

Soil as natural capital
Ecosystem services and
farmers economy

SOIL SERVICE project (FP7)
Katarina Hedlund Lund university



SOIL SERVICE project



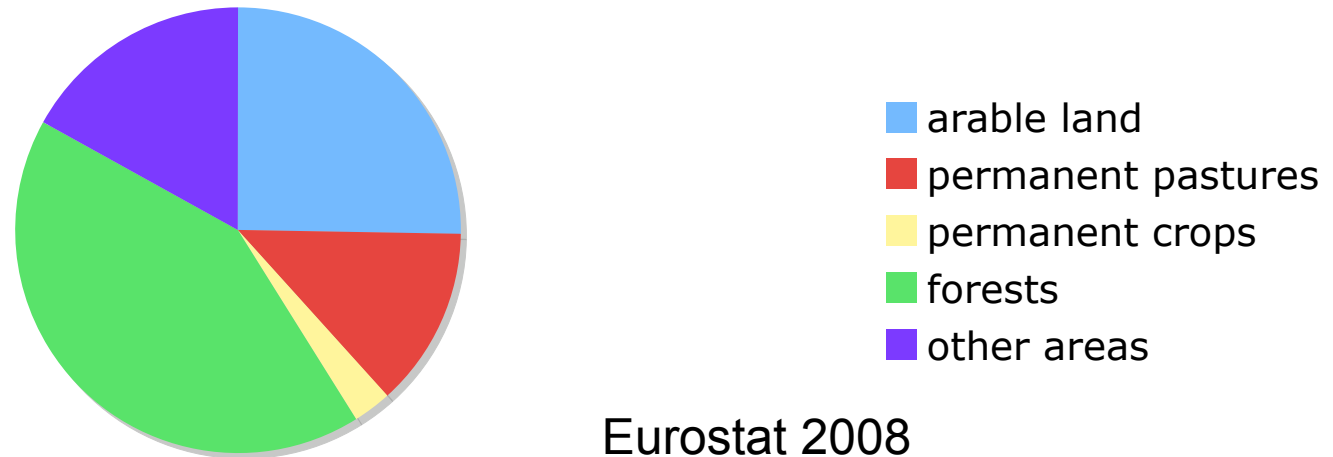


Land use projections

- Production of goods is increasing
 - Food, biofuels, timber, water use
- Natural habitats are declining
- Mitigating climate change
 - Increased pressure on land for production of biomass

Current land use in Europe

Land use in EU-27



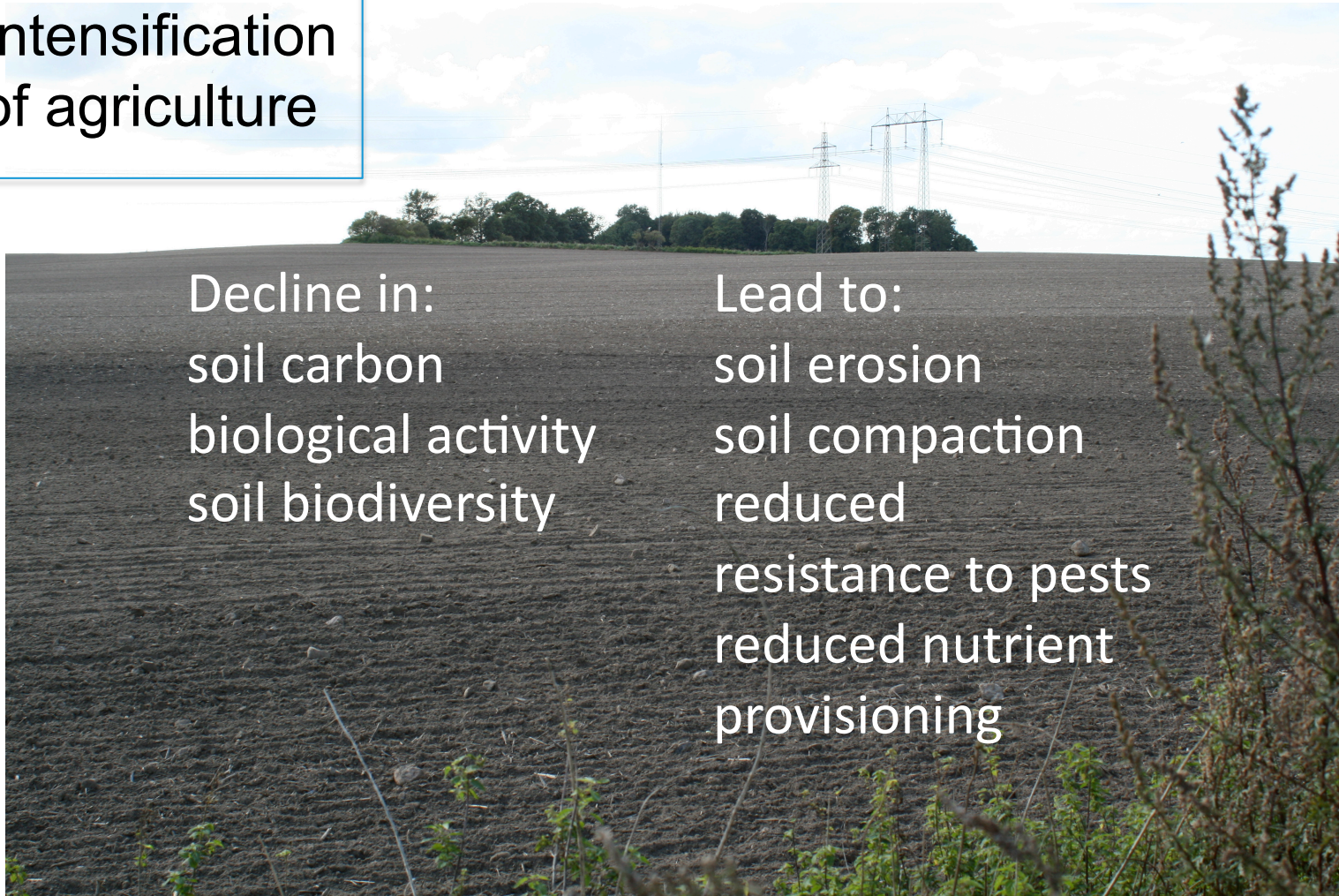


Agriculture and soil threats

Intensification of agriculture

Decline in:
soil carbon
biological activity
soil biodiversity

Lead to:
soil erosion
soil compaction
reduced
resistance to pests
reduced nutrient
provisioning





How to conserve ecosystem services and biodiversity ?

