



Ecological and economic benefits of traditional and modern agroforestry systems

Landcare Europe Workshop

„Agroforestry systems to improve biodiversity, water & soil management & economic viability in & outside Natura 2000 areas“

7-9 March 2023 Jaén, Andalucía (Spain)

Dr. agr. Rico Hübner



supported by:



Short intro DeFAF e.V.

- Founded on 25. June 2019 in Berlin
- Registered NGO

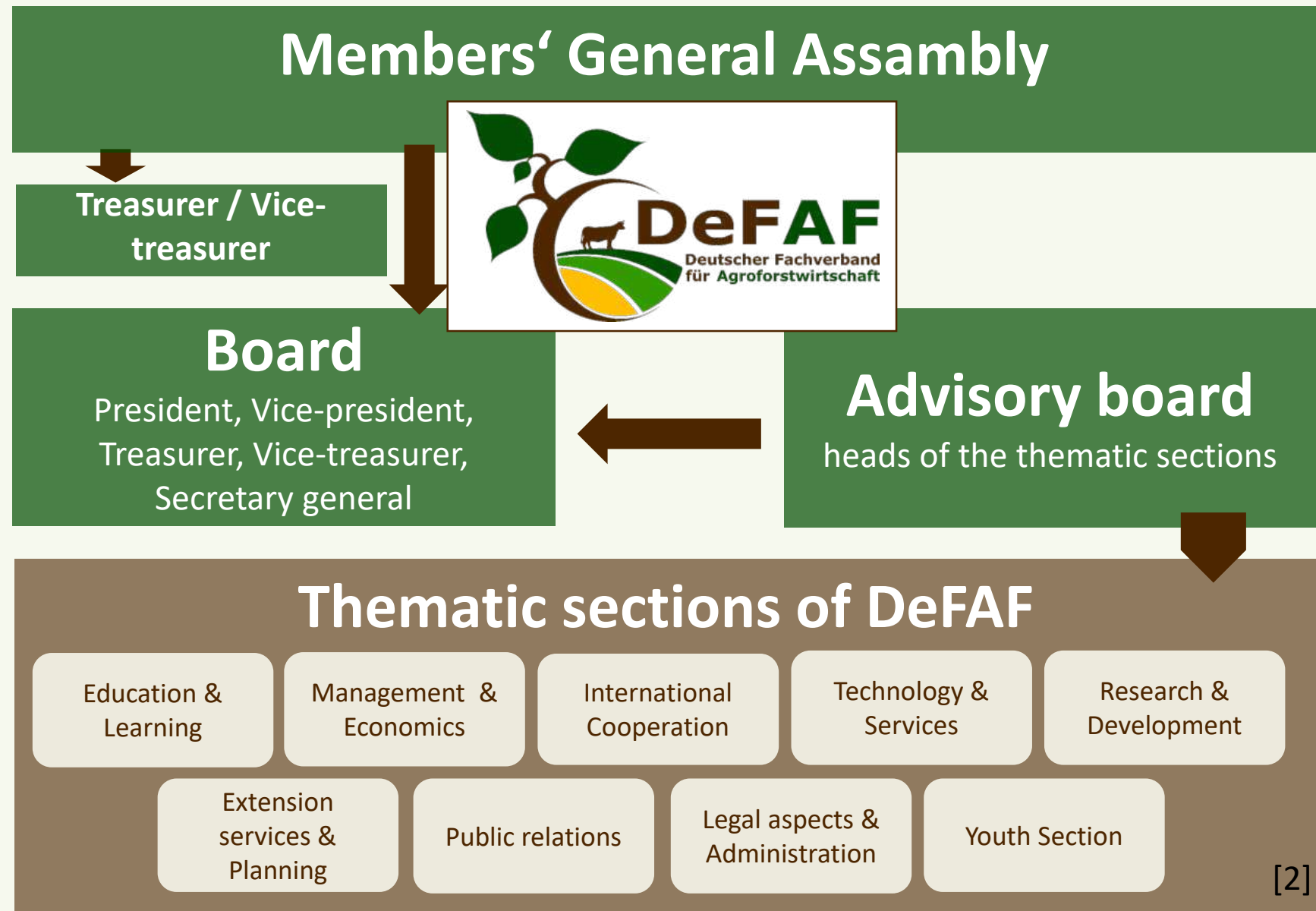
Goal: Support of agroforestry practices in Germany

- Awareness building, advisory service, provisioning of information on agroforestry
- Networking: practitioners, the sciences, politics
- Scientific support for policy advocacy



Structure of DeFAF e.V.

- ~370 members
- 9 thematic sections
- Temporal working groups
- 7 member of staff



Activities & services

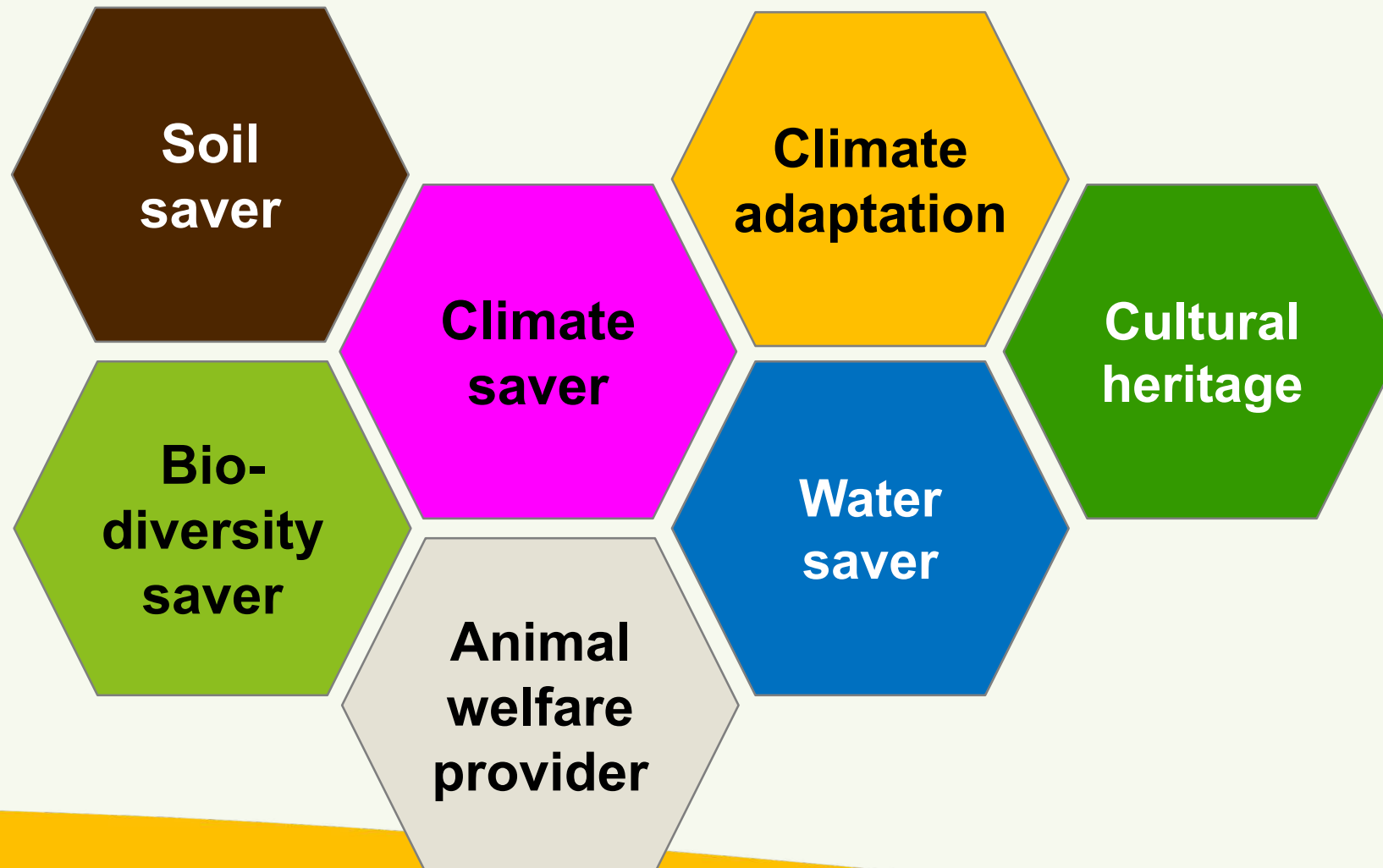
- www.defaf.de
- Quarterly Newsletter
- Information hub: handbooks, software tools, in-depth brochures
- Participation and starting of research activities
- Networking and partnerships
- Hosting of the bi-annual agroforestry forum
- 9th Forum Agroforstsysteme: 27.-28. Sept 2023 in Freiburg



