
Conversion of grassland (2)

Bacterial richness:



Bacterial richness for the four sampling dates (**S1** – initial grassland (n=6), **S2** – Vicia faba (n=6), **S3** – plant residues (n=4) and **S4** – control grassland (n=4))

Bacterial abundance:



Mean **relative abundance** for the five most abundant **phyla** (16S-Amplicon sequences). Different letters indicate significant differences ($p<0.05$) calculated with multivariate ANOVA (Tukey's post-hoc)

- Bacterial richness did not change significantly
- Significant change on **phylum** level observed for ***Proteobacteria***

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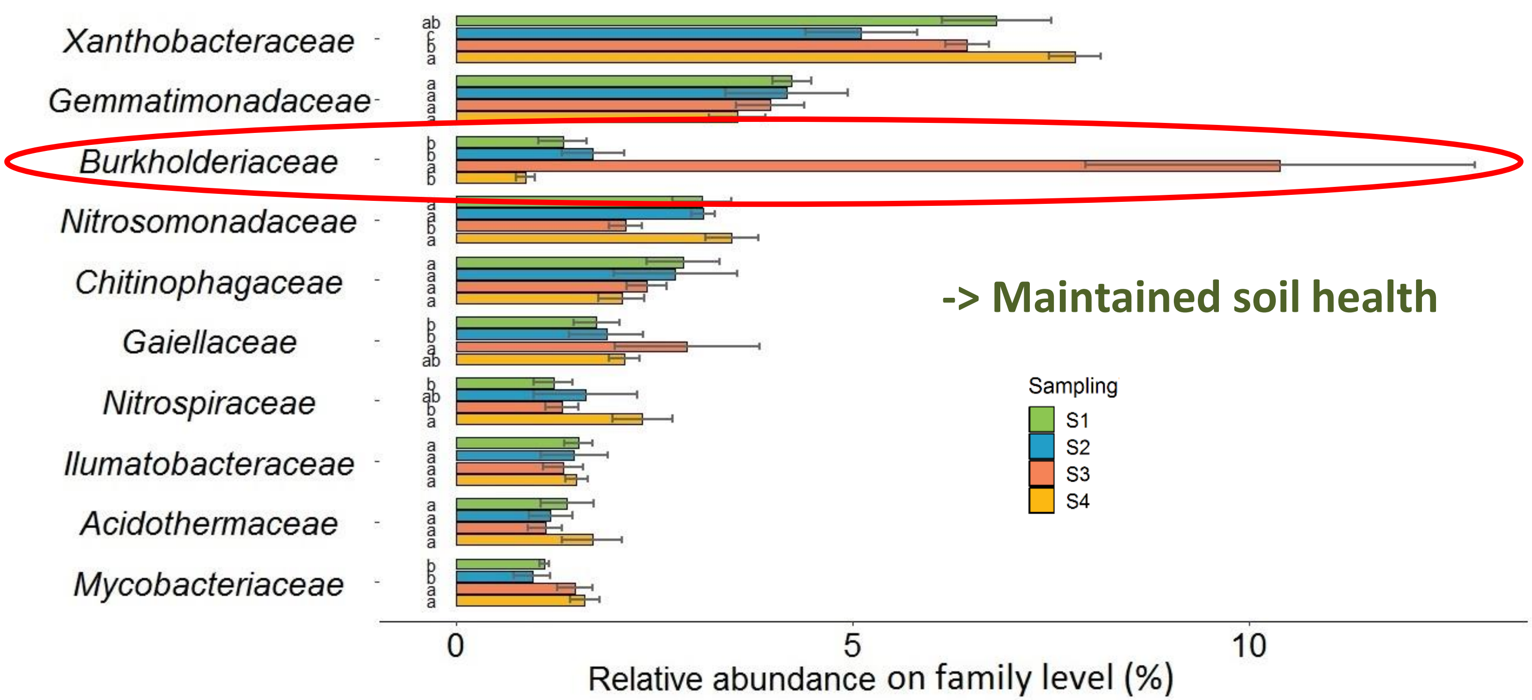
Conversion of grassland (3)

Bacterial abundance:



Broad bean (*Vicia faba* L.)

Mean **relative abundance** for the ten most abundant **families** (16S-Amplicon sequences). Different letters indicate significant differences ($p<0.05$) in multivariate ANOVA (Tukey's post-hoc).

- Most bacterial families remain constant
- Some **families** change significantly during conversion of grassland (S3) (e.g. *Burkholderiaceae* and *Gaiellaceae*)

-> genus ***Massilia* (*Burkholderiaceae*)** is main driver for this increase (plant-growth promoting rhizobacteria)

Field studies

INTENSE

Time series to examine the crop coverage

Barley
(*Hordeum vulgare* L.)