Protected areas

Extensification

Heterogeneity in landscapes

Integrate ecosystem services in intensive management

- Cover crops
- Variable crop rotations
- Low tillage farming



Biodiversity and ecosystem services

infectious disease mediation

crop production

forest production

regional climate and air quality regulation

preserving habitats and biodiversity

carbon sequestration

water quality regulation

water flow regulation

natural ecosystem

infectious disease mediation

crop production

forest production

regional climate and air quality regulation

preserving habitats and biodiversity

carbon sequestration

water quality regulation

water flow regulation

intensive cropland

infectious disease mediation

crop production

forest production

regional climate and air quality regulation

preserving habitats and biodiversity

carbon sequestration

water quality regulation

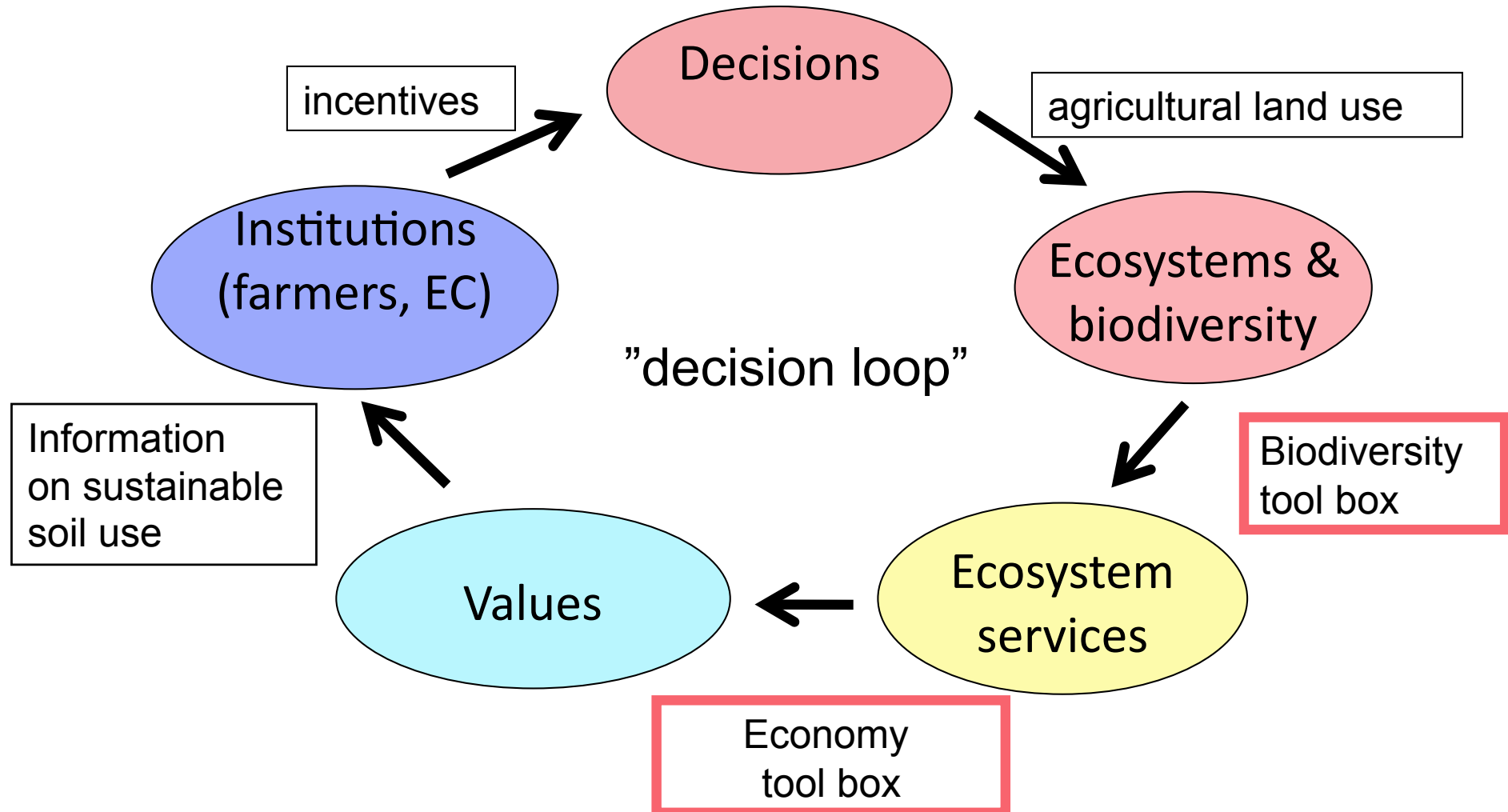
water flow regulation

cropland with restored ecosystem services

Foley et al Science 2005



Using ecosystem services for decisions



After Daaily et al 2009



Soil is a natural capital

Soil biodiversity

Actions and interactions among soil organisms

feeding
digging burrows
mycorrhiza



Ecosystem services

Nutrient retention
Carbon storage
Water retention
Resistance to pests
Regulation of above ground diversity



Ecosystem goods

Food
Feed
Biofuel
Clean water
Climate mitigation



SOIL SERVICE study regions



Regions for soil biodiversity and farm economy studies



SOIL SERVICE Field studies

Gradient of intensive crop rotation
to pastures in each region



Sweden



Greece



Biodiversity tool box



Soil
biodiversity



Ecosystem
services

Agricultural
land use:

crop rotation
biofuel crops
pastures

Link diversity to
functions:

biodiversity
food webs

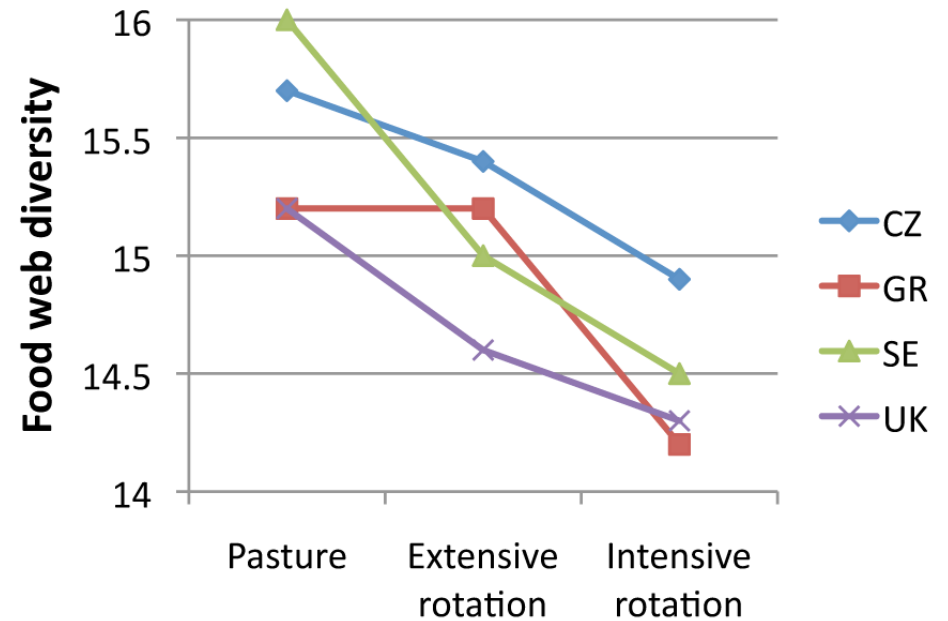
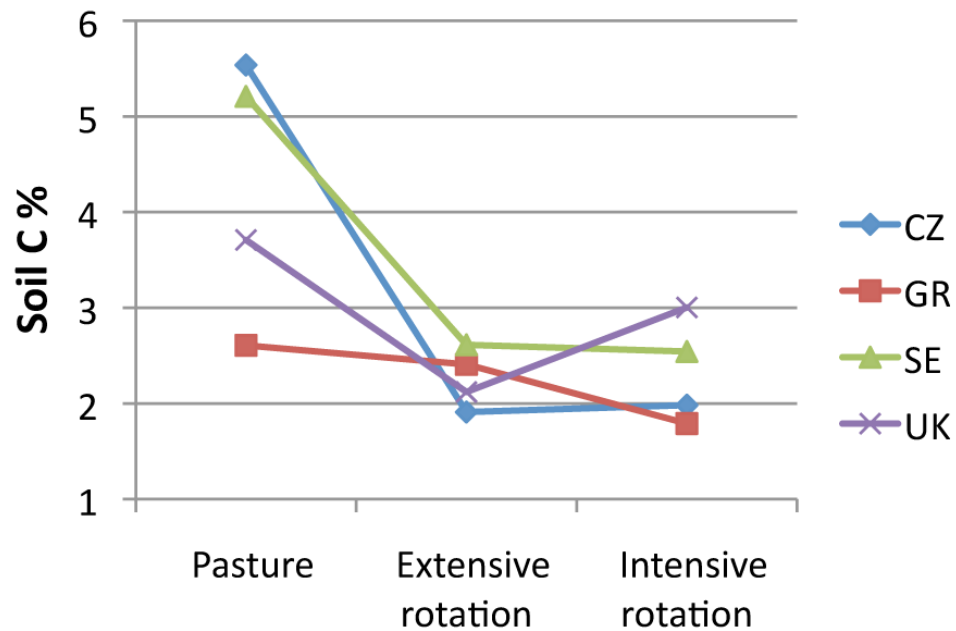
Quantify ES:

nutrient retention
carbon retention
resistance to pests
stability of services



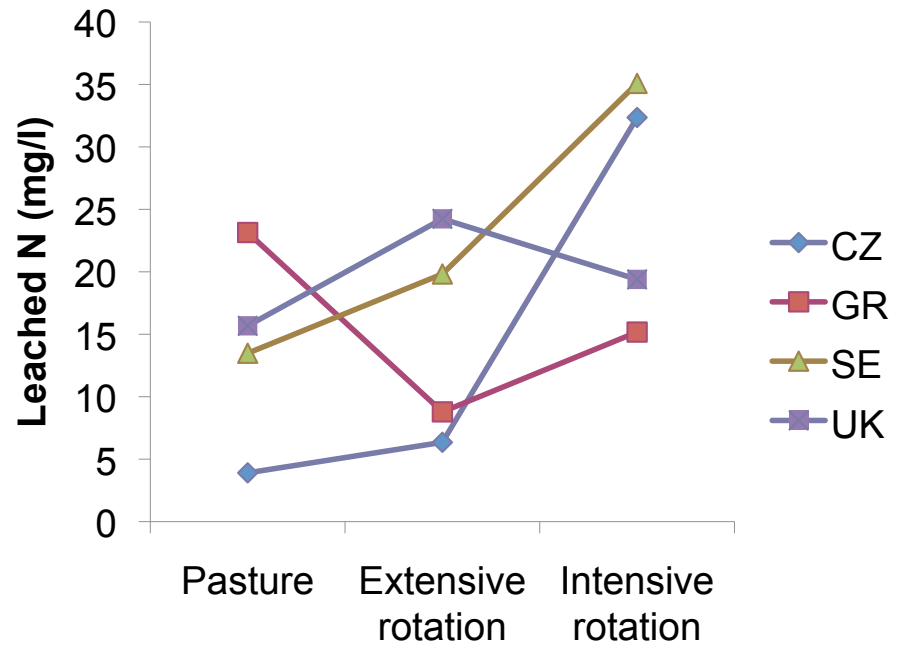
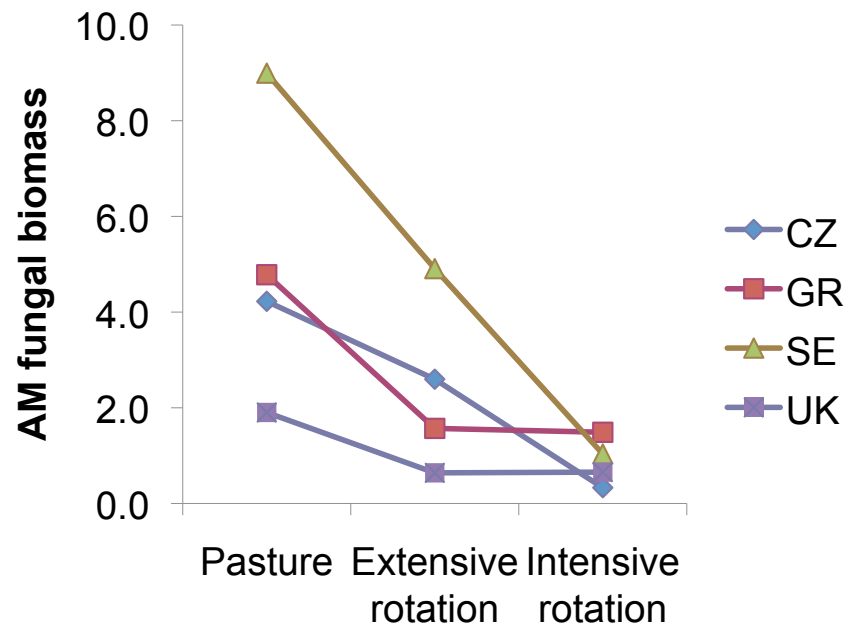
Soil biodiversity and agriculture

soil biodiversity—correlated to ecosystem services





Nutrient retention





Soil biodiversity & intensive agriculture

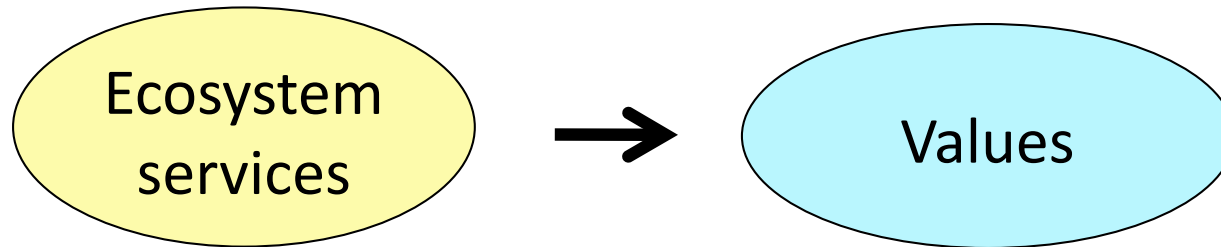
Pastures to crop rotation:

- Reduce species diversity
- Lower food chain length
- Soil carbon: 10 – 0.8 %C
- Soil nitrogen: 0.4 - 0.1%N
- Phosphorous uptake by AM fungi: from 150 to 15 kg/ha
- Reduced soil mixing: from 100 to 5 tons/ha





Economy tool box



Link production of services with beneficiaries

farmers

society

(Mark Brady Agrifood)



"Natural Capital" - The ecosystem services from nature which are essential for human life.

A screenshot of the Bank of Natural Capital website. The header is dark blue with the logo on the left, a search bar, and navigation links for Home, About, RSS, Instagram, Facebook, and Twitter. A secondary navigation bar contains links for Current Account, Natural Capital, Ecosystem Services (with a dropdown arrow), Stocks & Investments, and Advice & Guidance. The main content area features a large image of a forest with a fallen log. Overlaid on the image is the text 'Valuing the invaluable' in large white font, followed by a quote in an orange box: 'It's your wealth and your childrens' heritage that is being squandered when ecosystems and biodiversity are lost.' Below the quote is a 'Read more >' link.

