

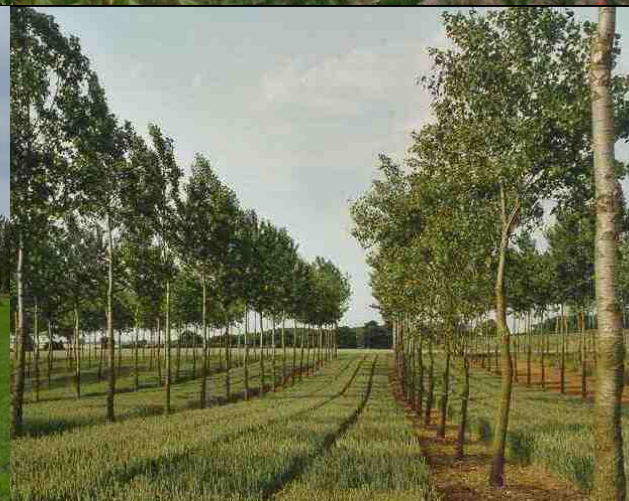


With trees against drought – How agroforestry can protect our fields!

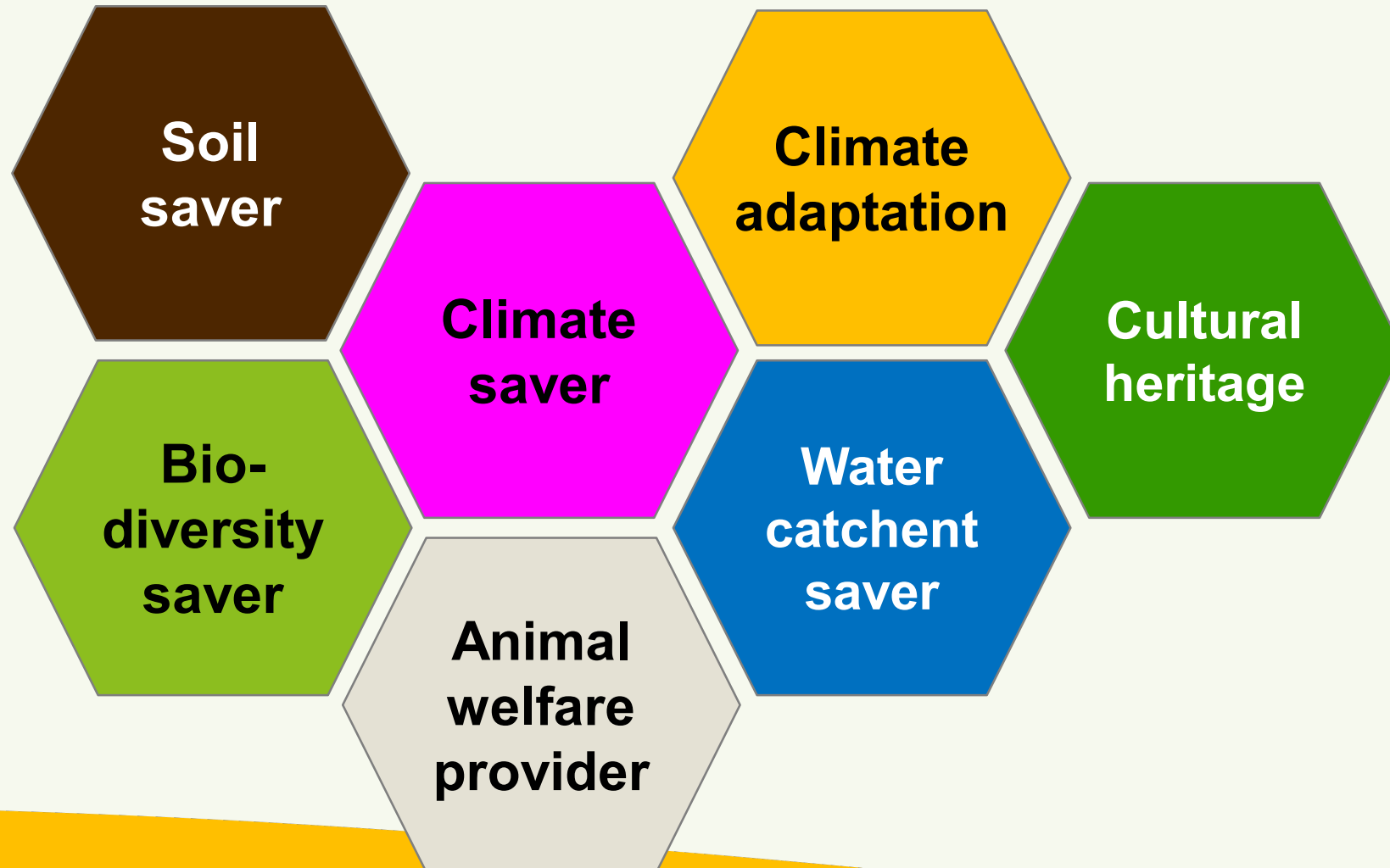
„Landwirtschaft & Klimakrise: WASSER – ein knappes Gut?“
VKU-Forum, Invalidenstraße 91, 10115 Berlin