30.06.17 | 07.07.17 | 21.07.17 | 01.08.17

Crop coverage at Martlhof (Bavaria, Ge). Orthophotos by Sony α6000 on an octocopter (Airborne Robotics – XR6) at four sampling times (30.06.17; 07.07.17; 21.07.17 and 01.08.17).

Drone imagery is useful as

-> early marker for plant health
first idea of expected yields
indicator of weed problems

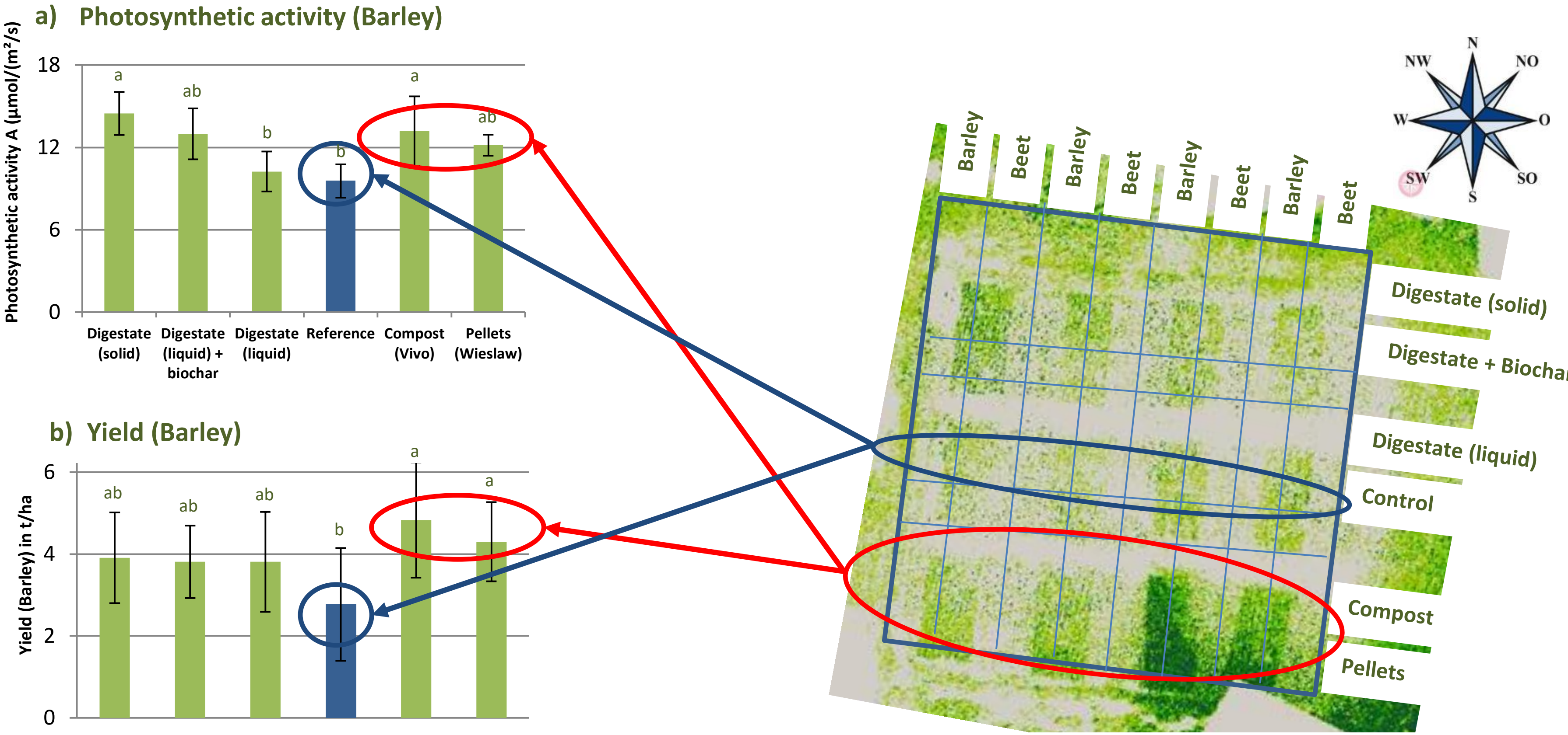
Moisture (TDR)	Barley	Beet	Grassland
Mean	35.2 %	31.4 %	44.7 %
Stabw	3.8 %	3.6 %	2.4 %

(01.08.17 - T_{mean} = 26.3 °C)

-> no significant differences between barley and beet plots
Grassland plots show higher water retention

Field studies

Correlation of plant performance (photosynthetic activity and yield) to remote sensing data (NDVI)