BANK OF NATURAL CAPITAL
PART OF THE TEEB STUDY

Home About RSS Instagram Facebook Twitter

Current Account | Natural Capital | Ecosystem Services ▼ | Stocks & Investments | Advice & Guidance

Valuing the invaluable

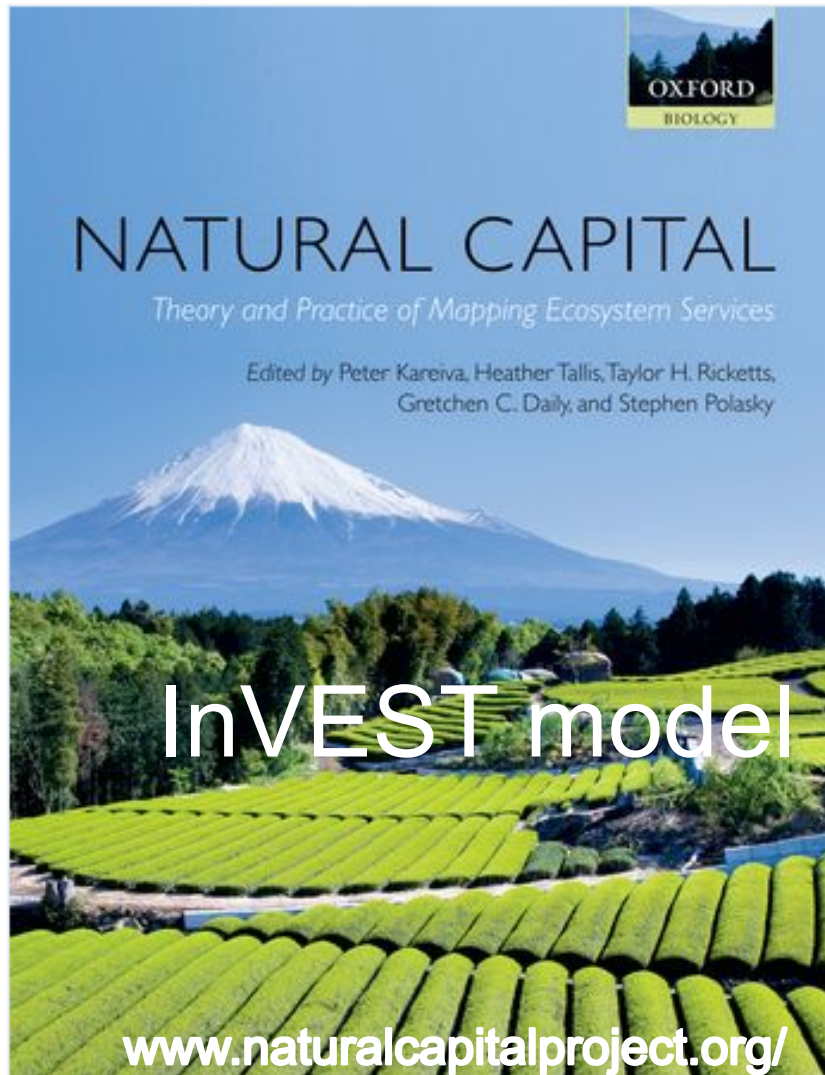
It's your wealth and your childrens' heritage that is being squandered when ecosystems and biodiversity are lost.

[Read more >](#)

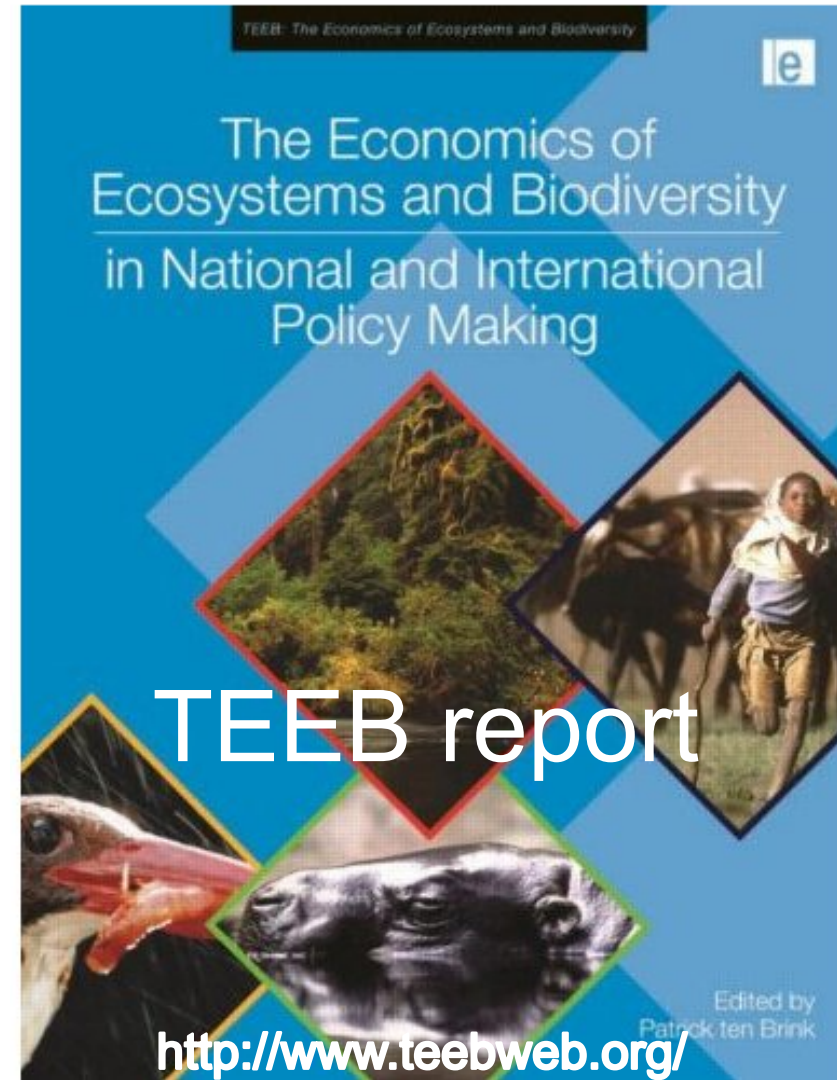
<http://bankofnaturalcapital.com/category/ecosystem-services/agriculture/>



Valuation of ecosystem services



InVEST model



TEEB report



Value of the soil ecosystem services

Value to farmers

- Fertile soils
- Water retention
- Less erosion
- Less use of
 - fertilizers
 - pesticides