10. März 2023

Dr. agr. Rico Hübner



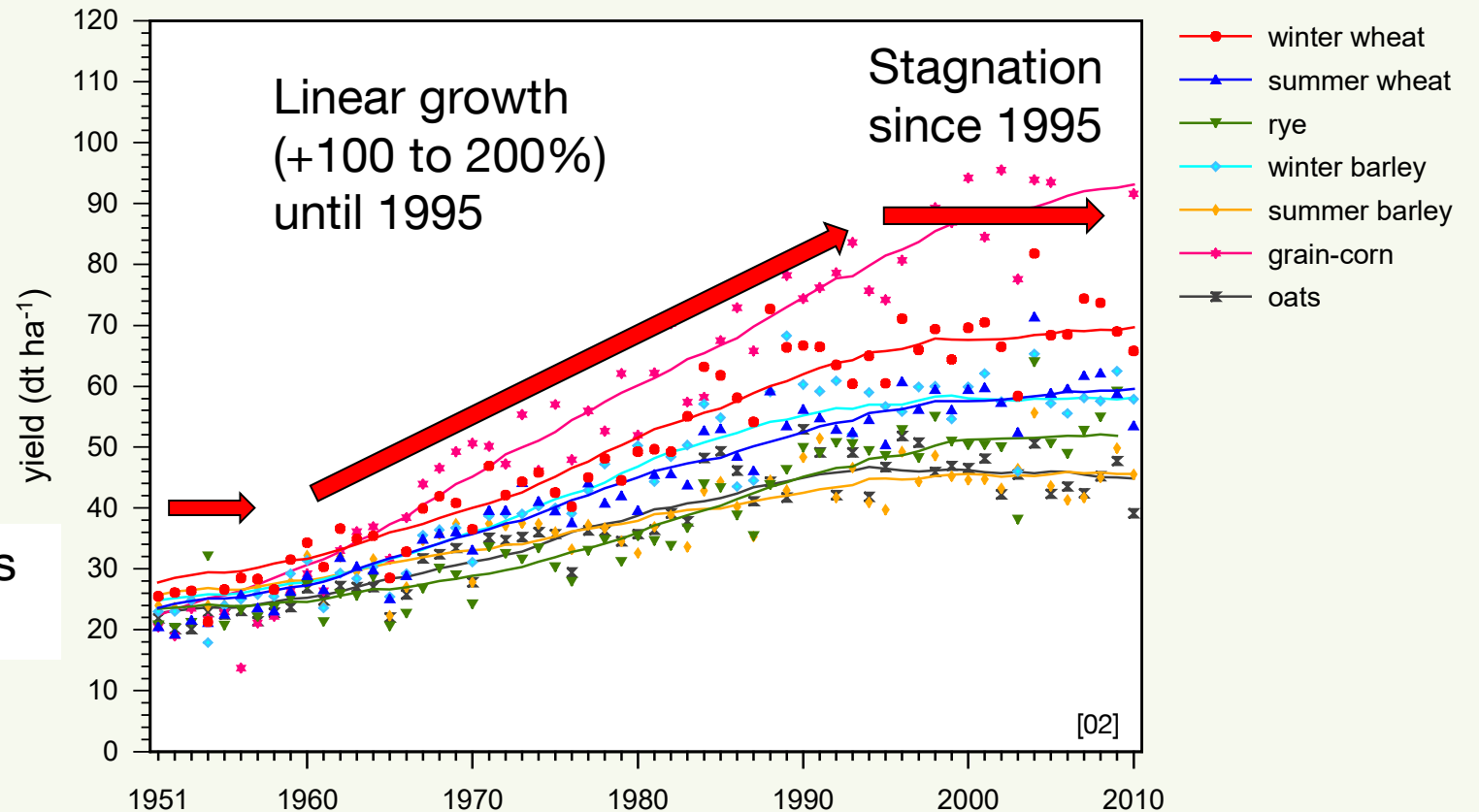
Ecologic benefits, agroforestry as ...



Stagnation of yields and C-inputs

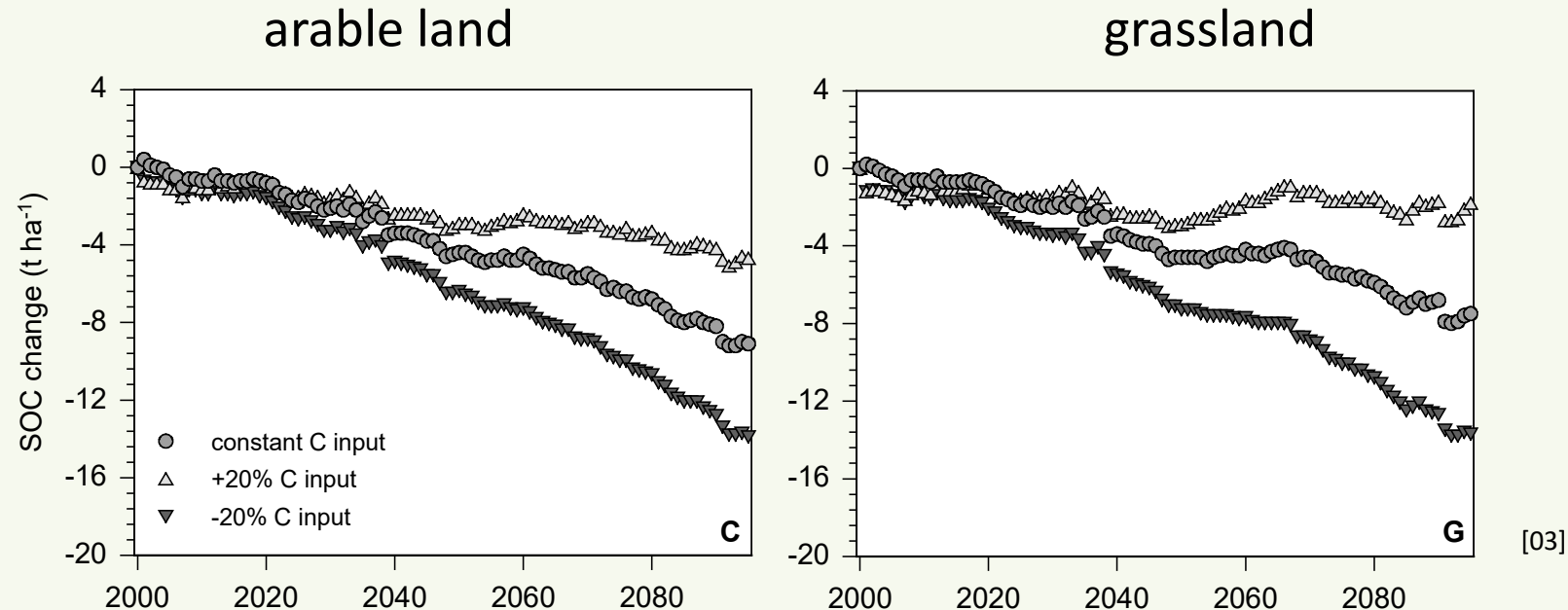
- Stagnating crop yields in Bavaria since the 90s (esp. cereals)
- Strong correlation
- Of the yields with C-Inputs → stagnating C-Inputs?

Constant yields until 1955



Modelling of humus

- reduction of the C_{org} -stocks in arable land by 7% (+20% C-input) until 24% (-20% C-input) until the end of 21st century, in grassland soils 3 to 19% reduction
- C-input would need to increase by 30% just to keep current C_{org} -stocks constant



[03]

Important soil functions

- substrate and nutrition source for plants, soil fauna and microorganisms
- purification and storage of water
- stabilization of the soil structure, protection against erosion
- storage and replenishment of nutrients
- stores carbon as humus (58% carbon thus C_{org} as a measure of humus)



- average soil erosion in conventional arable farming in Germany between 2.7 and 4.2 t ha⁻¹ yr⁻¹, bare fallow soil loss (often used as baseline): 45 t ha⁻¹ yr⁻¹ [04]
- just wind erosion rate up to 45 t ha⁻¹ yr⁻¹ [05]
- soil regeneration rate: 0.01 to 1 t ha⁻¹ yr⁻¹ [06]

