Ecosystem services from integrating perennial polycultures to crop rotation: An assessment.

Potential of lucerne-clover-gras and wildflower compositions in German agriculture

Peter Weißhuhn, Hubert Wiggering
(Universität Potsdam, ZALF)
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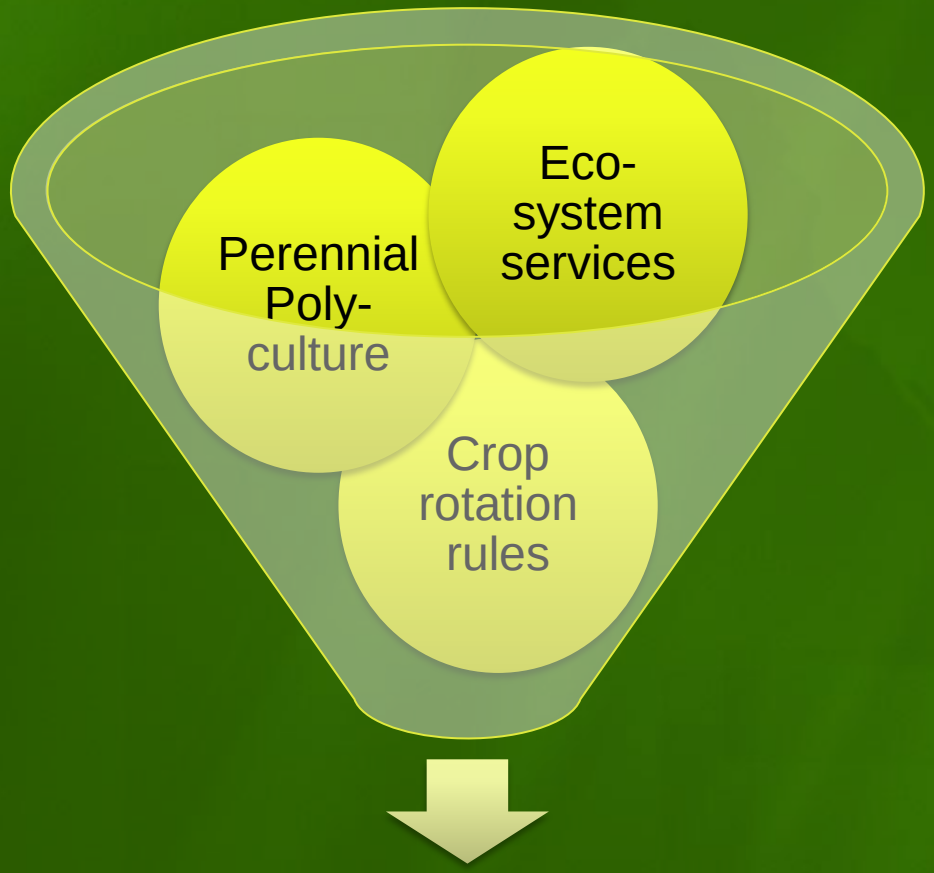
Hypothesis

A way of sustainable intensification is the regular integration of perennial polycultures to agriculture.

Combining approaches



Sustainability Assessment
of cropping systems

P. Weißhuhn, H. Wiggering

What are perennial polycultures?

What are perennial polycultures?

- Polyculture defines itself against monoculture
- Polyculture is similar to mixed cropping, also called intercropping (not the meaning of *„Zwischenfrüchte“*)
- Monoculture is more than „one-crop-rotation“, as every single species cropping is monocultural

- Perennials define itself against annuals
- Herbaceous plants living two or more years
- Perennials here do not include permanent crops, like wine, fruit or other plantations