(a) photosynthetic activity (µmol/(m²/s)) measured with LCi-SD and **(b)** barley yield in t/ha

Normalized Difference Vegetation Index (NDVI) calculated from spectral responses of a TetraCam (ADCSnap) and a drone (Airborne Robotics XR6)

Inreased yield by 30 %

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Clues from the INTENSE project: combining innovations will increase crop performance and yields

French site (barley)

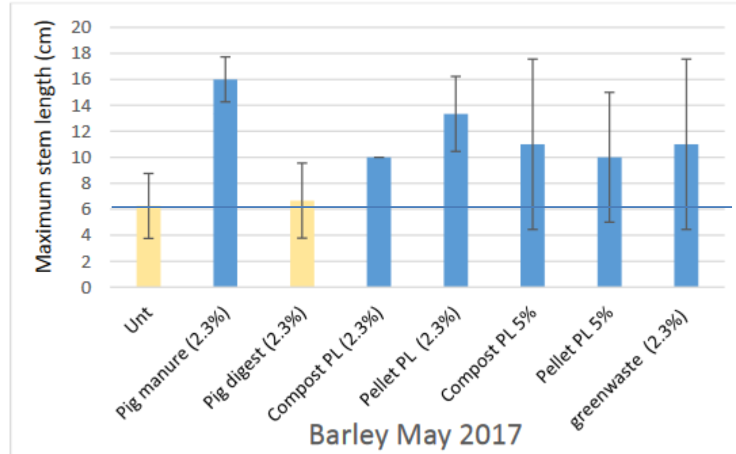
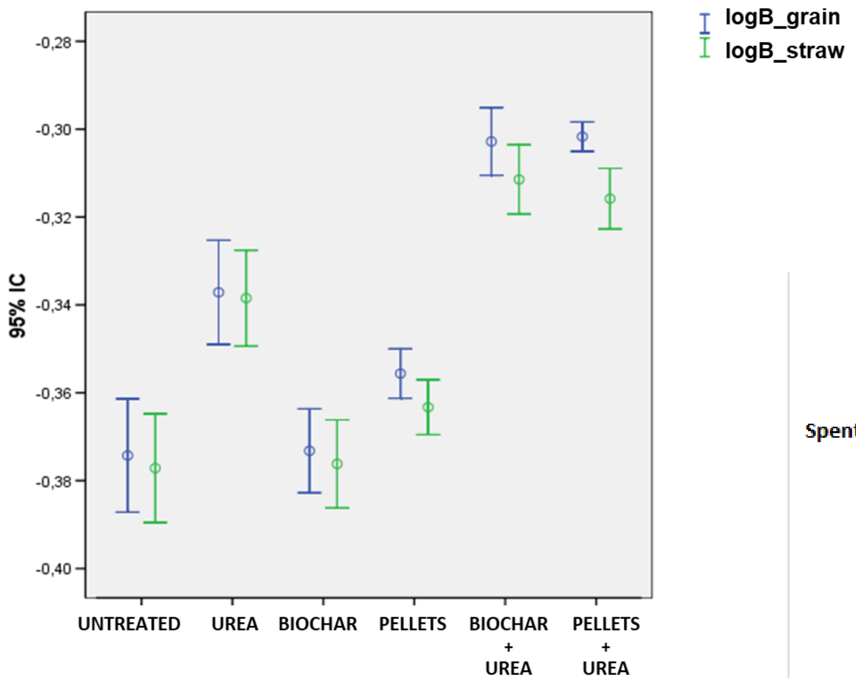
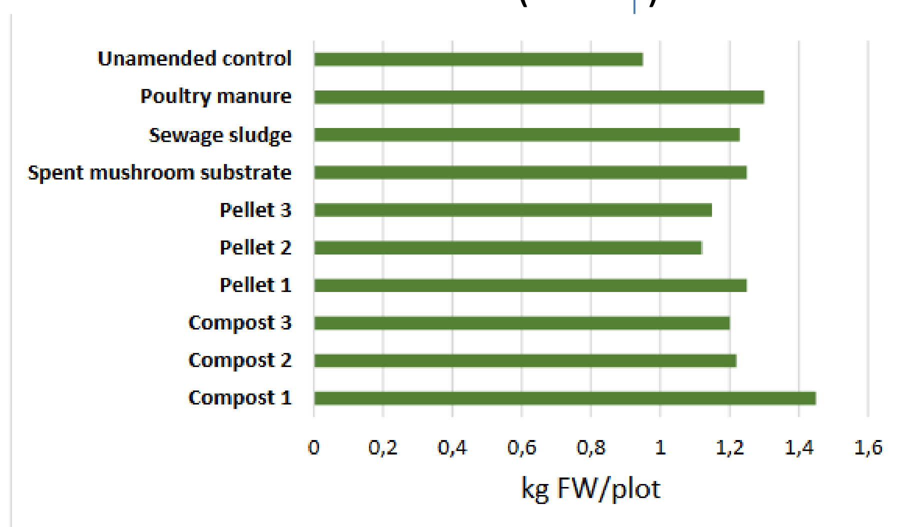