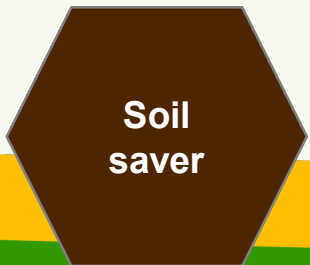
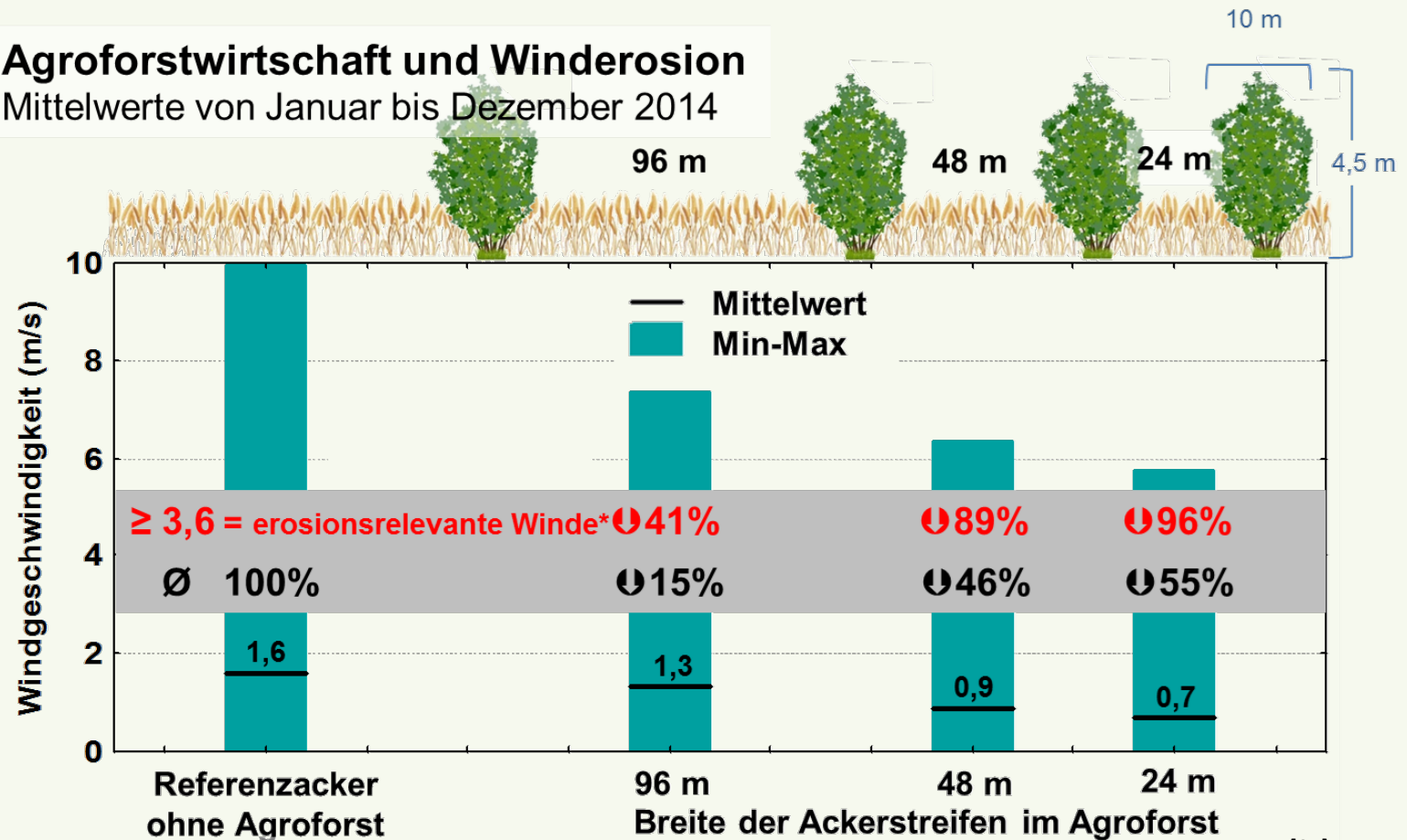
Soil
saver

Protection from wind erosion

- one of the main causes of land degradation
- despite the low tree height (4.5 m), the average wind speed on the 96, 48 and 24 m wide fields between the wooded strips was reduced to 85, 54 and 45 % of the outdoor wind
- erosion-relevant wind events reduced by 41, 89 and 96%

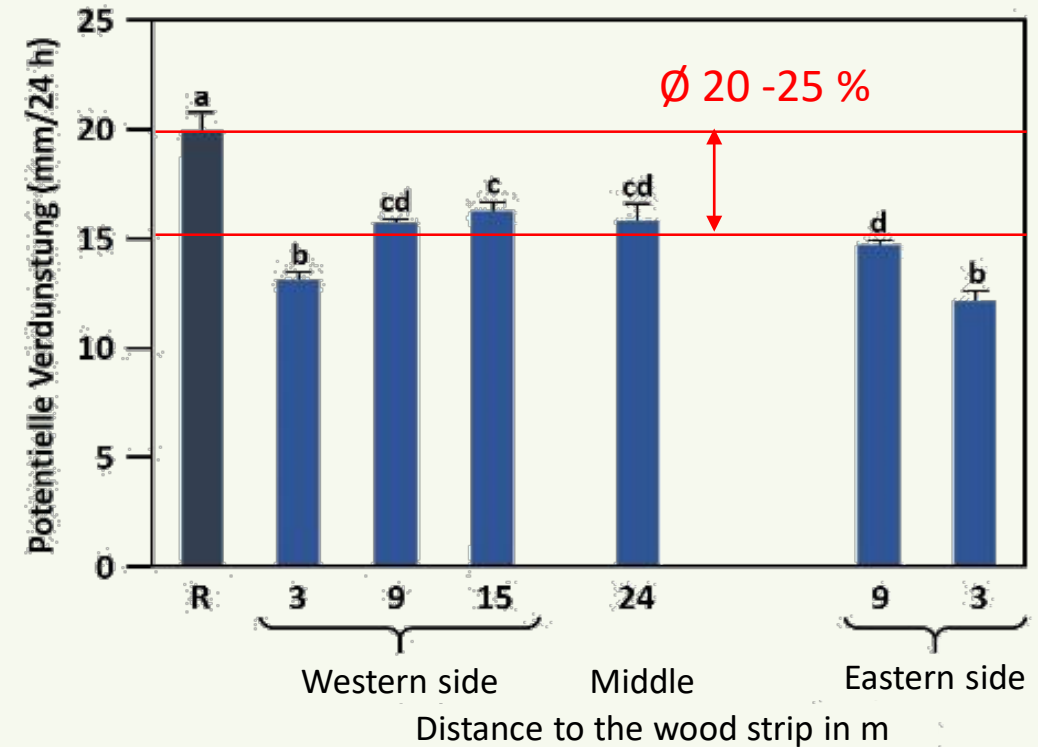
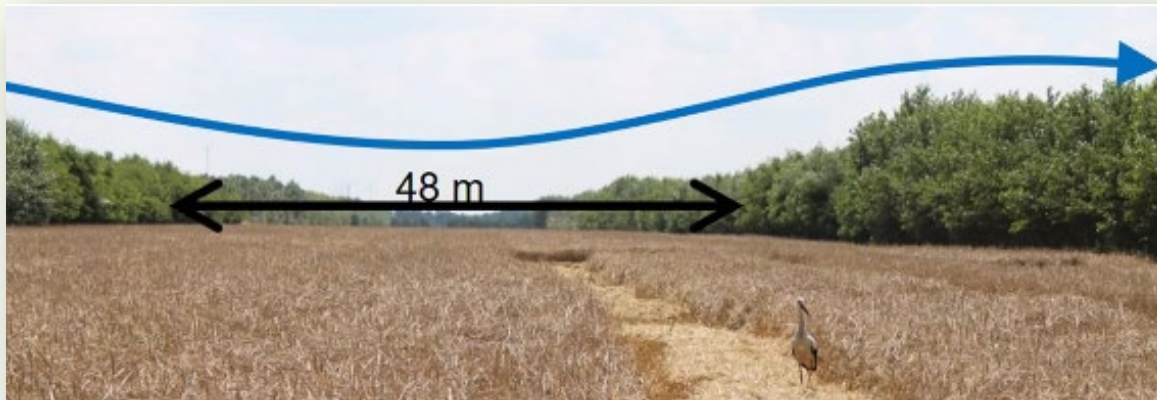
Agroforstwirtschaft und Winderosion