Two examples…

Lucerne-clover-gras

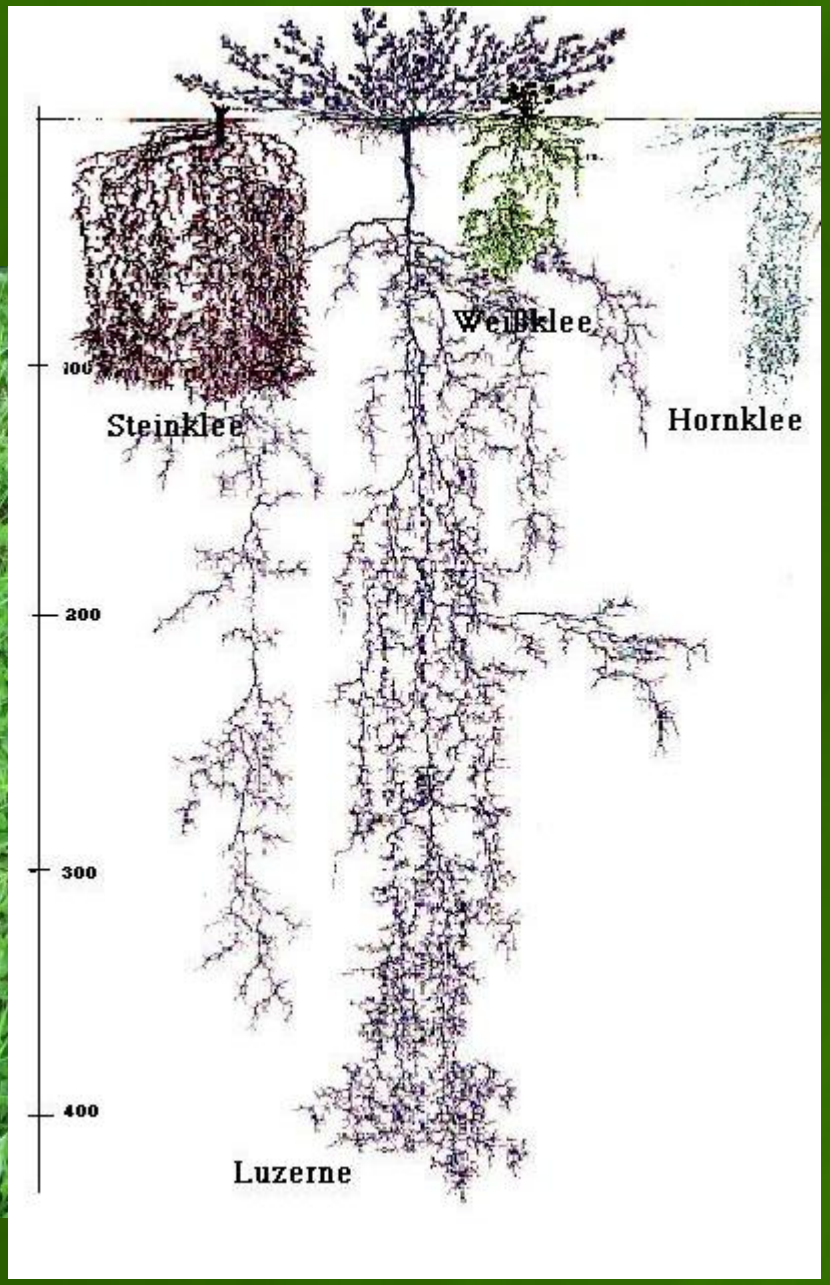
http://bodenfruchtbarkeit.org/fileadmin/bfbk/documents/bofru_themenblatt_gruenbrache.pdf

- 2 year-cropping
- Fodder
- N-fixation

Lucerne-clover-gras

http://commons.wikimedia.org/wiki/File:Medicago_sativa_-_harilik_lutsern_Keilas.jpg