Fig. 12 Maximum stem height of barley at Month 1, Biogeco site

Spanish site (barley)



Polish site (Maize)



Production of shoot biomass for maize in unamended and amended soils, with various organic amendments (SGGW, Miedniewice soil, PL) © Wieslaw Szulc

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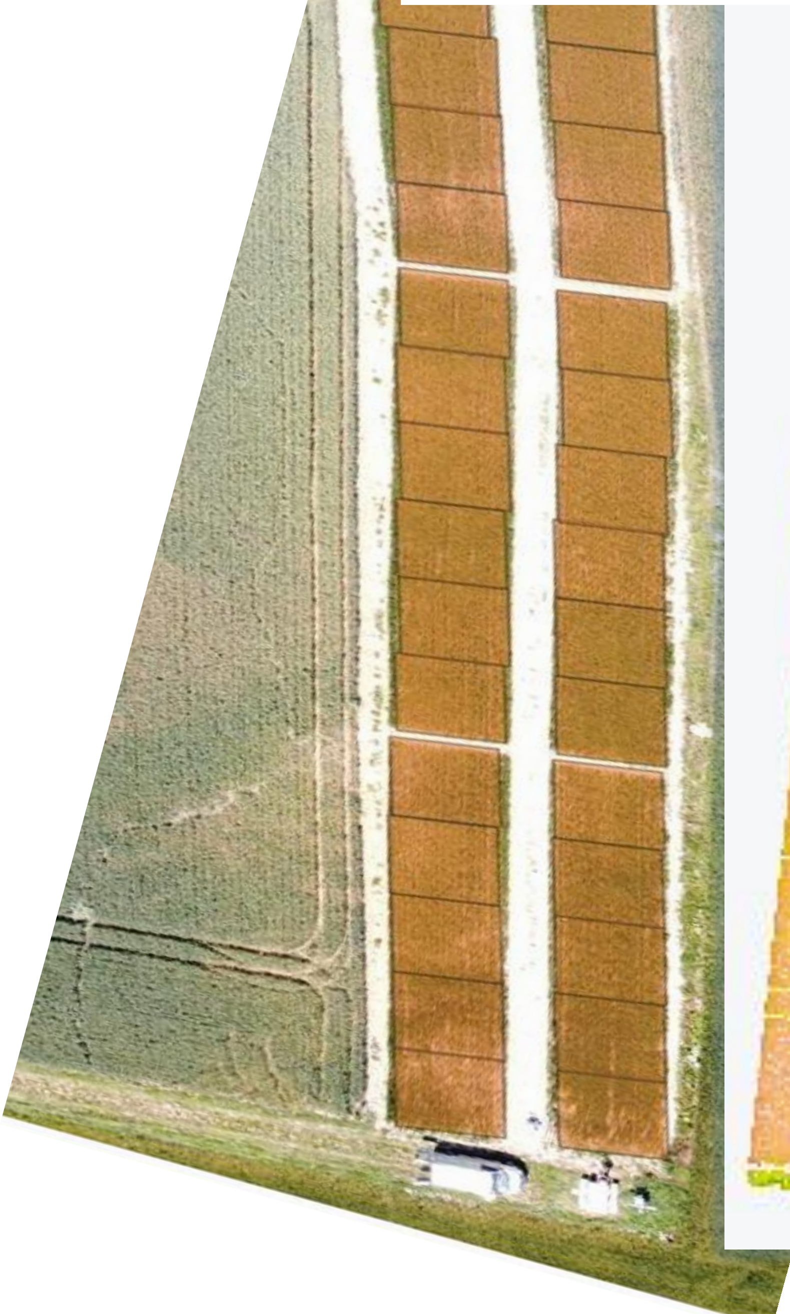
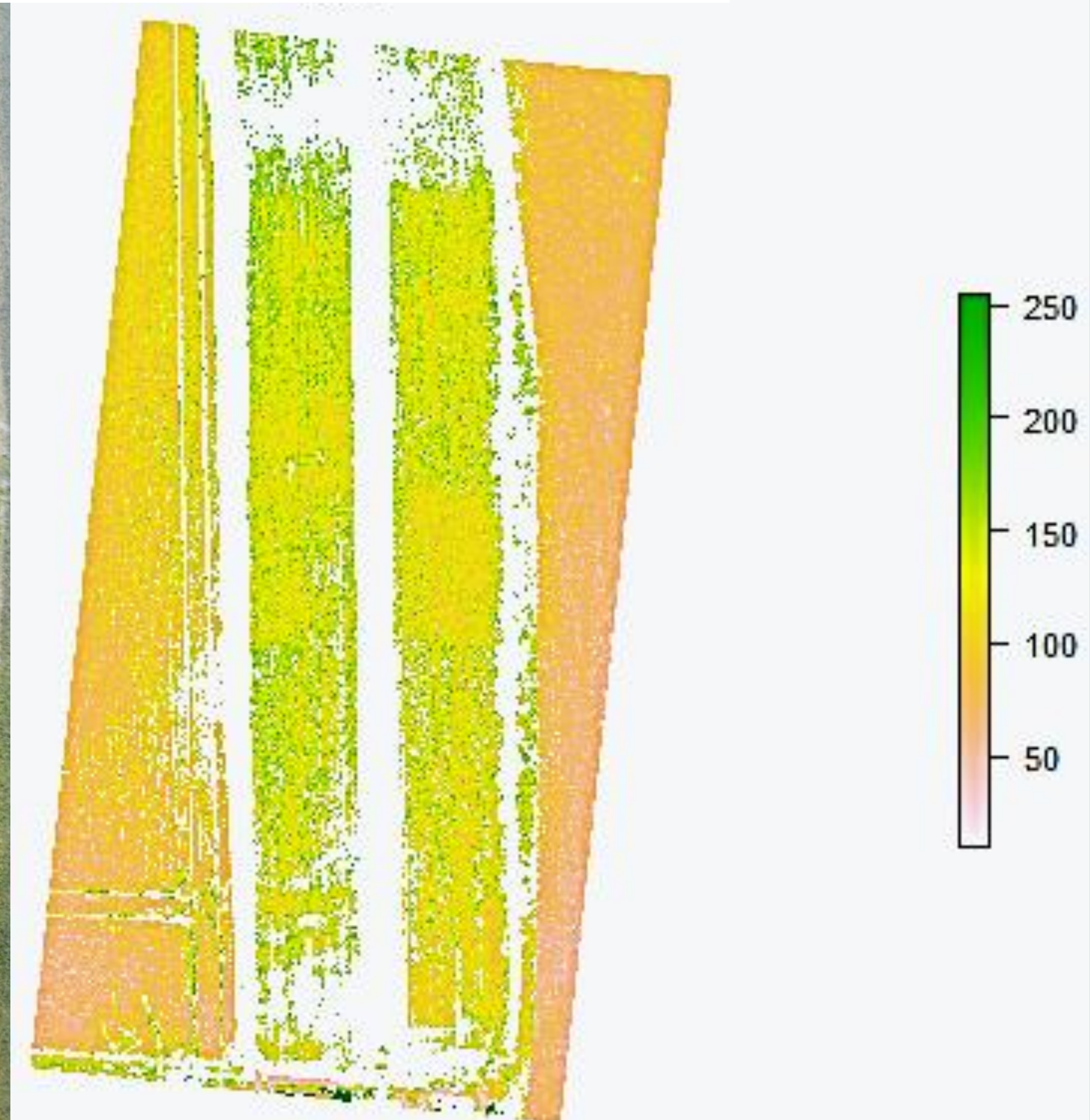
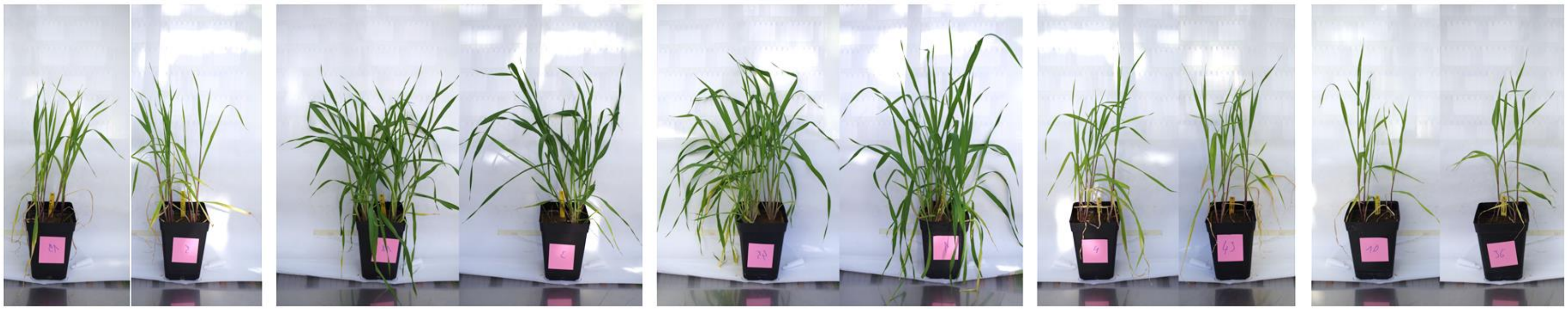
Ödwiesen in 2021: 8 new plots added to the northern part of the site.
Reason: sandy soils on the plateau, better statistics for field trials.