Mittelwerte von Januar bis Dezember 2014



Potential evaporation

Climate adaptation



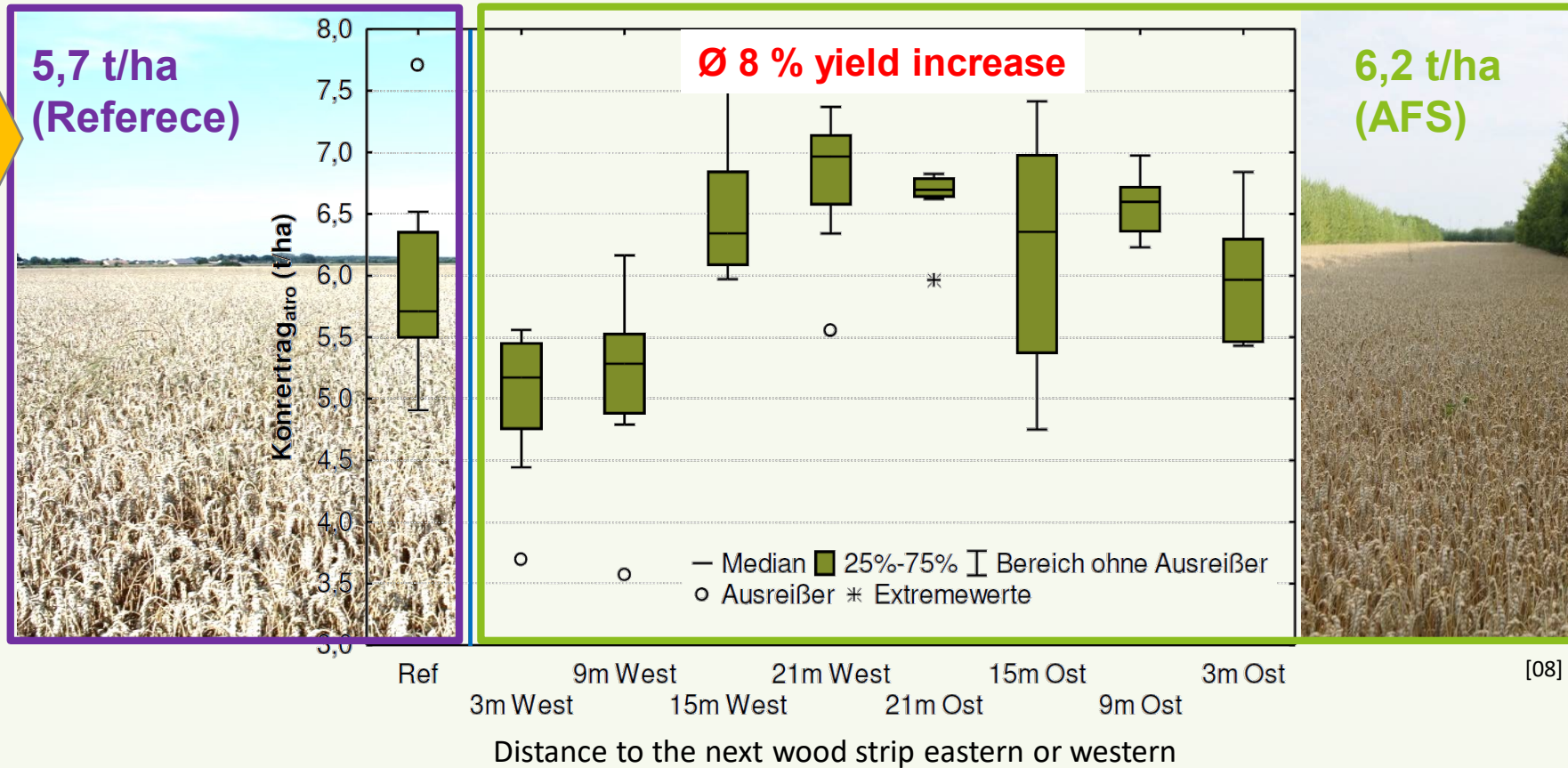
Potential evaporation (evaporation after Piche) within 24 hours (exemplary summer day) in an agroforestry system in southern Brandenburg and on a neighboring field plot without wooded strips (R = reference); the evaporation amounts are given at different distances to the wooded strips to the west and east; the width of the field strip is almost 50 m (error bars = standard deviation, n = 3, letters represent statistically significant differences ($p \leq 0.05$);

[07]

Yields

Grain yield winter barley on 48 m wide field strip

Climate adaptation



Surface area ratio: 83% (arable crops) vs. 17% (woody crops).

→ on 83 % of the area almost 91 % of the mono crop yield of barley could be grown;

LER = 1.1

Policy effect



4 potential sectors for carbon storage in AF

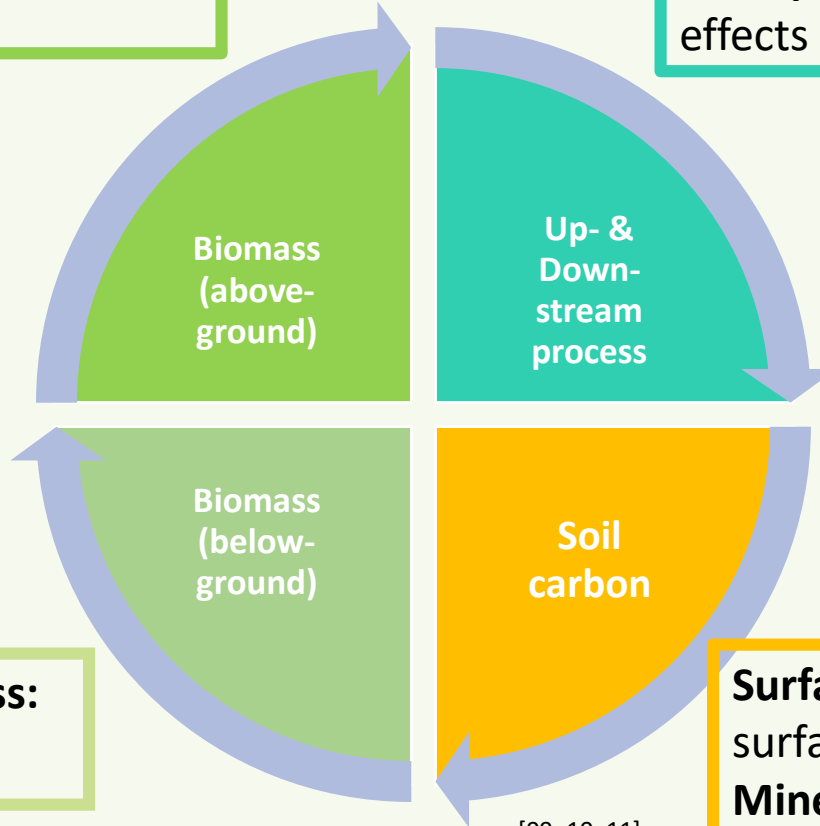


Above-ground biomass:
trunk wood, crown wood,
branches & twigs

Management: cultivation method,
PPPs, fertilisers
Use options: processing, substitution
effects