[3]



Ecologic benefits, agroforestry as ...



Important soil functions

- Substrate/habitate and food 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)

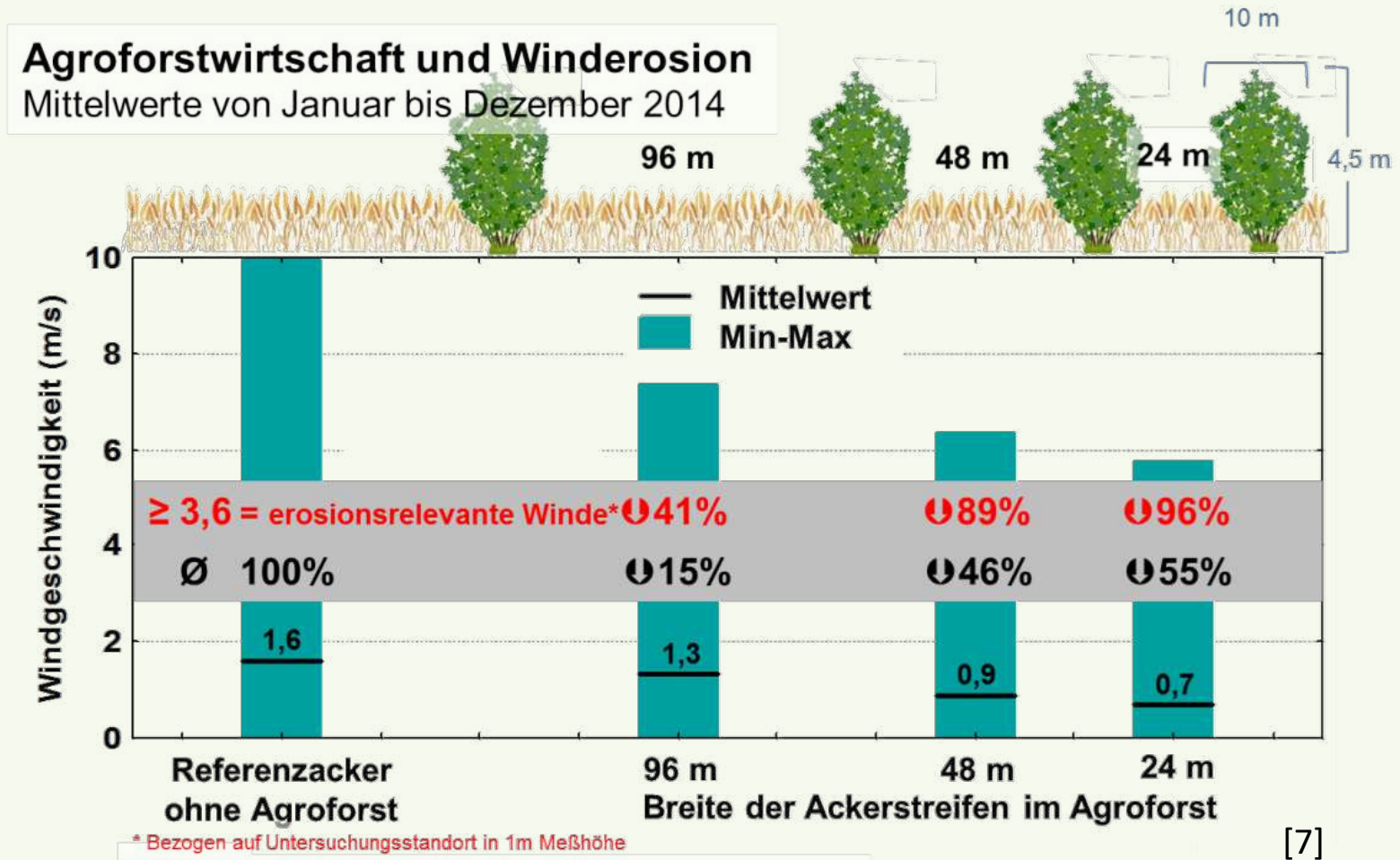


- Average soil erosion in conventional arable farming in Germany: $4.2 \text{ t ha}^{-1} \text{ a}^{-1}$ [4]
- In the case of individual events, short-term up to $50 \text{ t ha}^{-1} \text{ a}^{-1}$ [5]
- Soil regeneration rate: $0.01 \text{ to } 1 \text{ t ha}^{-1} \text{ a}^{-1}$ [6]

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%



Soil
saver

Farm #1: Domin Farm

Farmsize

- 50 ha grassland
- 320 ha arable (including 130 ha mining re-cultivation areas)
- 50 ha forest

Animal production

- 30 suckler cows
- 30-40 fattening pigs
- 200 heads poultry (geese & ducks)
- 50 laying hens

Workforce

- 8 in total (5 full-time, 3 part-time)
- support from the whole family



Species selection

Fast-growing tree species (SRC)

- Poplar
- Willows
- Alders
- Black locust

Valuable woods and shrubs

- Sweet chestnut
- Tree hazel
- Field maple
- Copper rock pear
- Elderberry

- Production target of wood chips for energy recovery
- Harvest every 5 to 7 years (“rotation period”)
- Life time around 20 to 30 years
- Finally, recultivation and use as arable land