Drone flights unravel heterogeneity





Soil 1: more sandy soil, top of the field



controls | N P K 100 | N P K + Si | Pellets | Pellets + Si

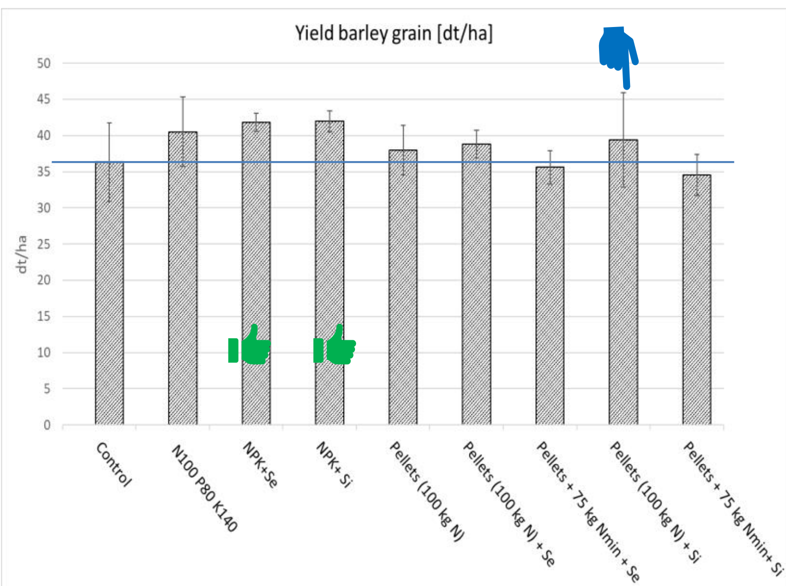
controls | N P K 100 | N P K + Si | Pellets | Pellets + Si

Soil 2: more loamy, clayey, heavier soil, bottom of the field

Main demands of FACCE Surplus:

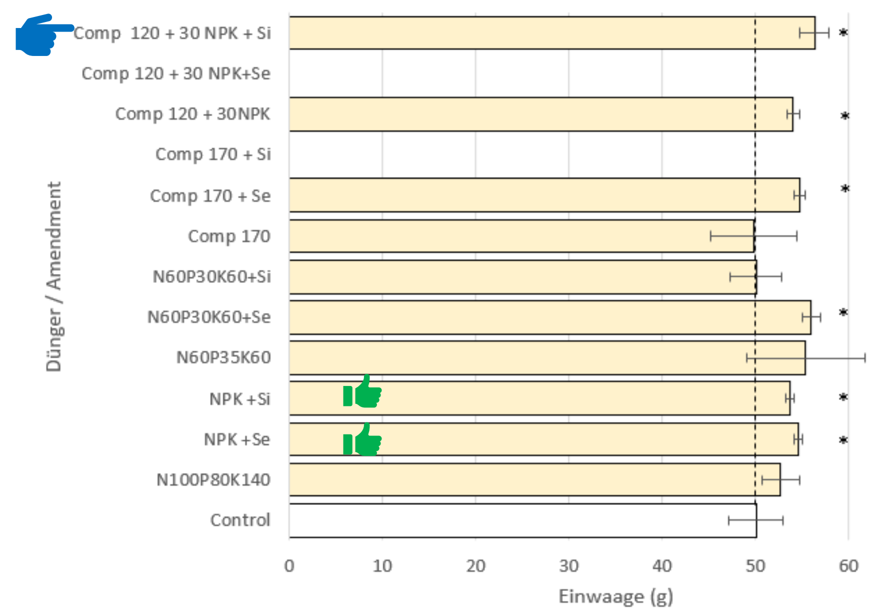
- Adopt measures of circular bioeconomy
- Sequester CO_2
- Increase yields from marginal soils by 20 %