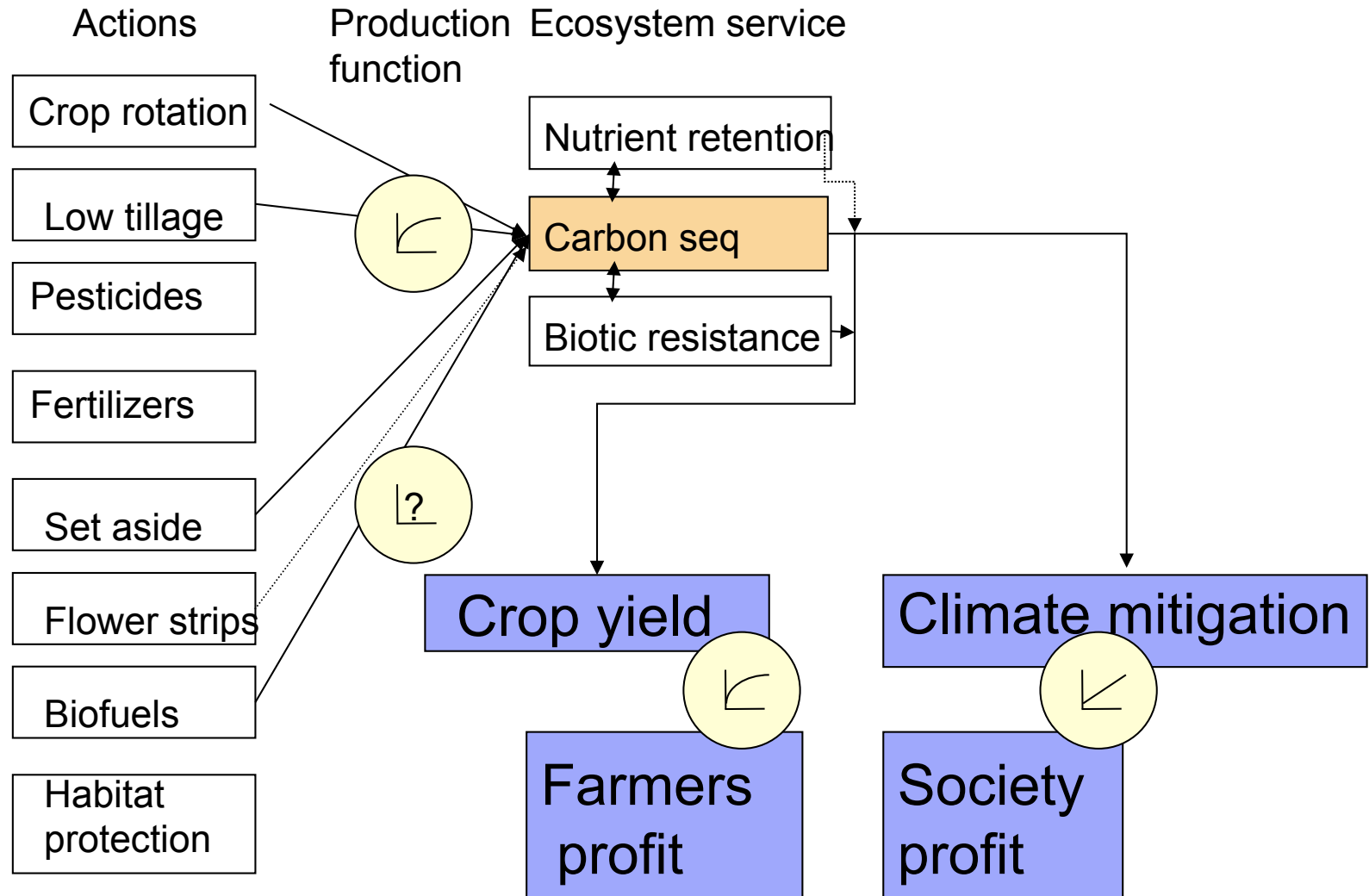
Value to society

- Reduce eutrofication
- Clean water
- Carbon retention

€?