Photo: T. Domin



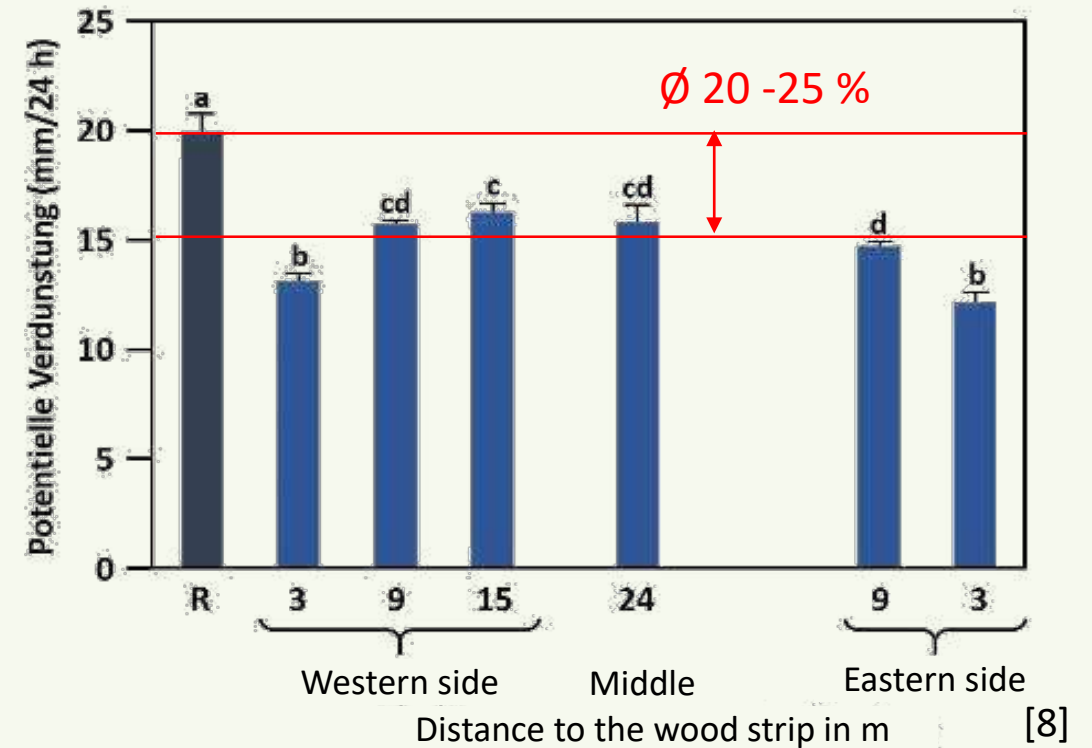
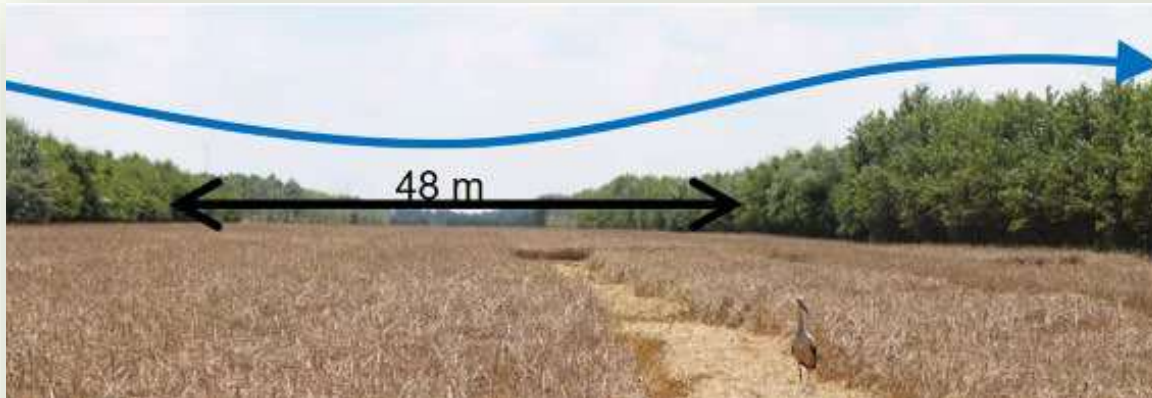
Photo: T. Domin



Photo: T. Domin

Climate adaptation

Climate
adaptation

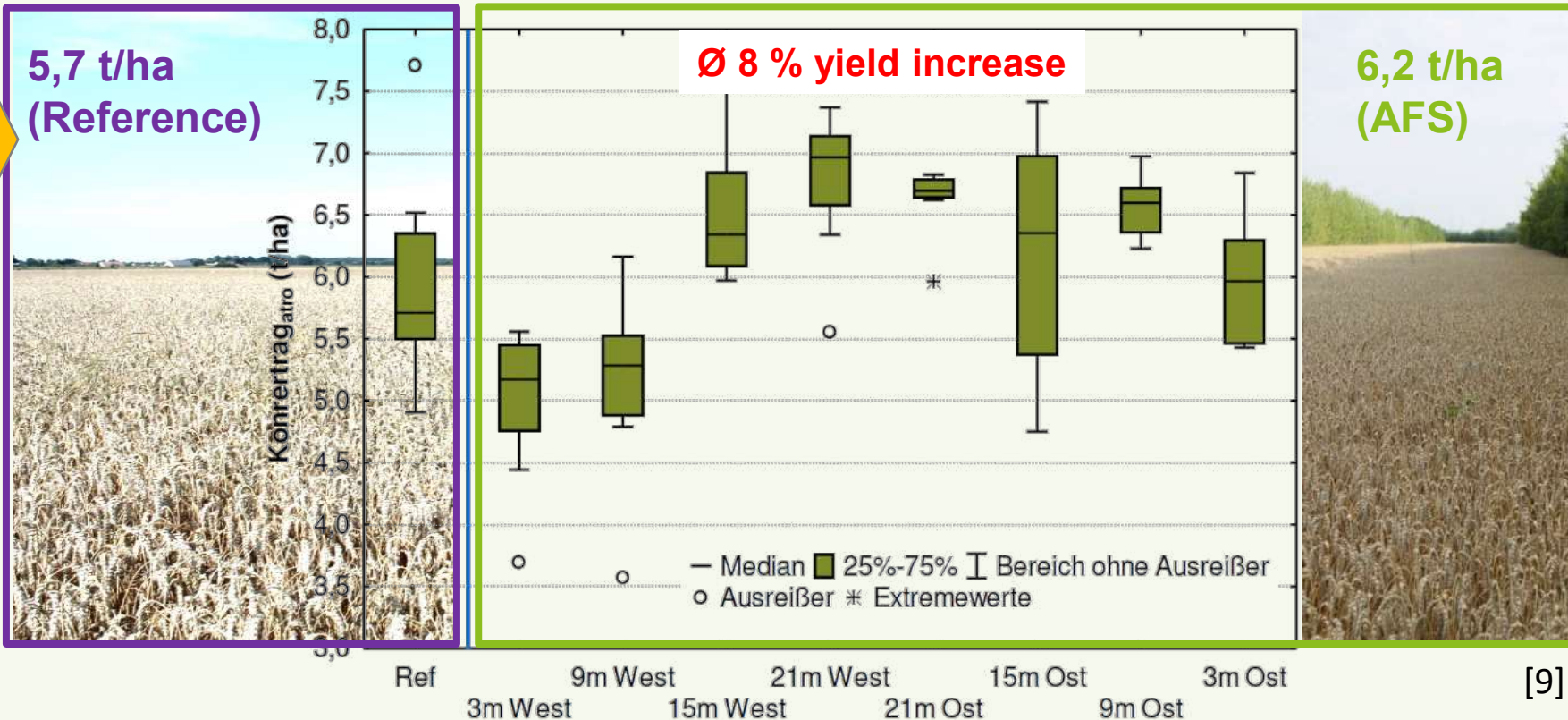


Potential evaporation (evaporation after Piche) within 24 hours (exemplary summer day) in an agroforestry system in southern Brandenburg and on a neighboring field plot without wooded strips (R = reference); the evaporation amounts are given at different distances to the wooded strips to the west and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