Below-ground biomass:
coarse & fine roots

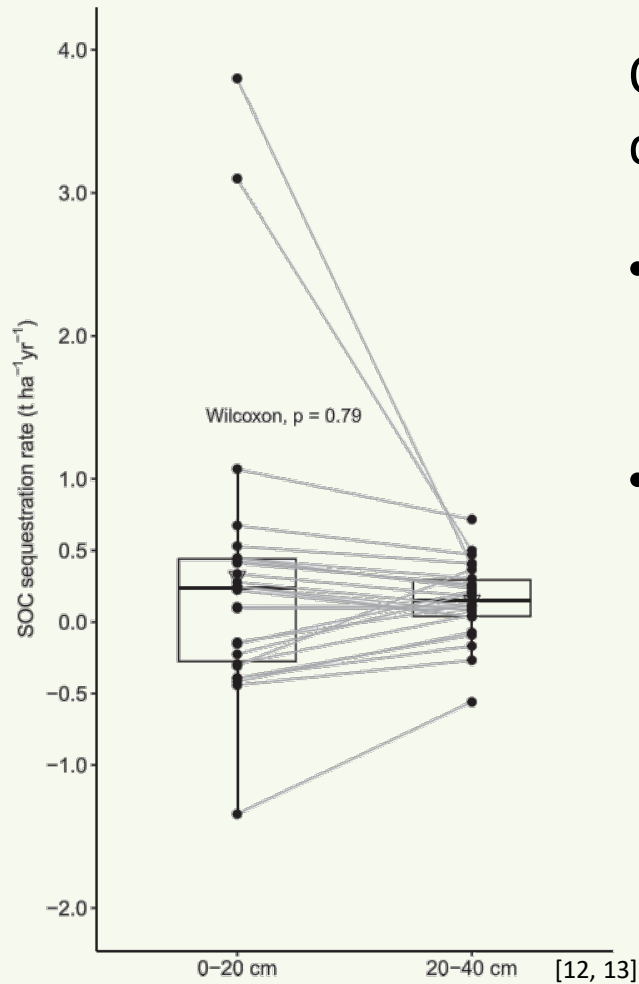


Surface horizon:
surface & leaf litter
Mineral soil:
soil organic carbon (C_{org})

[09, 10, 11]

**Climate
saver**

Soil carbon sequestration rates

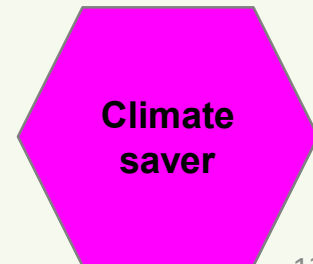


OC sequestration rates ($\text{t ha}^{-1}\text{yr}^{-1}$) by AFS at 0-20 cm and 20-40 cm soil depth from 61 studies in temperate climate:

- SOC sequestration rate was on average slightly higher at 0-20 cm compared with 20-40 cm soil depth (0.21 ± 0.79 and $0.15 \pm 0.26 \text{ t ha}^{-1} \text{ yr}^{-1}$, respectively)
- 17 observations (28% of all) showed negative SOC sequestration rates in 0-20 cm as well as 5 plots (19%) in 20-40 cm depth

Context and Impact indicators 14/02/2023 – Version 8.0 [22]

INDICATOR C.40	Indicator I.11 Enhancing carbon sequestration: Soil organic carbon in agricultural land
Indicator Name	Soil organic carbon in agricultural land
	The indicator estimates the total organic carbon content in soils on agricultural land.



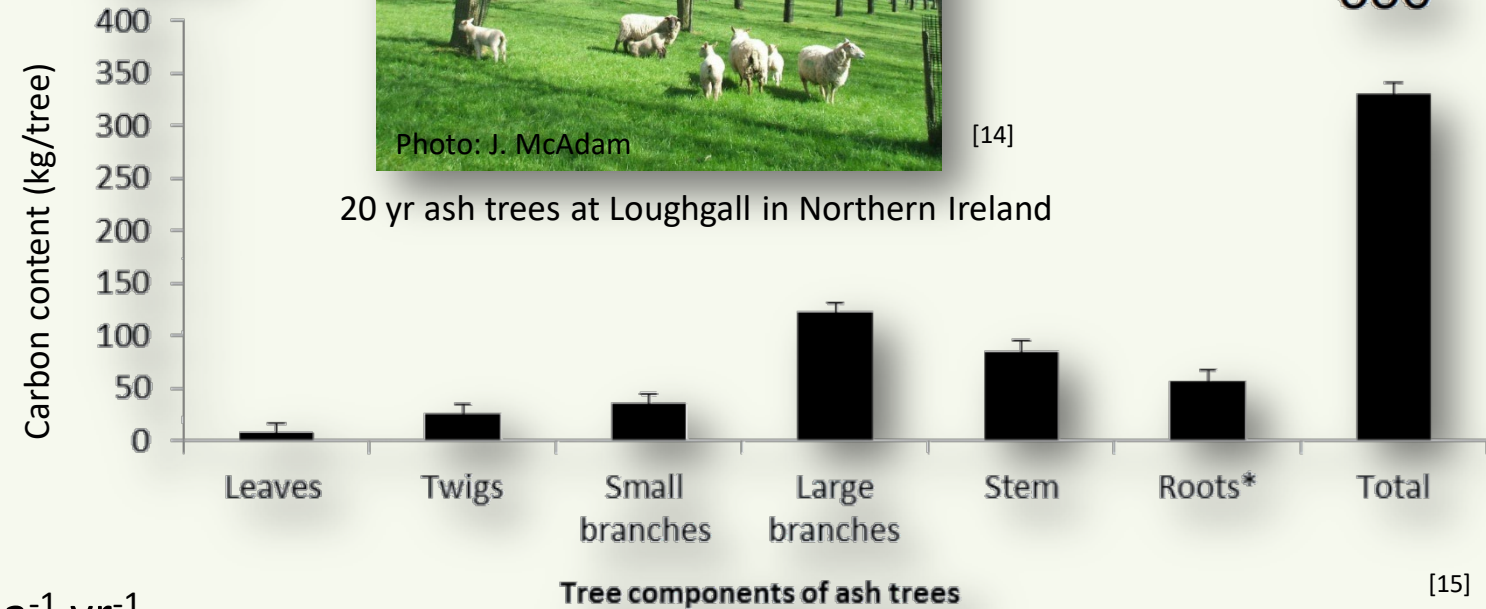
Biomass

- Root pruning useful and necessary



[16]