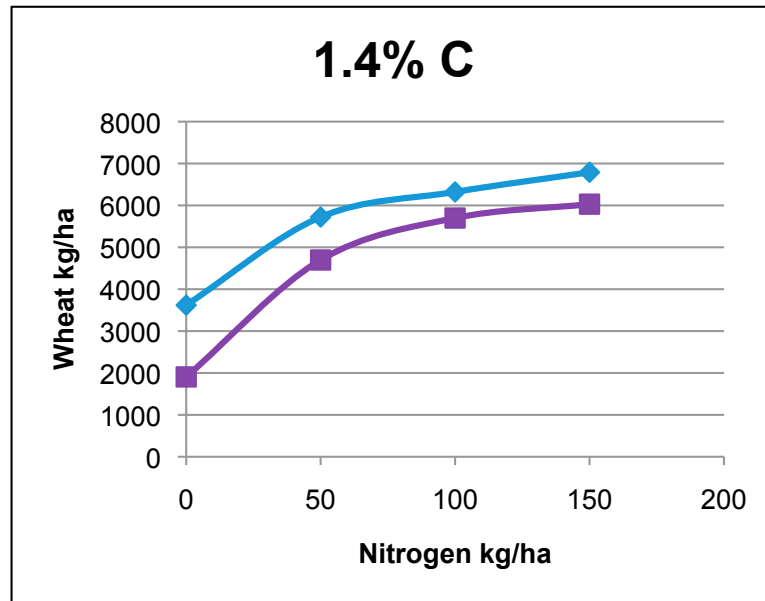
Valuation of ecosystem services



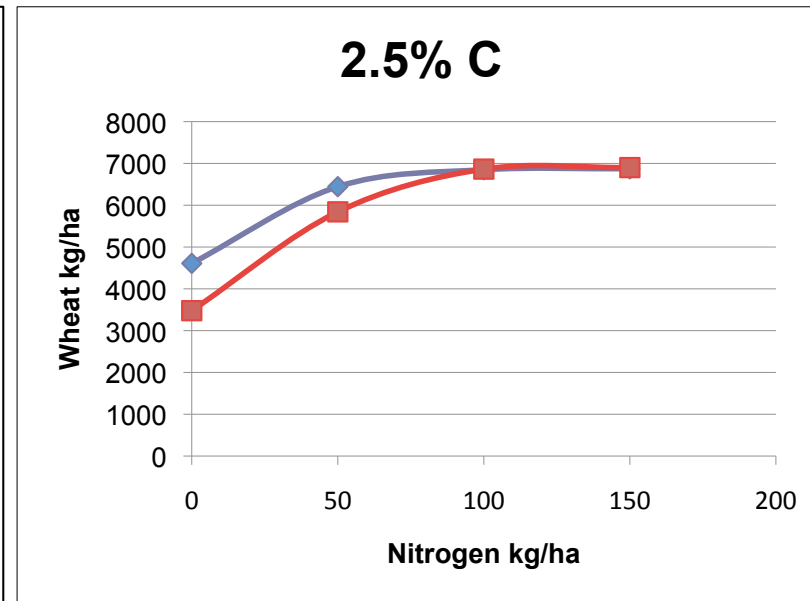


Agricultural production functions

Farm A



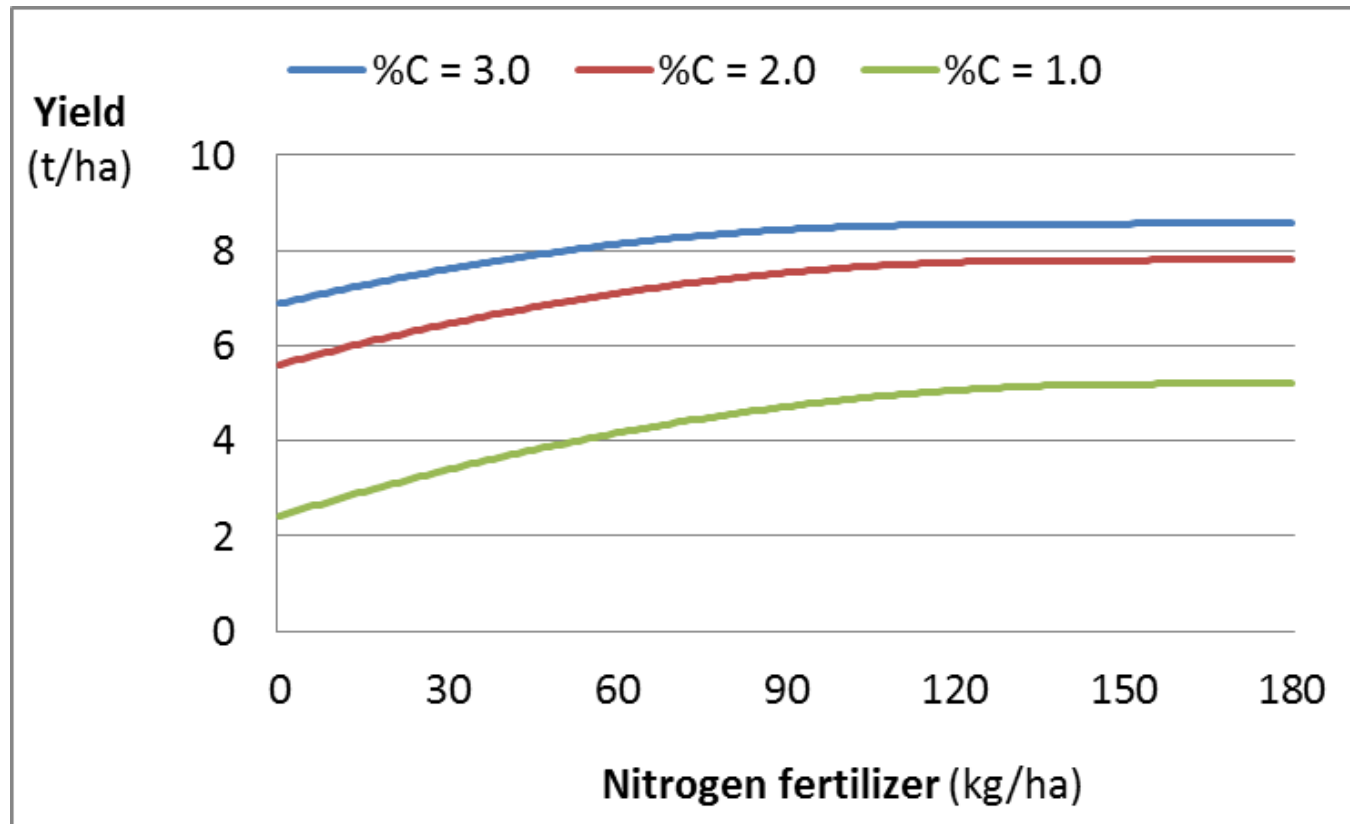
Farm B



0.2 % C between the treatments

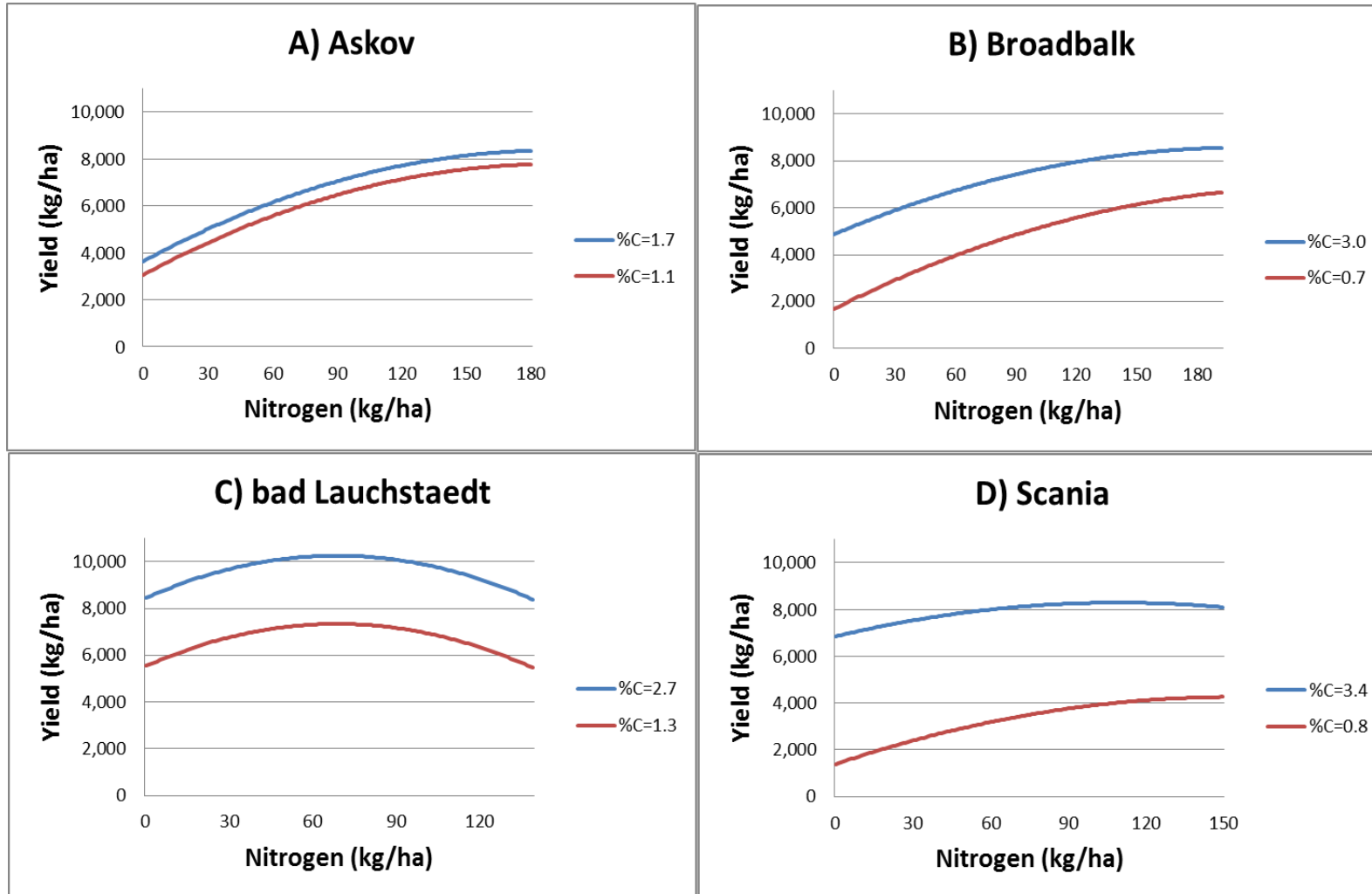


Economic valuation: Carbon a currency for natural capital





Effect of changing soil natural capital on wheat yield