Grain yield winter barley on 48 m wide field strip

Climate
adaptation

5,7 t/ha
(Reference)



[9]

Distance to the next wood strip eastern or western

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



Four potential sectors for C-storage in AF



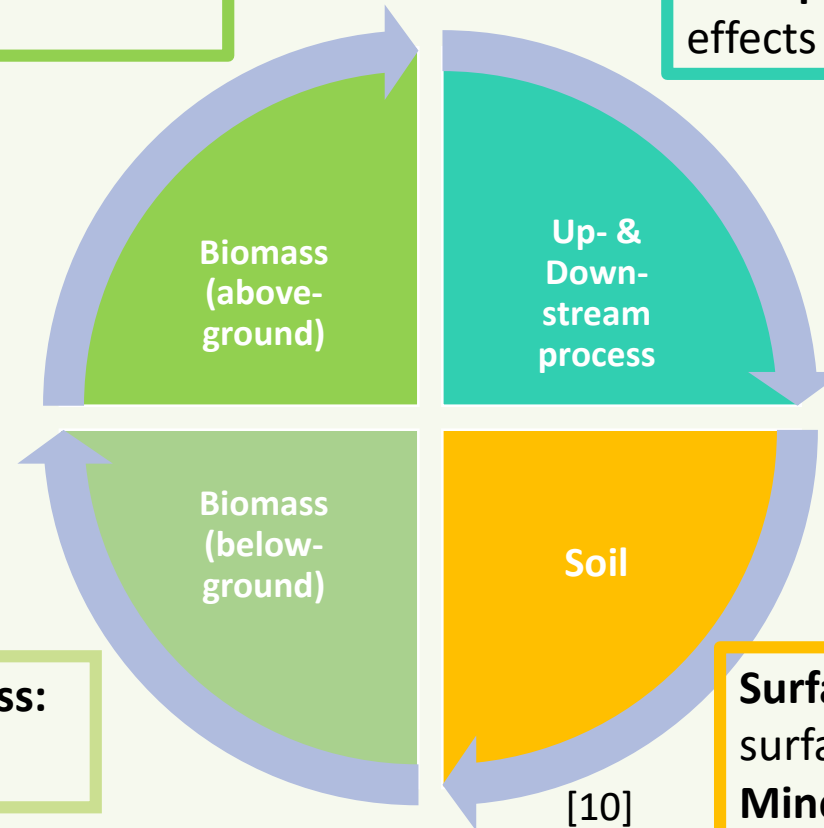
Photo: Elron Wiedermann

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



Photo: Elron Wiedermann

Below-ground biomass:
coarse & fine roots



Management: cultivation method,
PPPs, fertilisers

Use options: processing, substitution
effects

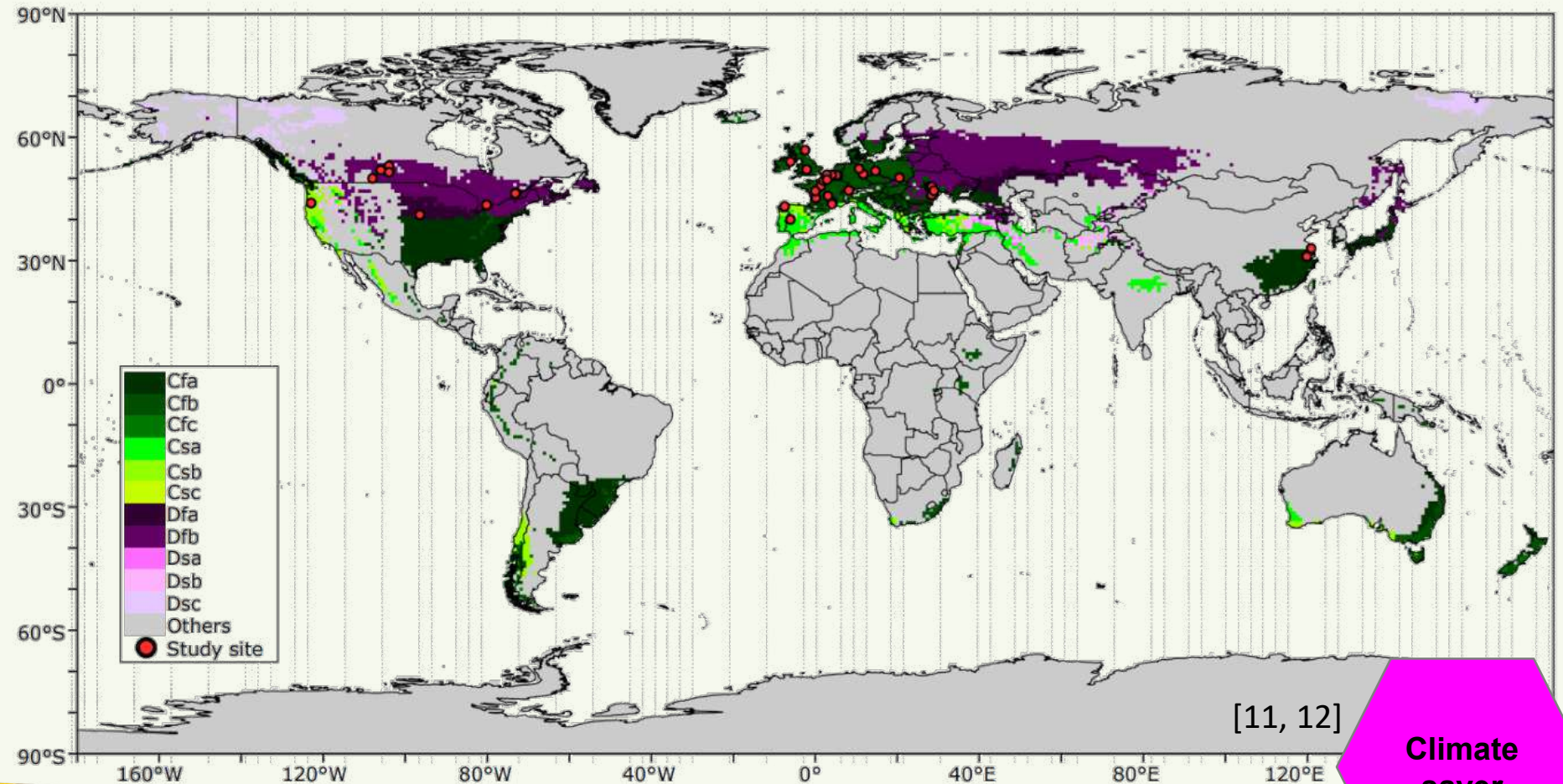


Surface horizon:
surface & leaf litter
Mineral soil:
soil organic carbon (C_{org})