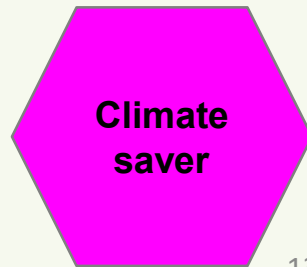
Shape of root in AFS (left) and without (right)



20 yr ash trees at Loughgall in Northern Ireland

- EU-wide meta study 0.3 to 26.8 t CO_{2eq} ha⁻¹ yr⁻¹ C-sequestration in above- & belowground biomass [17]
- only moderate C-sequestration rate in „Streuobst“ of 1.5 t CO_{2eq} ha⁻¹ yr⁻¹ [18]

- C-sequestration rate total biomass of 2.5 t C ha⁻¹ yr⁻¹ + 0.8 t C ha⁻¹ yr⁻¹ in the soil
- equals to 9.2 + 2.9 t CO_{2eq} ha⁻¹ yr⁻¹



Water catchment saver

↑ inclusion of legumes & shrubs,
↑ biotope reconnection



↓ surface runoff & ↑ water retention in the catchment

↑ buffering (e.g. PPM drift)

↓ fertilisation of woody areas (no need)

↑ shading, ↓ water-temp. ↓ algal blooms & ↑ O₂-provision