Lucerne-clover-gras



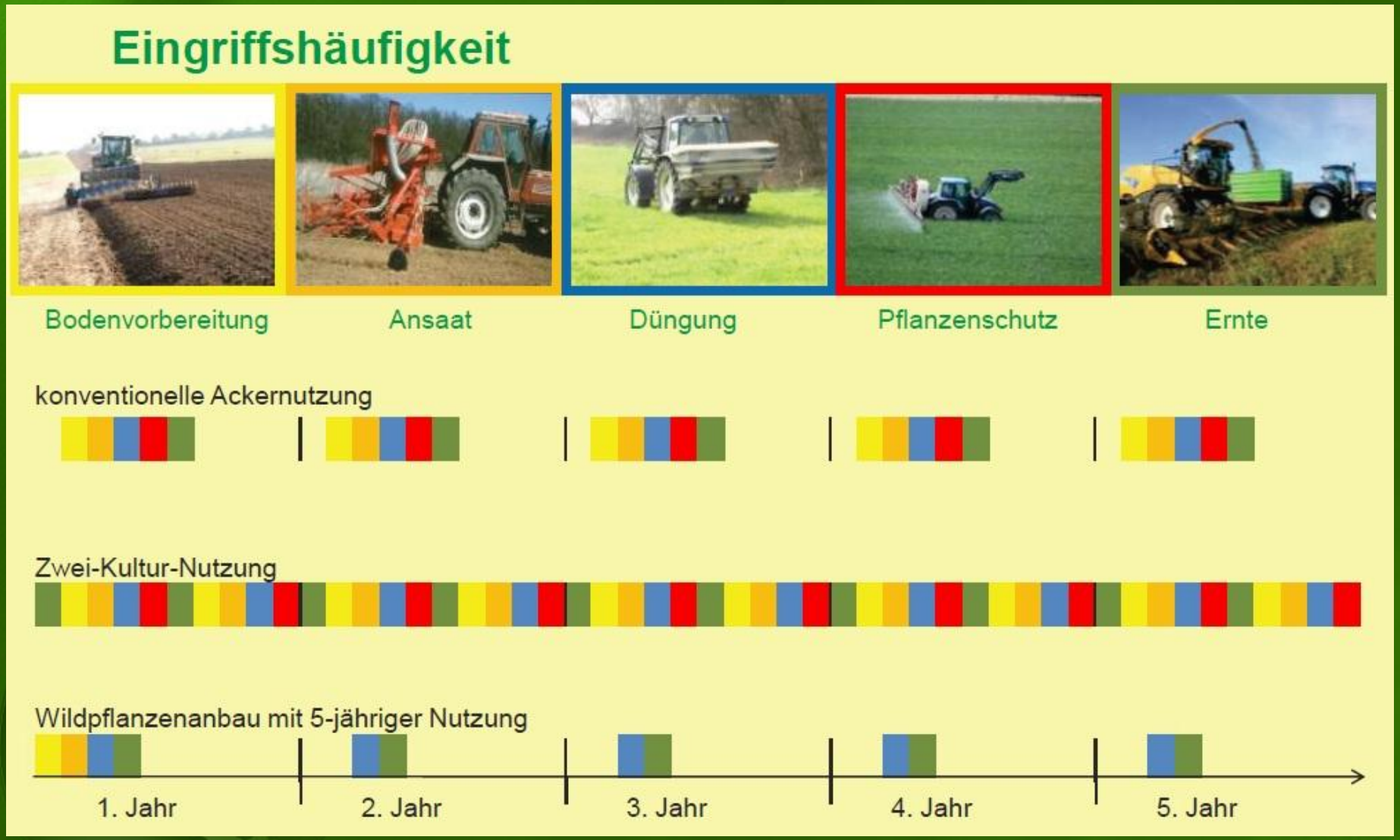
(Braun, Schmidt and Grundler 2009)

Wildflower mixtures

Bayerische Landesanstalt für Weinbau und Gartenbau (LWG) Abteilung Landespflege (2012)