**Climate
saver**

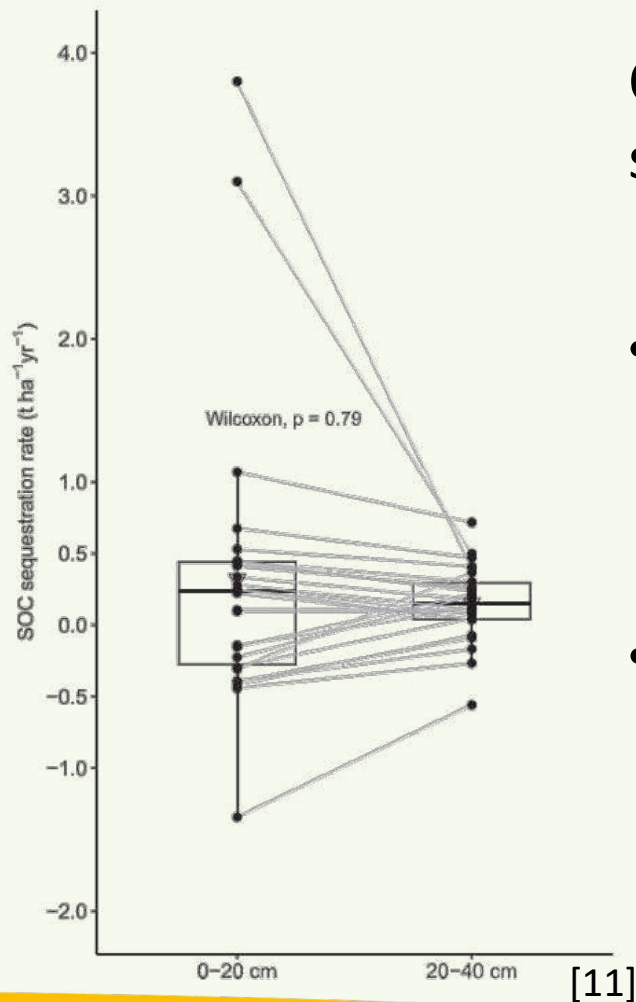
61 study sites & distribution in temperate climate zone

- alley cropping systems (25)
- hedgerows (26)
- silvopastoral systems (10)



Climate
saver

Comparison of SOC sequestration rates



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

- The 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)
- A total number of 17 observations (28% of total observations) showed negative SOC sequestration rates in 0-20 cm as well as 5 plots (19%) in 20-40 cm depth

Climate
saver

Farm #2: Loughgall in Northern Ireland

- 30 years silvopastoral trial
- Full basic payments, full livestock output for 12 years, with grass yields recovering after thinning at 12 and 17 years
- Welfare benefits to sheep from a longer grazing period
- Access to ash leaves for forage
- Environmental benefits (weather amelioration, biodiversity, reduced nitrate losses and ammonia emissions, reduced fire risk, soil porosity increased etc.)
- A measured carbon sequestration rate of 2.5 t C/ha/yr from the trees and 0.8 t C/ha/yr in the soil pasture.



[12]

Photo: Jim McAdam



Converted silvoarable system, Loughgall, NI

[13]

Photo: Jim McAdam



Silvopastoral site: Loughgall, Northern Ireland

Photo: Jim McAdam



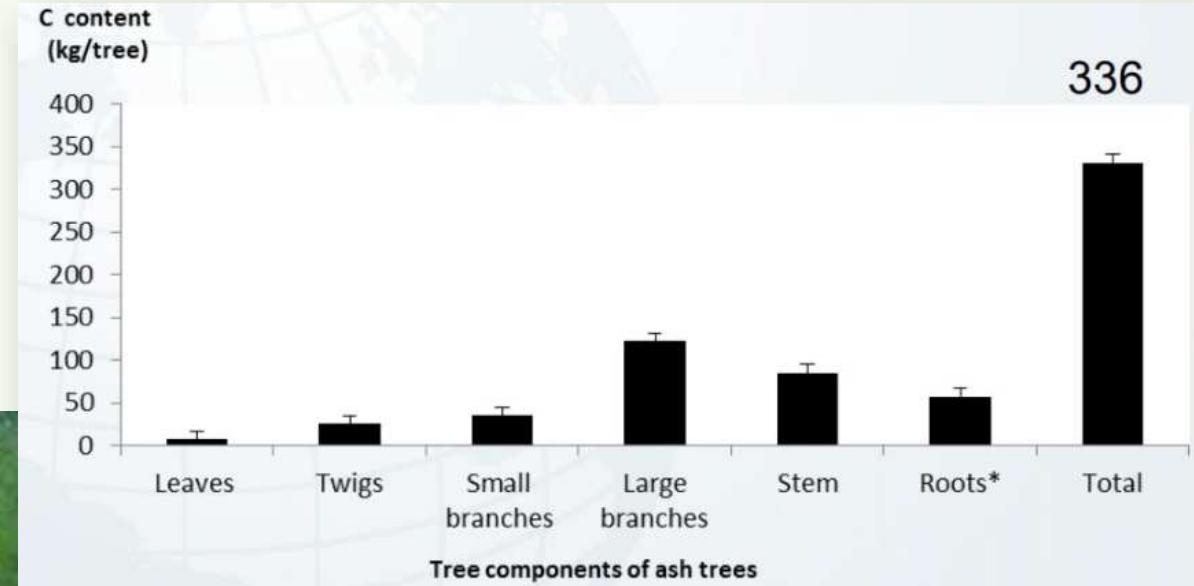
Site visit by students from Bangor University

Tree felling and unrooting

- Tree age: 21 years, measurement of carbon in ash trees (dry mass)



[18]



[12, 15]