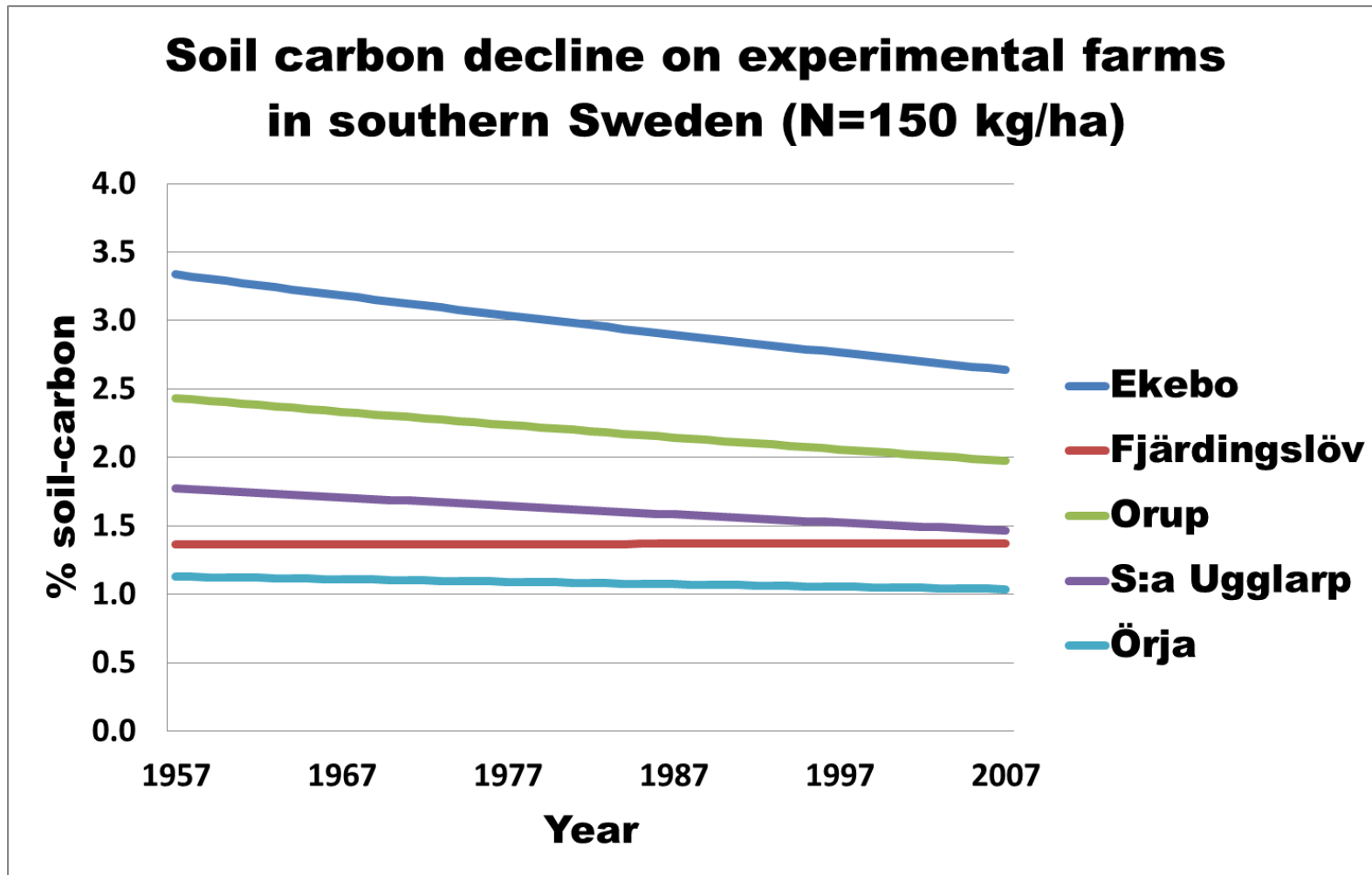
How can we affect Soil C

Management	C decline per year	
Intensive cereal production	-1.0%	UK
Inorganic fertilisers	-0.5%	SE
Farm yard manure (5 ton/ha)	-0.2%	SE
Straw addition (3 ton/ha)	-0.2%	DK

Management	C increase per year	
Cover crops	0.2%	FR
Straw addition (12 ton/ha)	0.3%	DK
Farm yard manure (35 ton/ha)	0.4%	UK
Sewage sludge	0.9%	SE
Miscanthus grass (bioenergy)	?	