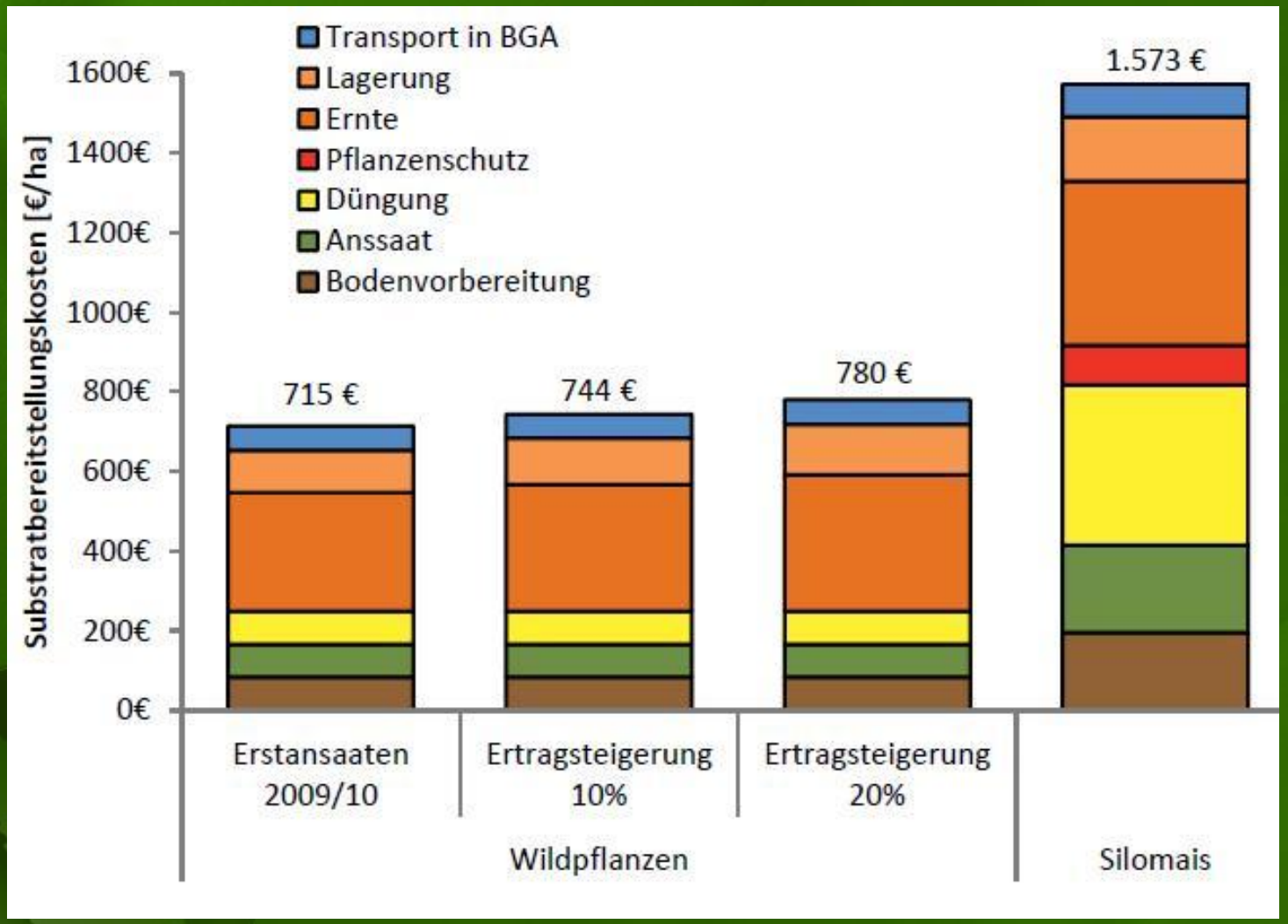
Vollrath et al. (2010)

Wildflower mixtures



Vollrath (2011)

Wildflower mixtures



LWG (2010)

Crop rotation: traditional knowledge reissued?

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General crop rotation rule	Target ecosystem service (according to MEA)
create or maintain tilth	regulating services: erosion control, water storage and discharge
create or maintain soil fertility, e.g. by integration of legumes	supporting services: nutrient cycling (N-fixation, C-accumulation+ release)
Alternation winter & summer seed, integrate perennial forage crops	regulating services: weed control
spaced cropping in accordance with each plant species' requirements	regulating services: plant disease control
extended/ diversified crop rotation	regulating services: pest control

The Role of ecosystem maturity

The role of ecosystem maturity

Attribute	Young System	Mature System
Organic material	less	much
Biodiversity	low	high
Growing pattern	r-selecting	K-selecting
Nutrients	highly exchanged, free	incorporated, detritus recycling inevitable
Species interaction	low development	highly developed
Disruption resistance	low	high
Production „doctrine“	quantity	quality

Succession

after Odum (1969)

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after Odum (1969)

Cultivation

The role of ecosystem maturity

4 phases:

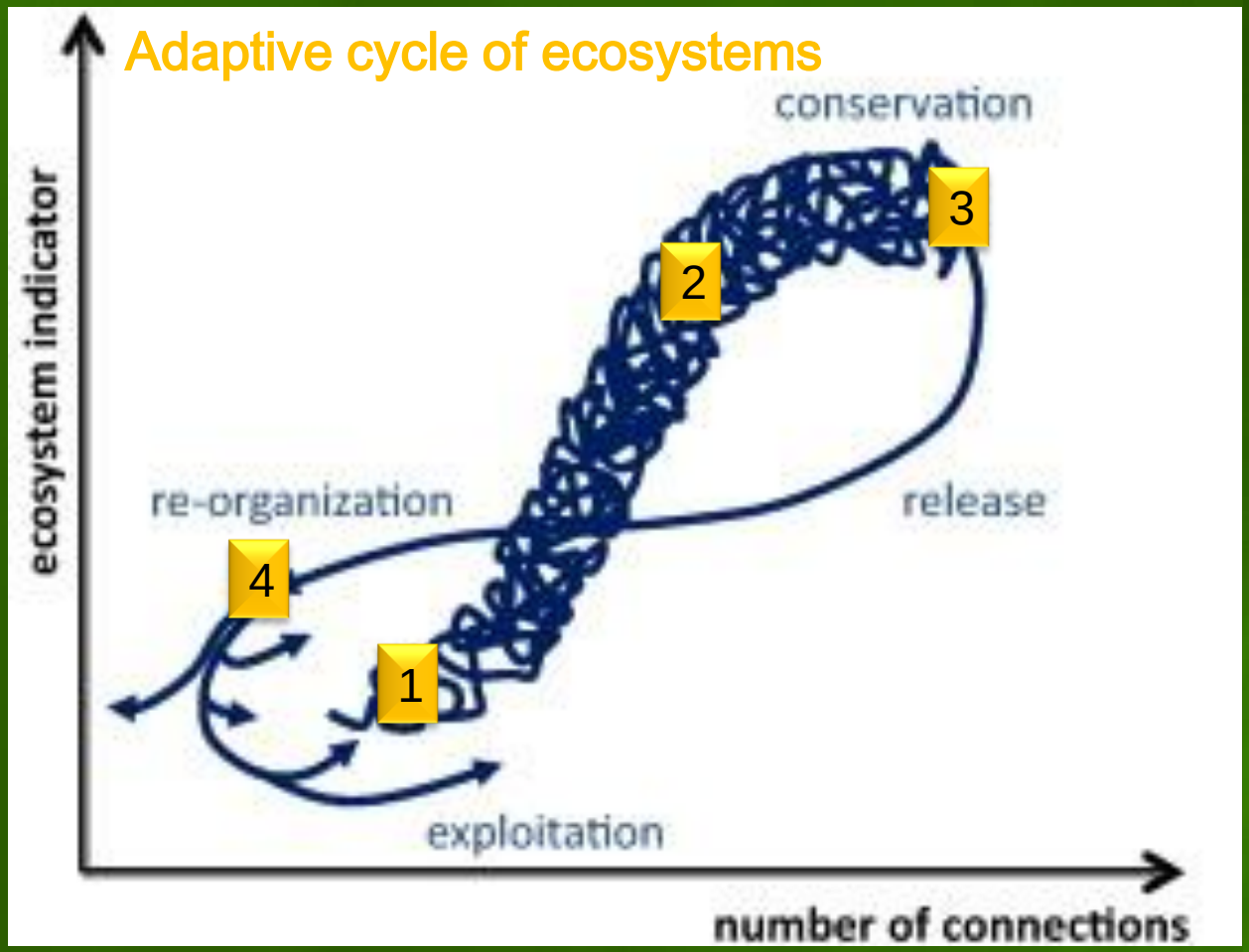
1) = r

2) = K

3) = Ω

4) = α

original metaphor from Holling (1973)



after Burkhard et al. (2011)