total C in wood
biomass 77.28 t/ha

Water
saver

↑ inclusion of legumes & shrubs,
↑ biotope relinking

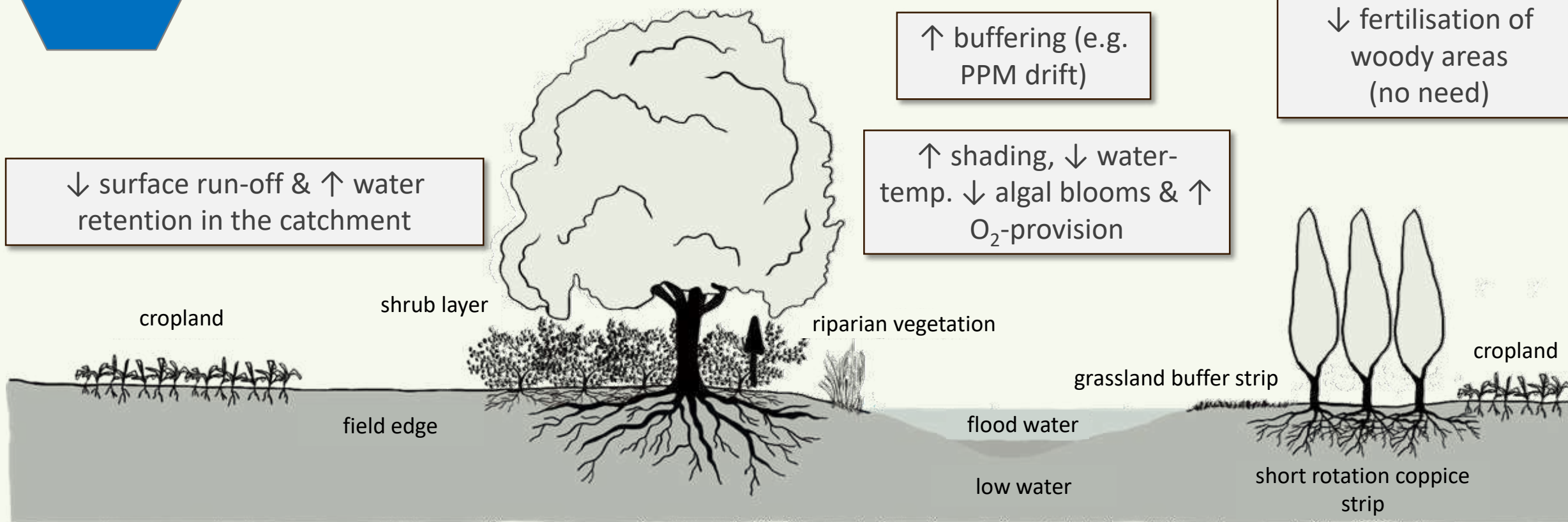


↑ buffering (e.g.
PPM drift)

↓ fertilisation of
woody areas
(no need)

↓ surface run-off & ↑ water
retention in the catchment

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



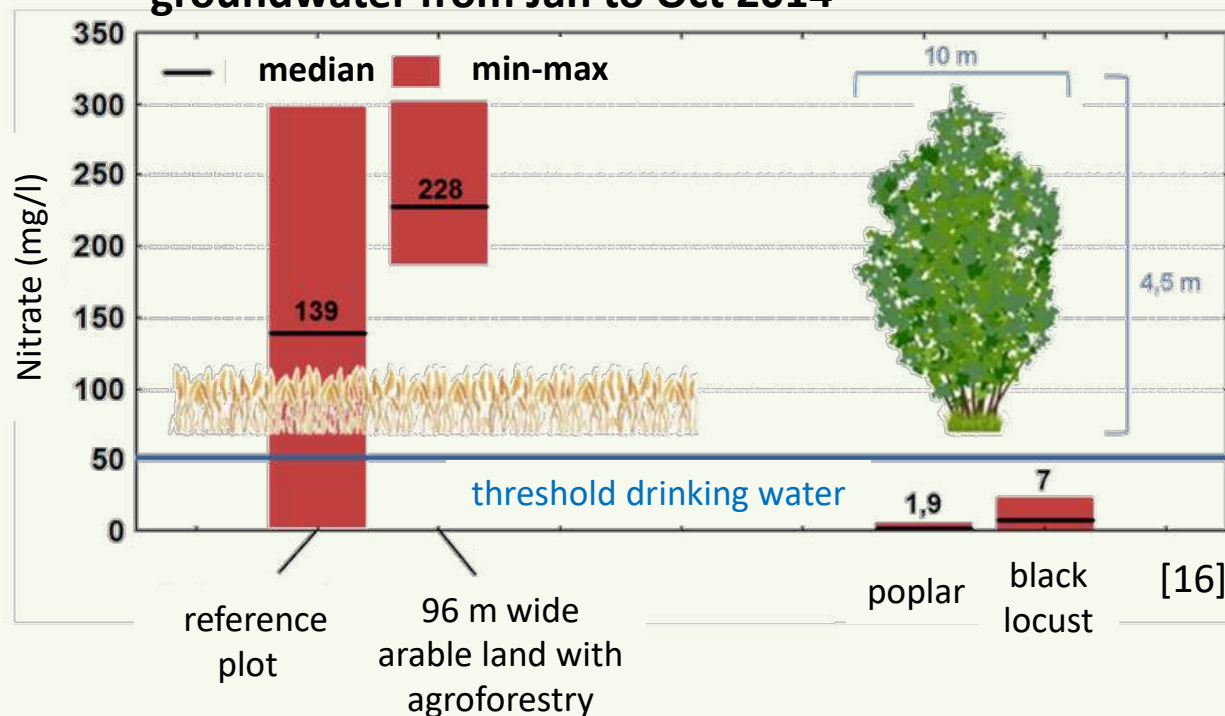
↓ nutrient inputs into the
groundwater

↑ 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

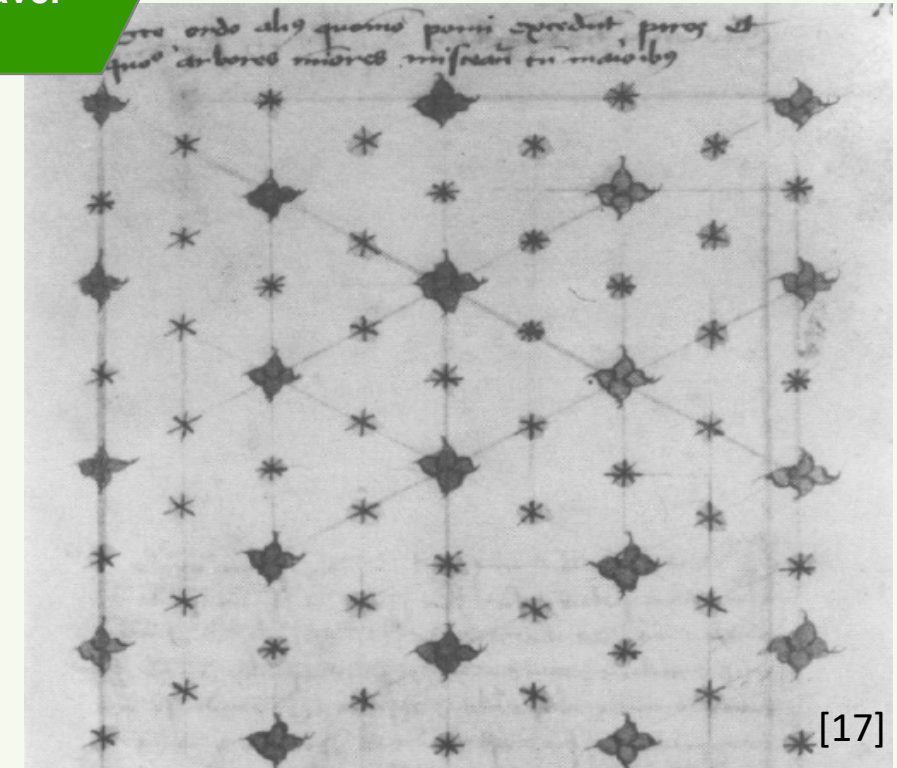


- Measured nitrate concentration in the near-surface groundwater of an alley cropping agroforestry system.
- The risk of leaching in the area of woody plants in agroforestry systems is significantly lower than in arable crops.
- This is not only due to the absence of fertilisers in the area of the woody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