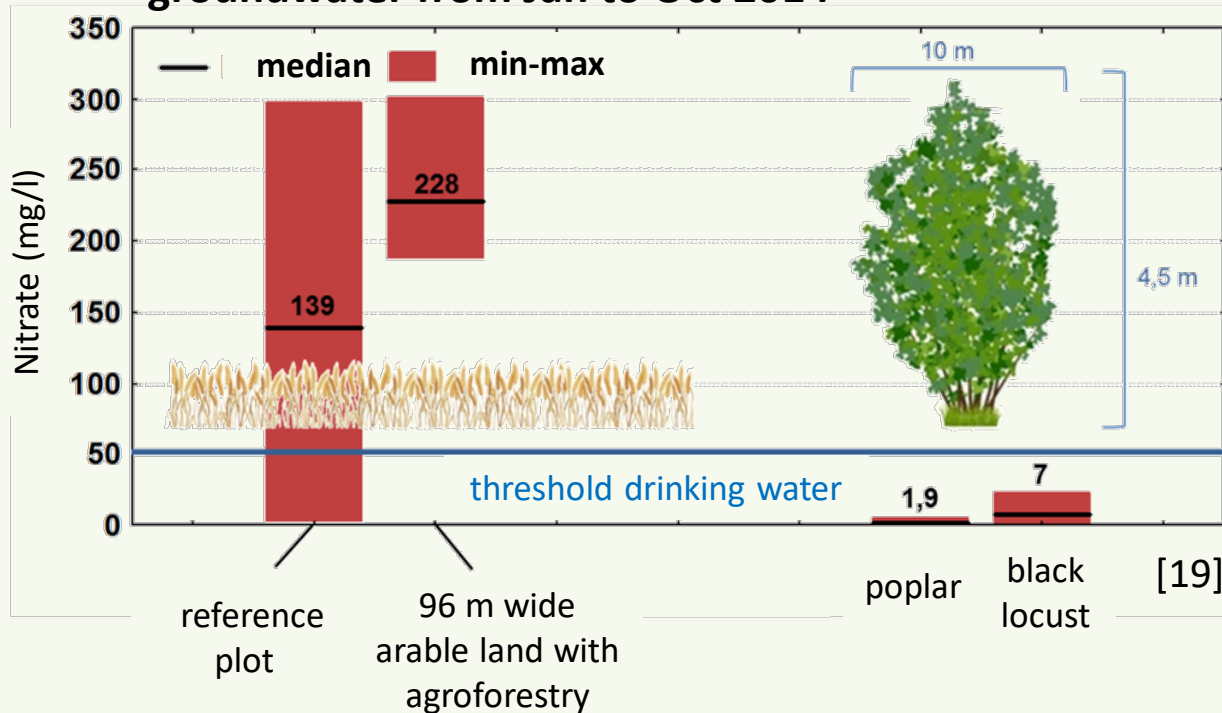
↓ nutrient inputs into the groundwater

↑ upward water- & nutrient-pump trough deep reaching tree roots

↑ flood protection

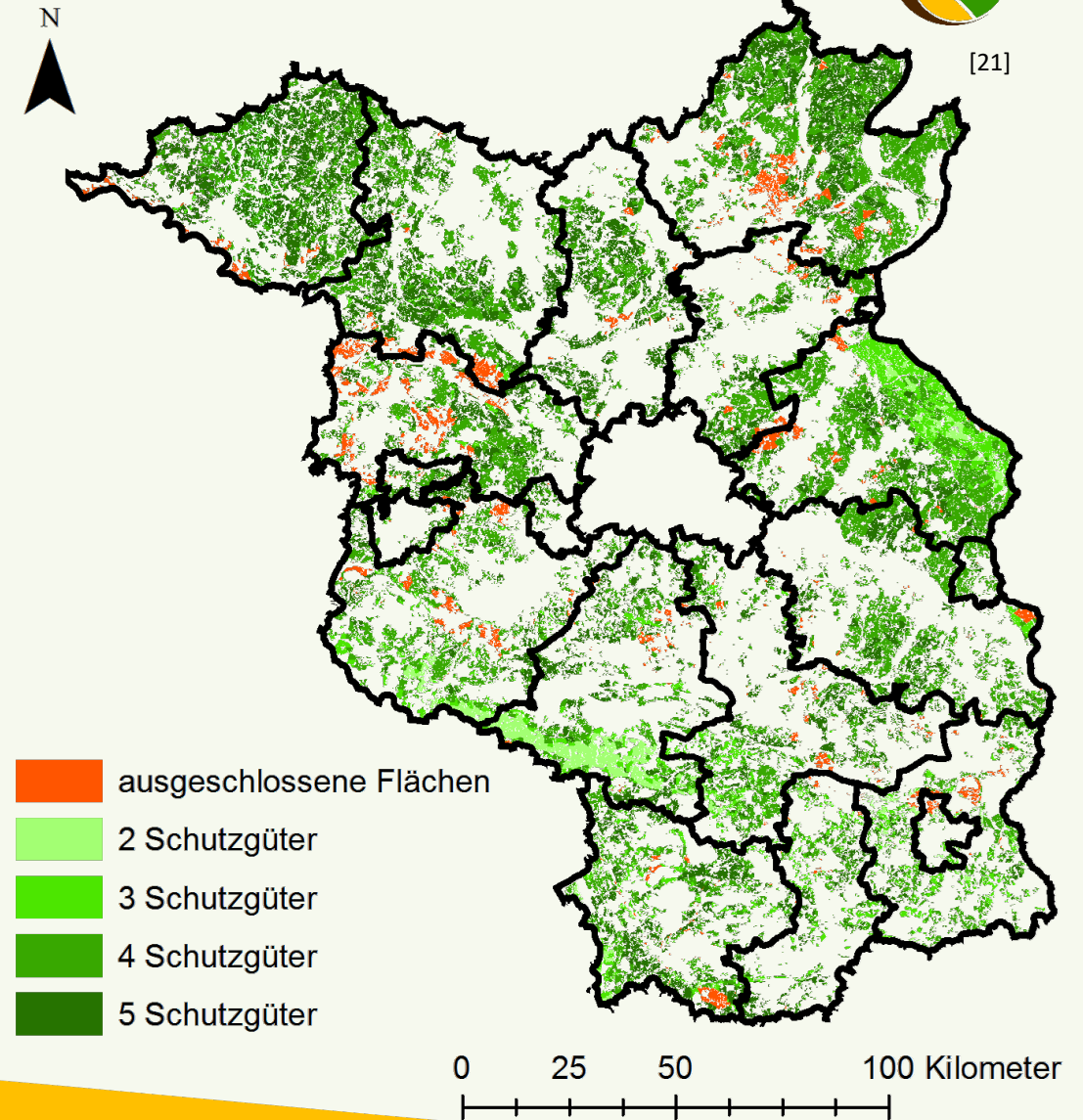
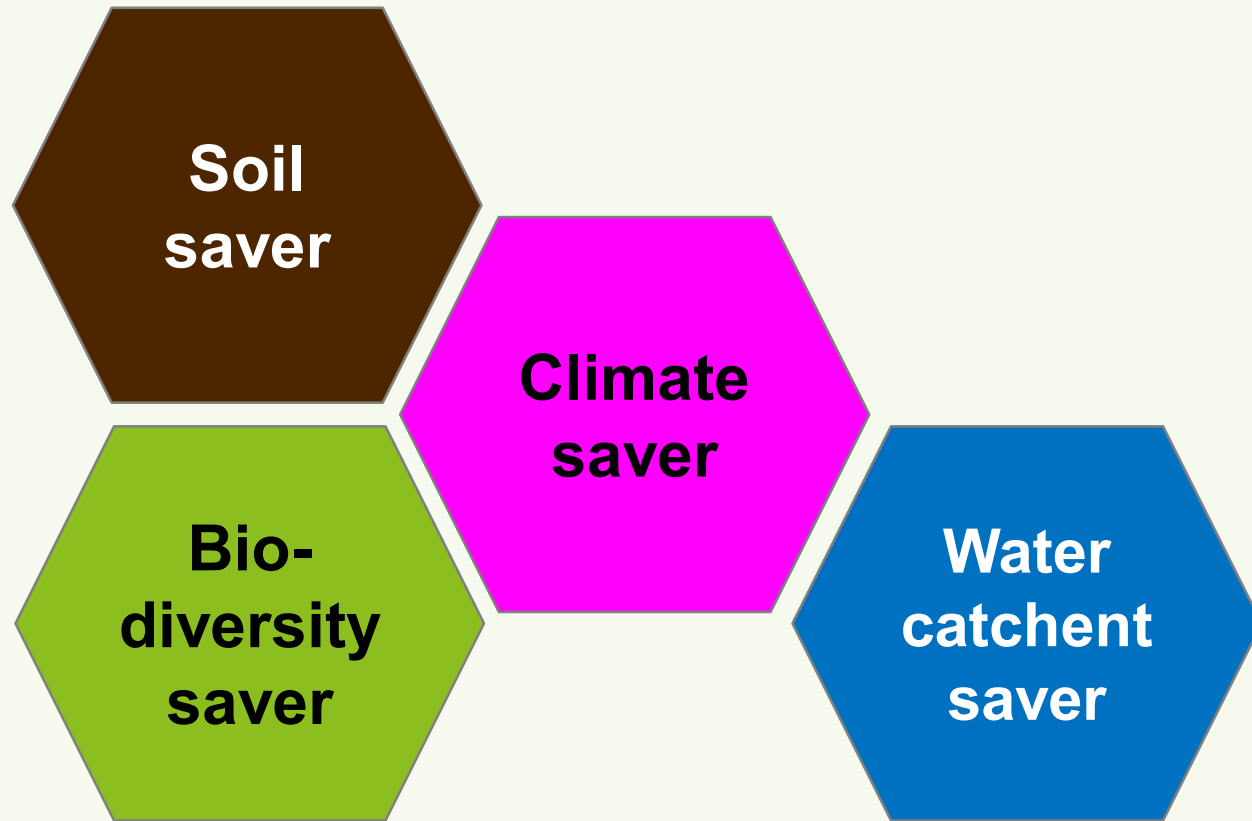
↑ downward water infiltration into the soil trough macro-pores & tree roots

Medium values of nitrate concentration in the groundwater from Jan to Oct 2014



- lower measured nitrate concentration in the near-surface groundwater of an alley cropping agroforestry system
- the risk of leaching in the area of woody plants in agroforestry systems is significantly lower than in arable crops
- this is not only due to the absence of fertilisers in the area of the woody plants, but also due to their distinctive and deep root system