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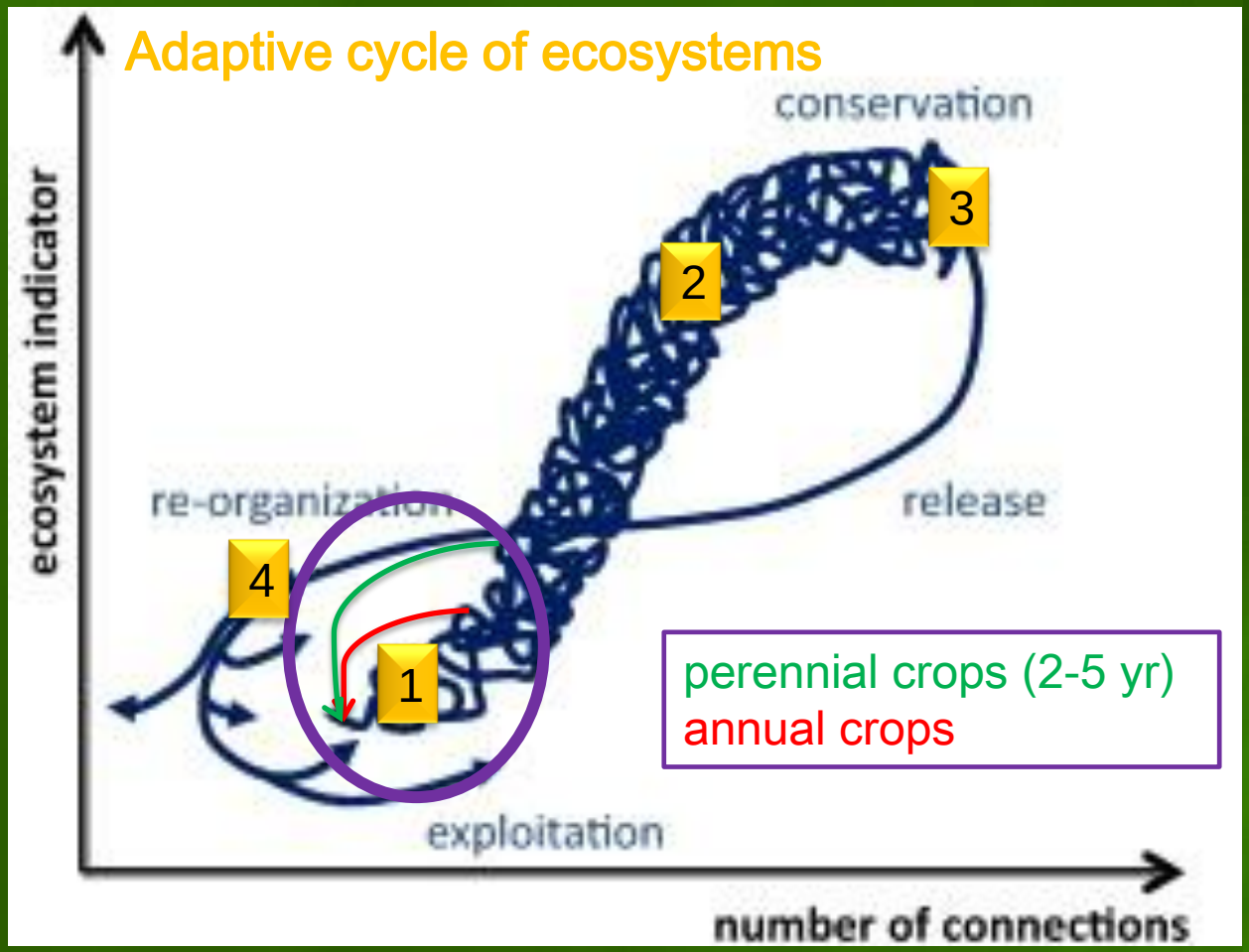

after Burkhard et al. (2011)

Which ecosystem services?

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Agricultural context

Biomass production	Landscape aesthetics
Soil fertility	Erosion control
Water regulation	Climate regulation
Pollination	Pest control
Weed control	Protection against threats*

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*Charges could be soil compaction or contamination

Comparison

Comparison to a reference crop

Reference: idealized intensive cropping system with annual cultures, including externalities of the necessary production measures

qualitative categories:

++	considerably better performance
+	better performance
≈	Indifferent or equal performance
-	worse performance
--	considerably worse performance

Comparison to a reference crop

Ecosystem service	Lucerne-clover gras	Wildflower composition	Reference culture
Soil fertility	++	+	0
Biomass production	--	-	0
Protection against threats	++	+	0
Erosion control	++	++	0
Water balance	+	≈	0
Climate regulation	++	++	0
Pollination	≈	++	0
Pest regulation	+	++	0
Weed control	+	++	0
Landscape aesthetics	+	++	0