Orchard meadows „Streuobst“ history

Cultural
heritage
saver

- long tradition... first references from 4500 BC.
- cultivation methods and breeding were brought to Germany by the Romans, later monasteries played a role in the spread
- >15th century, fruit trees were mainly grown near settlements, strong increase in the 16th century, as sovereigns ordered fruit trees to be planted to improve the food situation of the population
- 18th and 19th centuries further increase of orchards in Germany



Ecce ordo alius, quomodo pomi excedunt piros, et quomodo arbores minore misceantur cum maioribus

Historic drawing to teach the layout of apple and pear tree planting in a fruit garden (from "Büchlein über das Pflanzen von Bäumen" by monk Konrad Ayrinschmalz from Tegernsee, Bavaria, dated 1479)

Landscape features disappear

Cultural
heritage
saver

- Re-organisation of fruit growing: high-stem orchards were converted to low-stem systems or removed altogether.
- The conversion was supported by government subsidies from DE
- EU CAP financially supported the elimination of traditional agroforestry systems from 1965-1974.
- Between 1951 and 2000, the German orchard population decreased by >70%.
- Bavaria, with 20 million scattered fruit trees in the 1960s – today it is still 5.6 million, decline estimated at about 100,000 trees per year.



Field blocks 1953
and today



Animal health in silvopastoral AFS

Social behavior & grooming

- Cows stand closer, increased social licking behavior (41% of behavior in open pasture vs. 78% in AF).
- Coat & skin care, animal health

Shade & shelter

- In cold weather: ground 6°C warmer than open land
- Wind at 24 km/h cools from 2°C to -7°C (0°C critical temperature of healthy cattle, for every 1 K less, 2% more energy use)
- Reduced calf/lamb mortality (-30%)
- Dairy cows latent heat stress from 18°C, moderate from 20-25°C, inflammation, high cell count (SCC).

Supplementary feed & medicinal effect

- Thigh feed value, proportions possible up to 55% cattle, 76% sheep and 93% goats
- Self-medication when grazing, anti-inflammatory/anti-bacterial/fungal



Economics of animal production

- Silvopastoral AF plots are 42% more productive compared to conventional systems
- Increase in offspring survival rate
- Partially increased weight gain
- Increase in wool production
- Increase in milk yield, +20% (study in Brazil),
 - Lower somatic cell count (SCC) – Milk quality



Animal
welfare



Landscape & Biodiversity

- Promotion of biodiversity: +200% birds, +30% ants, more butterflies.
- Enhancement of the landscape
 - e.g. concealment of unsightly structures
 - Recreational function through shading of field paths, windbreak, richness of variety



Bio-
diversity
saver



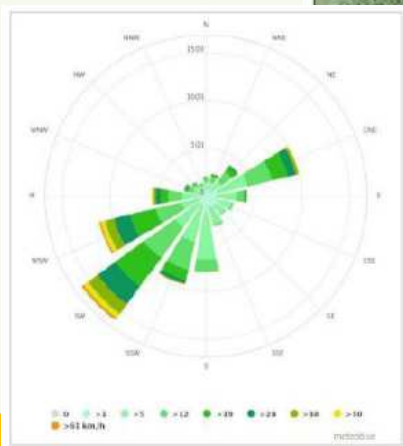
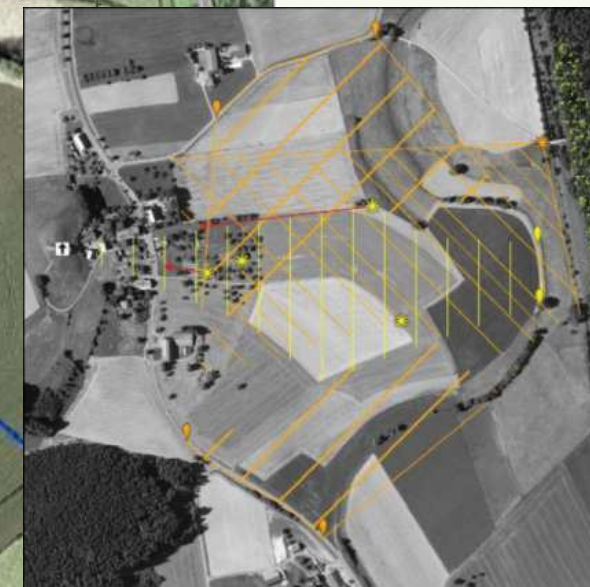
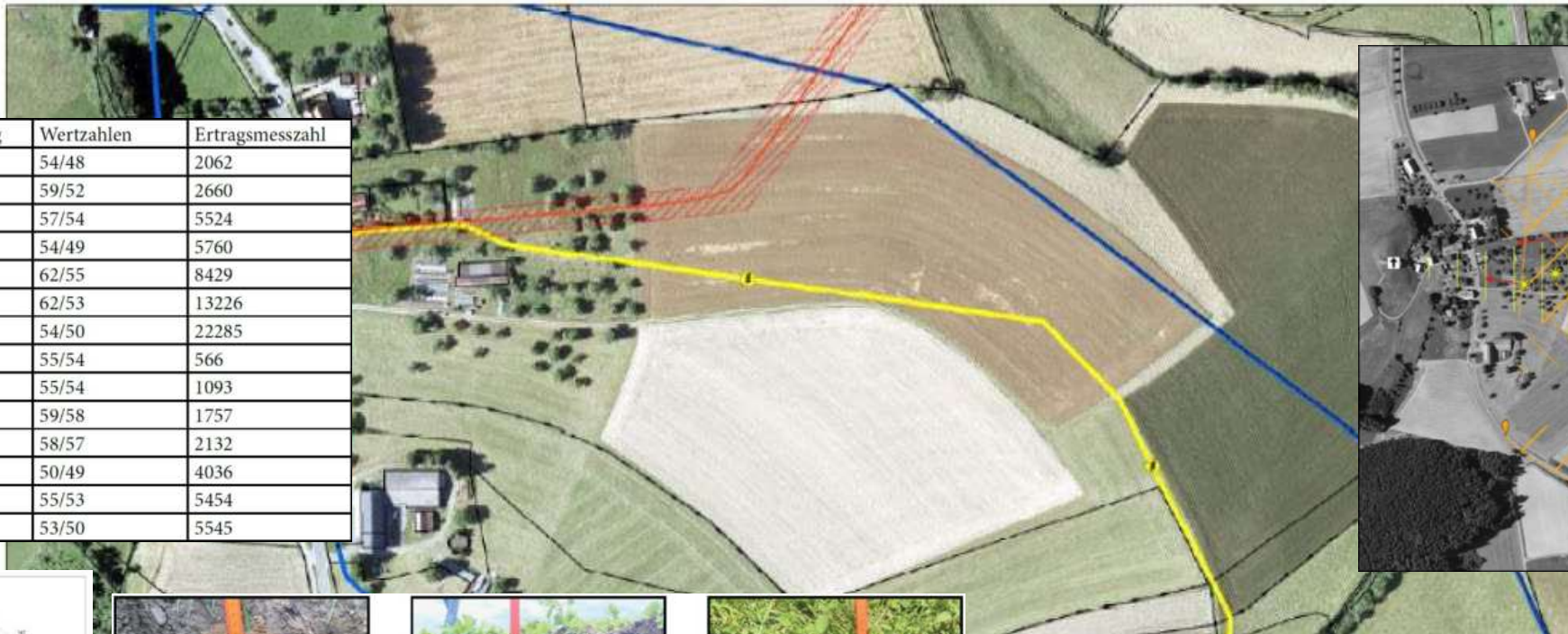
Farm #3: Volkertshaus