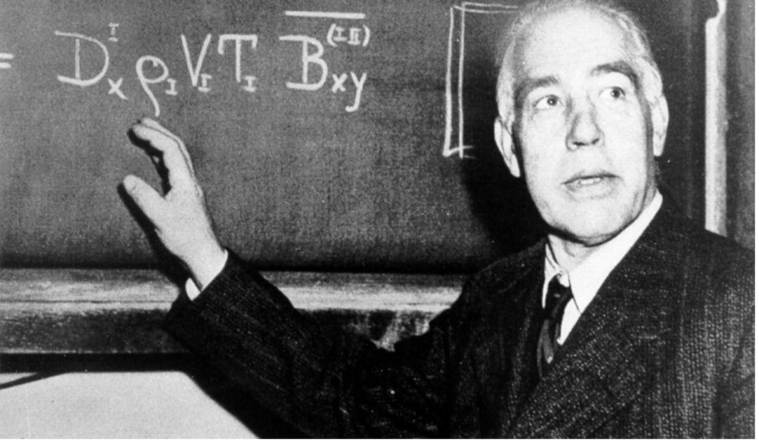
Yield 2020



Yield 2021

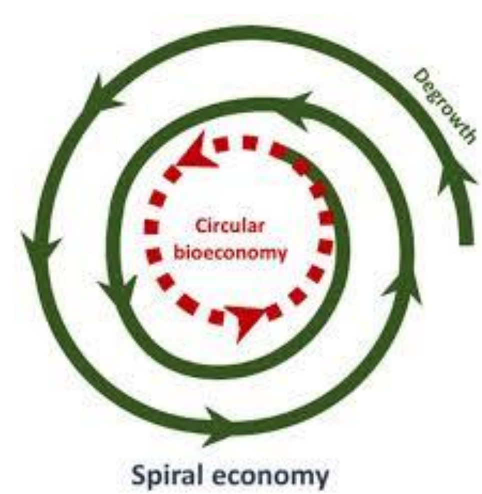
Thousand grain weight [g]





Niels Bohr: “It is difficult to predict, especially the future”

But it might be useful (and fun) to pick out some recent results which might be the forerunner of things to come.



Climate change ahead!

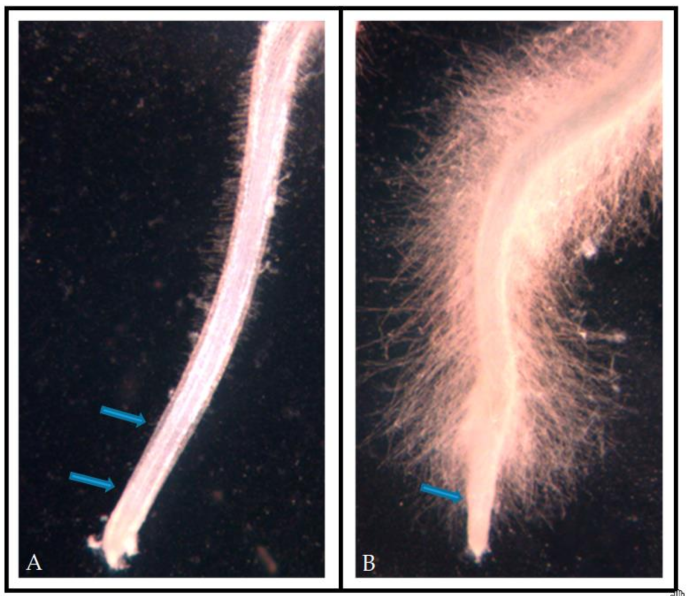
Concern: abiotic & biotic stress expected