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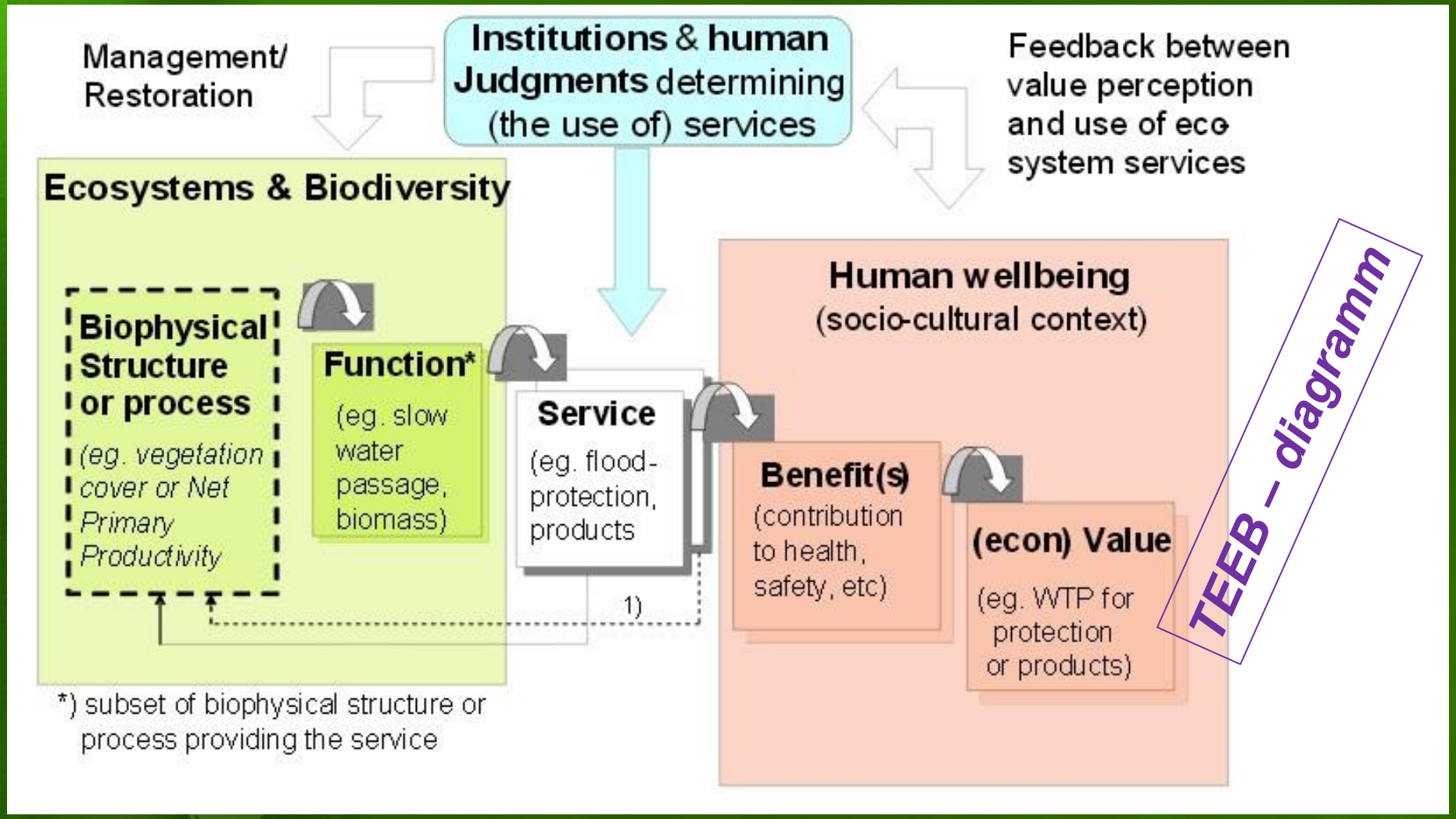
So why not yet implemented?

So why not yet implemented?

- Lower yield
- Higher seed costs
- Not efficient with high soil prices („good soils“)
- Not for food production, but fodder and biogas
- Weed control in the years after the perennial polyculture
- Multiple ecosystem services of agriculture not rewarded
- Insufficient farmer‘s knowledge on handling

THANKS FOR YOUR ATTENTION

weisshuhn@zalf.de


Management/
Restoration
Institutions & human
Judgments determining
(the use of) services
Feedback between
value perception
and use of eco
system services
Ecosystems & Biodiversity
Biophysical
Structure
or process
(eg. vegetation
cover or Net
Primary
Productivity
Function*
(eg. slow
water
passage,
biomass)
Service
(eg. flood-
protection,
products
1)
Human wellbeing
(socio-cultural context)
Benefit(s)
(contribution
to health,
safety, etc)
(econ) Value
(eg. WTP for
protection
or products)
TEEB - diagramm
*) subset of biophysical structure or
process providing the service