Animal
welfare

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



Volkertshaus – results & future



Entwurf M 1:2.500

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

Luftbild: (LGL 2019)



Entwicklung in 30 Jahren M 1:2.500

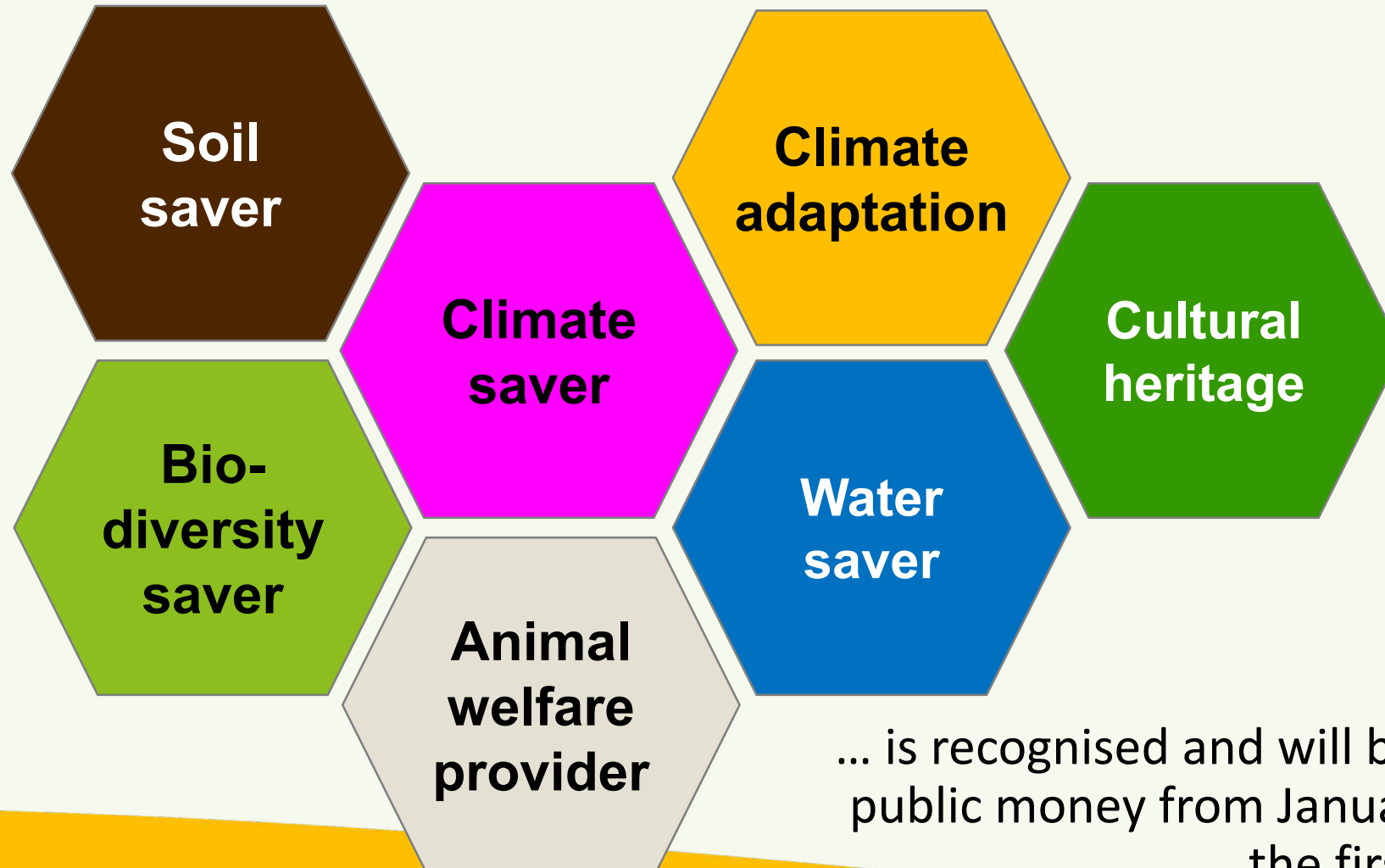
Legende		
Grundlagen		
— Grenze USG	● Wertholz schmale Kronen	— Baumstreifen
	● Wertholz große Kronen	— Windschutz
	● Pioniergehölze schmale Krone	— Blühstreifen
	● Pioniergehölze große Krone	— Beerenobst
	● Streuobstgehölze	■ Beete

Luftbild: (LGL 2019)

0 0,025 0,05 0,1 0,15 0,2 Kilometers

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	

Services by agroforestry as...



... is recognised and will be supported by public money from January 1, 2023 for the first in Germany.

A: Regulation on the implementation of CAP direct payments (GAPDZV, § 4 Abs. 2)

- Legal clarification of AF as **agricultural practice**, safeguarding **direct payments** from the guarantee fund.
- **Status** of land as arable land, permanent grassland or permanent crop remains;
- Agroforestry remains part of the **productive land** and is not set-aside (e.g. GAEC 8);
- In the case of woody plants scattered over the area, their number must be between **50 and 200 per hectare**;
- In the case of agroforestry systems established in strips, there must be at least **two strips** of woody plants and they must occupy no more than **40% of the area**.
- Only tree and shrub species that are not on the negative list may be planted (Annex 1 of the GAPDZV);

Acer negundo – Ash maple

Buddleja davidii – Butterfly bush

Fraxinus pennsylvanica – Red ash tree

Paulownia tomentosa – Bluebell tree

Prunus serotina – Late weeping cherry

Quercus rubra – Red oak

Rhus typhina – Vinegar tree

Robinia pseudoacacia – Black locust

Rosa rugosa – Potato rose

Symphoricarpos albus – Common snowberry



B: EcoScheme #3: "Maintenance of agroforestry management on arable land and permanent grassland"

- In addition to the basic premium **60€ per ha of wooded area**, however, higher requirements for planning and area selection for the area share of the woody strips
- Share of wooded area **2-35%** of the plot, the width of the individual woody **strips must be 3-25 m**
- The maximum distance between two woody strips and between a woody strip and the edge of the area must not exceed **100 m**, the smallest distance (see above) must be at least **20 m** (exception: the distance to the edge of the area may be smaller in areas along or near watercourses).

C: Investive support by CAP-EAFRD

- Inclusion of agroforestry in the GAK framework plan: substantial participation of the Federal State of Germany
- Target: creation of 200,000 ha of agroforestry woodland area in the program period (6 yrs)



[18]



- Bavaria: KULAP I 84 Creation of agroforestry systems*

*As matters stand 5th Oct. 2022

SRC: 1.566 €/ha

Shrubs: 4.138 €/ha

Trees: 5.271 €/ha

Questions? Comments?



1

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2

DeFAF
www.defaf.de

3

Twitter
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[@agroforst_defaf](https://twitter.com/agroforst_defaf)

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