Suitability map for AFS



Example farm Volkertshaus, Bad Waldsee



Photo: Sebastian Fenk



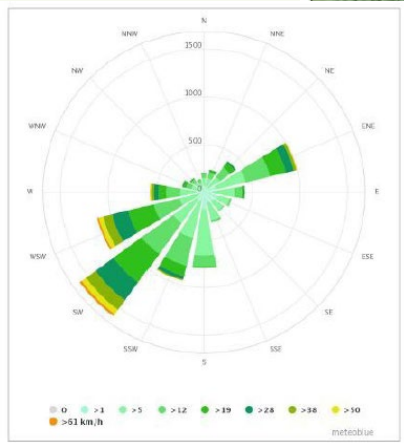
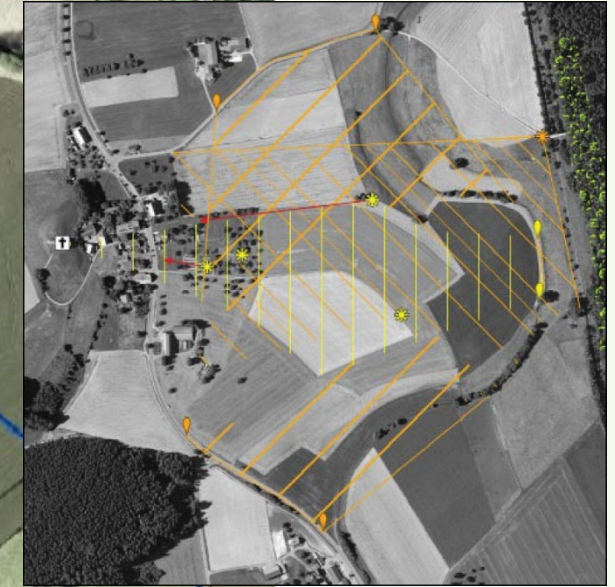
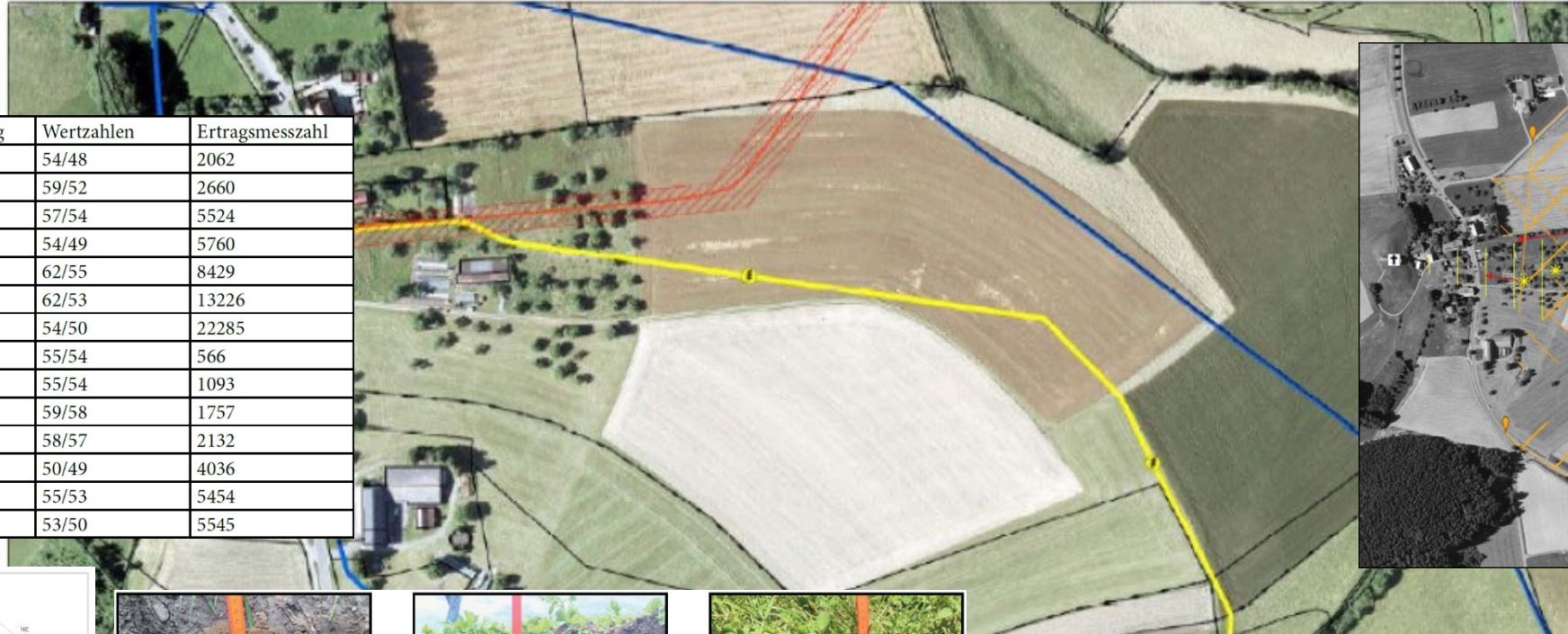
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Baden-Württemberg, www.lgl-bw.de



Photo: Sebastian Fenk

Volkertshaus – planning process

Fläche Nr.	Bodenschätzung	Wertzahlen	Ertragsmesszahl
1	SL3D	54/48	2062
2	sL3D	59/52	2660
3	SL3D	57/54	5524
4	SL3D	54/49	5760
5	sL3D	62/55	8429
6	sL3D	62/53	13226
7	SL3D	54/50	22285
8	IS1b2	55/54	566
9	IS1b2	55/54	1093
10	L1b2	59/58	1757
11	L2b2	58/57	2132
12	IS1b2	50/49	4036
13	IS1b2	55/53	5454
14	IS1b2	53/50	5545



Bodenprofil 1
Verdichtet in 20-40 cm



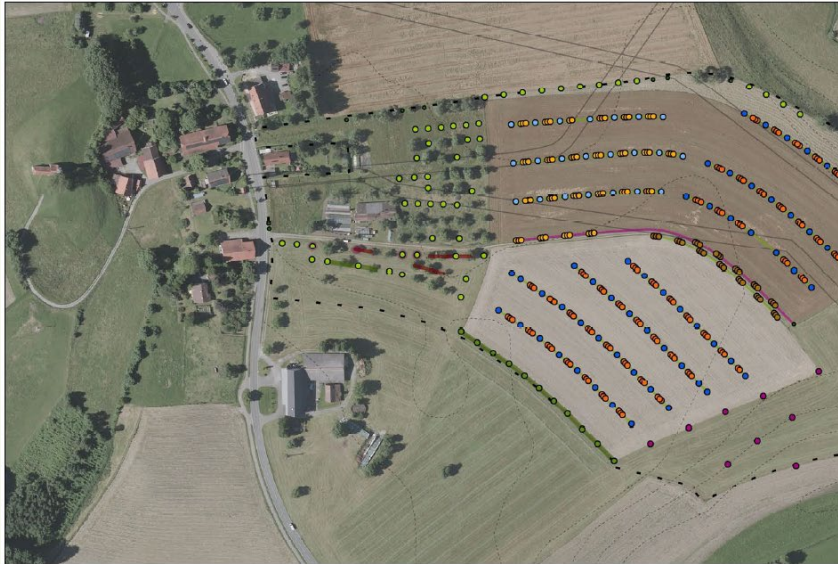
Bodenprofil 2
Verdichtung in 30-40 cm



Bodenprofil 3
Verdichtung in 20-40 cm



Volkertshaus – results & future



Entwurf M 1:2.500

Entwicklung in 30 Jahren M 1:2.500

Legende	Bäume	• Solitär-bäume
Grundlagen	• Wertholz für Naturschutz	• Werthölzer an Weg
--- Grenze USG	• Wertholz Auenbereich	Pflanzungen
..... Höhenlinien	• Wertholz uneingeschränkt	— Baumstreifen
— Schutzbereiche	• Pioniergehölze heimisch	— Windschutz
• Baumbestand	• Pioniergehölze uneingeschränkt	— Blühstreifen
	• Streuobstgehölze	— Beerenobst
	• Windschutzgehölze	■ Beete

Luftbild: (LGL 2019)

Legende	Bäume	Pflanzungen
Grundlagen	• Wertholz schmale Kronen	— Baumstreifen
--- Grenze USG	• Wertholz große Kronen	— Windschutz
	• Pioniergehölze schmale Krone	— Blühstreifen
	• Pioniergehölze große Krone	— Beerenobst
	• Streuobstgehölze	■ Beete

Luftbild: (LGL 2019)



Agroforstsystem Einöde Sankt Anton	
Volkertshaus	
Bearbeiter: Julia Kleinwechter	Betreuung: Dr. agr. Rico Hübner
01.08.2019	
Karte 5: Entwicklung in 30 Jahren M 1:2.500	

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Questions? Comments?



1

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