from Field

Check available seed and germplasm collections for tolerant varieties & traits

Genes

Metabolites



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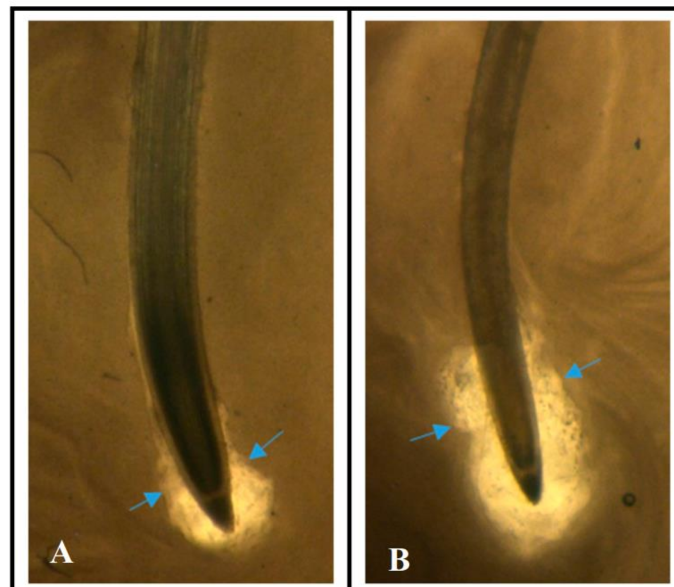
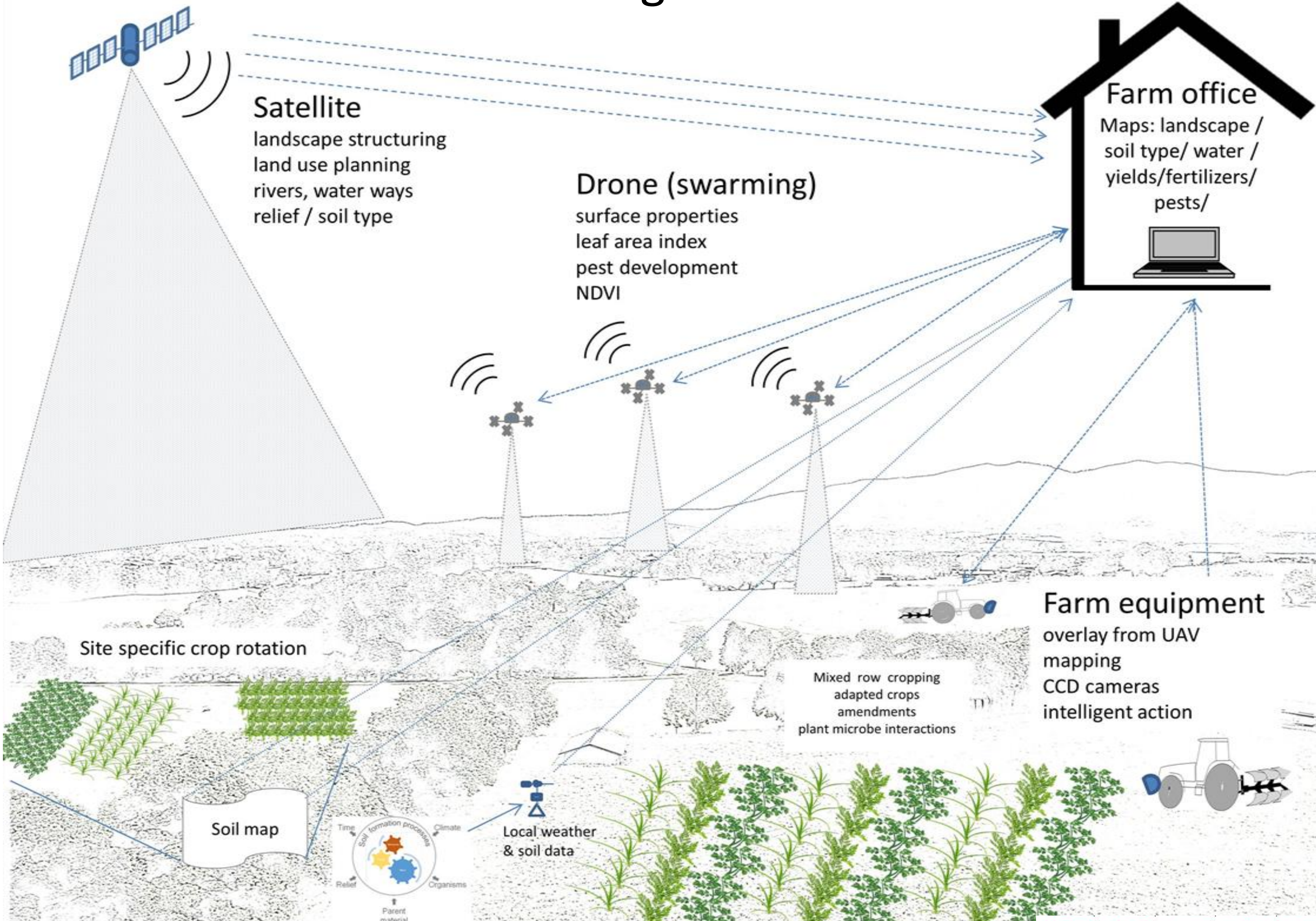


Cultivars tolerant against biotic and biotic stressors

To Field !!

Carter et al. 2019, Agronomy, 9, 220; doi:10.3390/agronomy9050220

Farming 5.0



Schröder et al. 2019

HelmholtzZentrum münchen
German Research Center for Environmental Health

Only a Vision…?

- Improve knowledge on our soils
- Combine organic & conventional tools
- Restrict water losses by modern technologies
- Promote farming by soils & circulate fertilizers
- Breed for improved (non-GMO) plants
- Utilize intercropping & mixed cropping
- Communicate indicators, results and options to farmers & the public

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INTENSE

Special thanks to:

Euroopa Lill maaelu arenguks

Euroopa Maaelu Arengu Põllumajandusfond: Euroopa investeeringud maapiirkondadesse

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