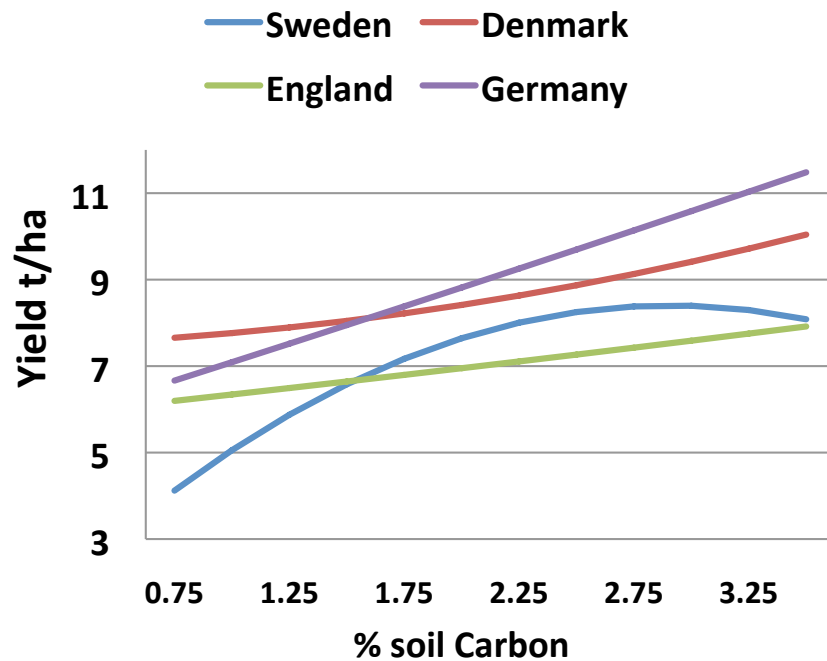
Long term decline of soil-C in Europe



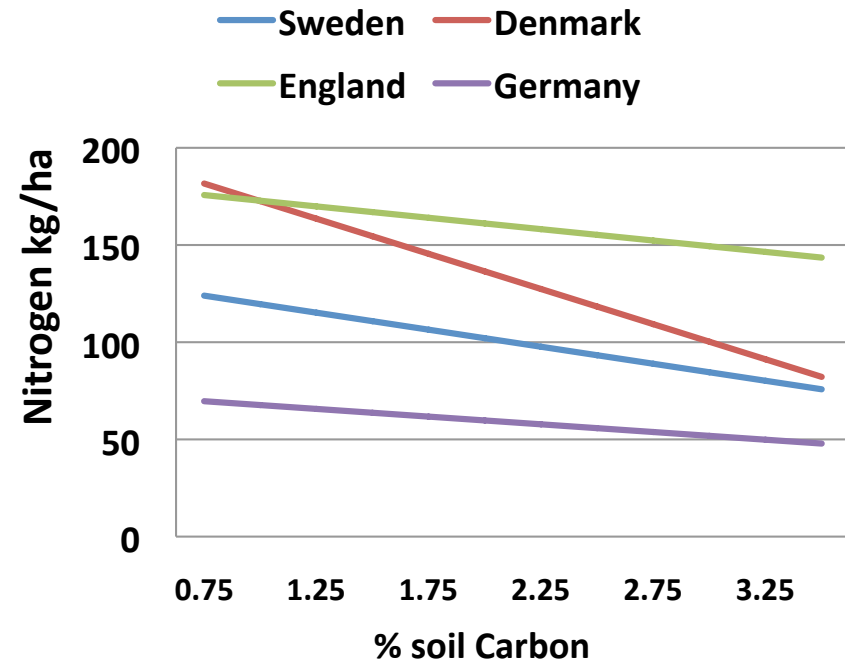


Optimal use of soil C

Optimal yield

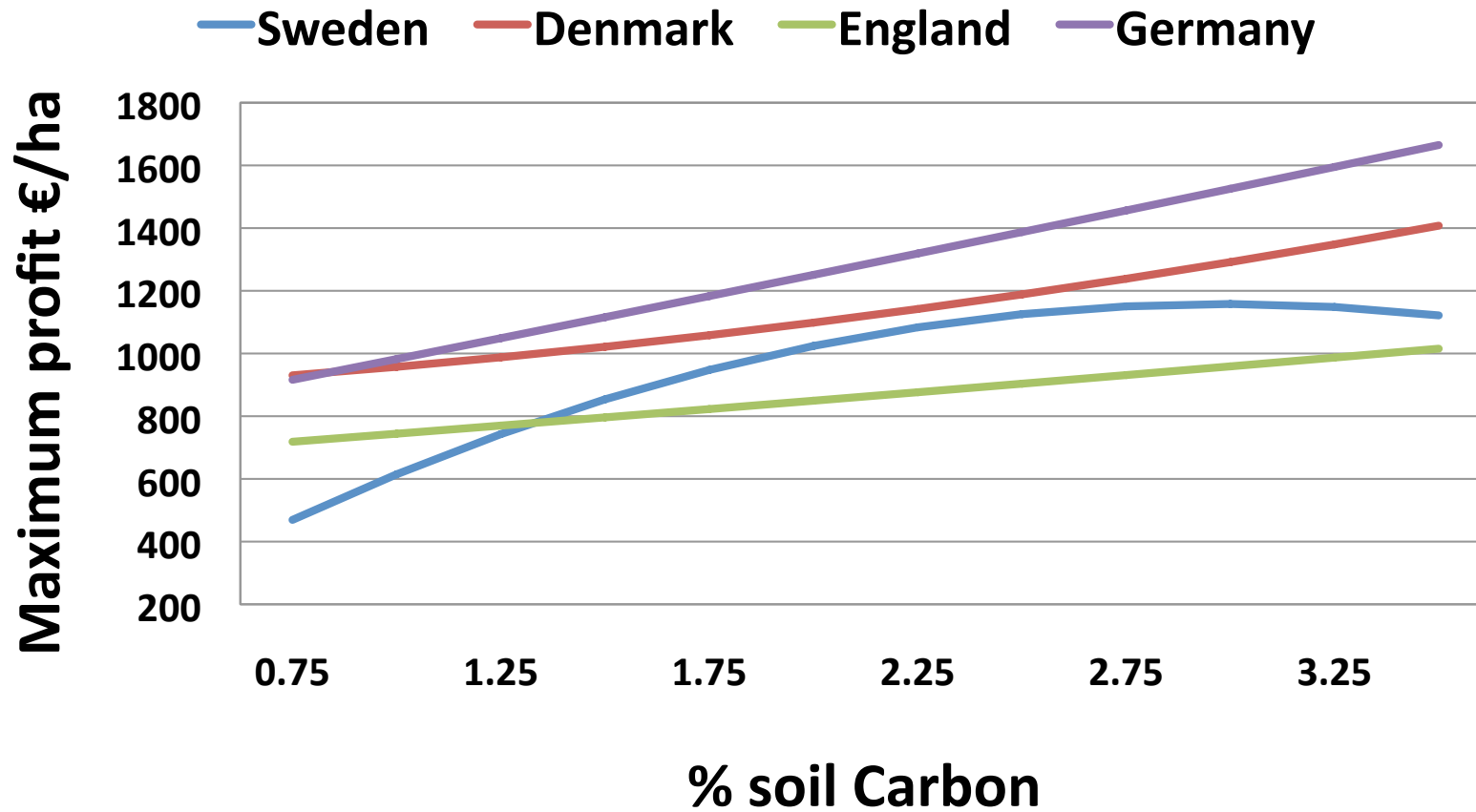


Optimal fertiliser use





Carbon a natural capital





Scenarios for predicting the future

	World Market	Regional Enterprise	Global Sustainability	Local Stewardship
Yields	High	Medium	Medium	Low
Crop Price	Low	Low	Low	Medium
Energy price	Low	Medium	Medium	High
Global pop	Low	High	Low	Medium

Adopted from the ACCELERATES project
(Abildtrup, et al. 2006)



Farm profits and C change in 2035

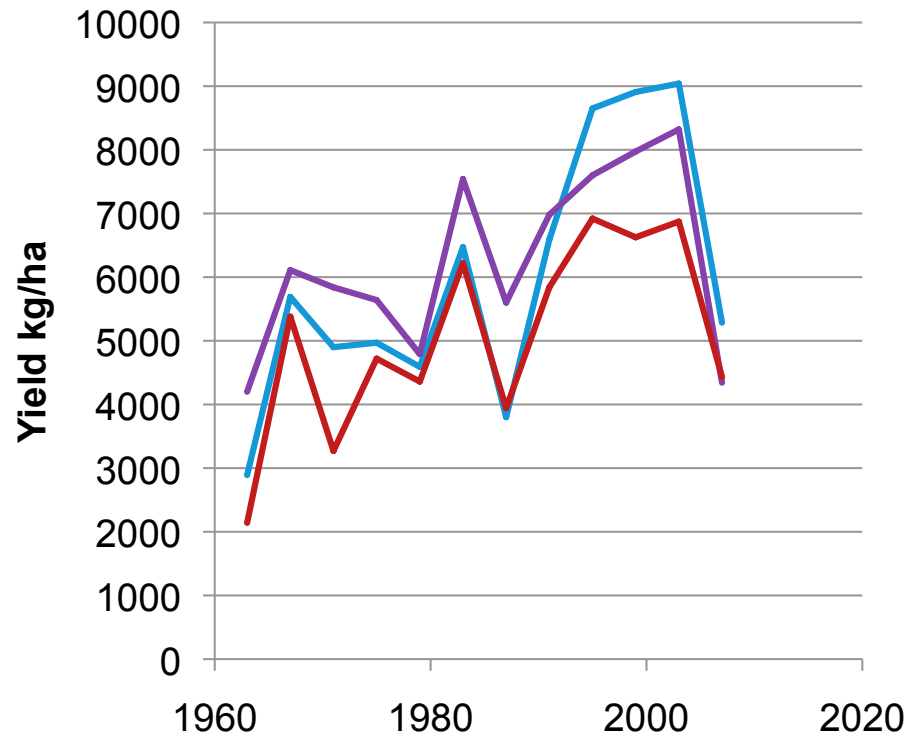
No change in C	2010	WM	RE	GS	LS
Yield (kg/ha)	7 907	13 673	10 858	10 824	8 295
Total revenues (€/ha)	1 832	2 364	2 223	2 591	2 233
Farmers profit (€/ha)	813	1 321	1 084	1 160	783

C change - 0.5 %/yr	WM	RE	GS	LS
Yield (kg/ha)	13 144	10 438	10 406	7 974
Total revenues (€/ha)	2 057	1 935	2 255	1 944
Farmers profit (€/ha)	974	742	753	416

C change +0.5 %/yr	WM	RE	GS	LS
Yield (kg/ha)	13 953	11 081	11 046	8 464
Total revenues (€/ha)	2 709	2 548	2 970	2 560
Farmers profit (€/ha)	1 703	1 457	1 603	1 179



Insurance value of conserving soil-C



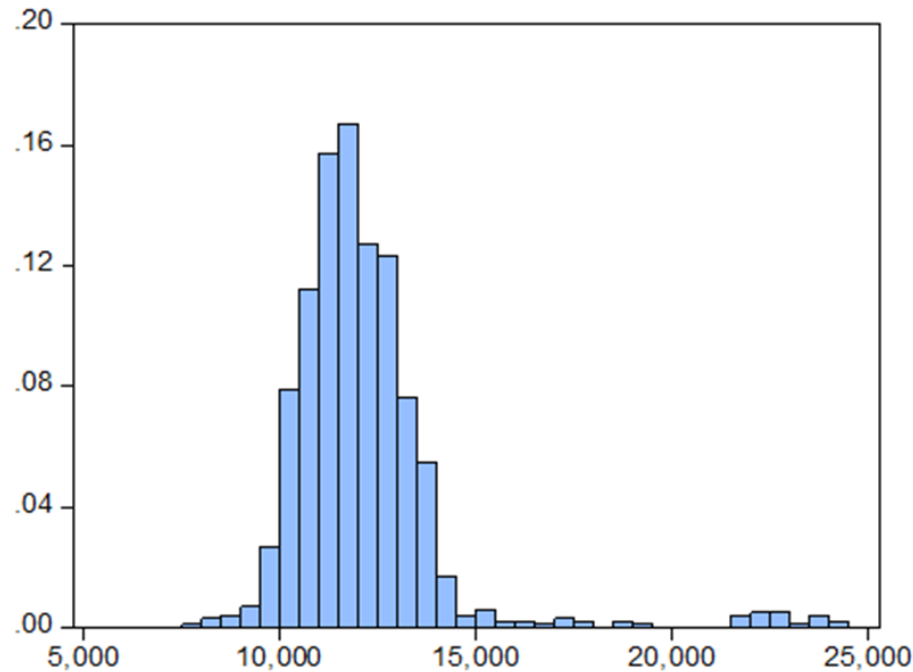
Yields vary with climate

Winter wheat harvests from
3 farms in Sweden

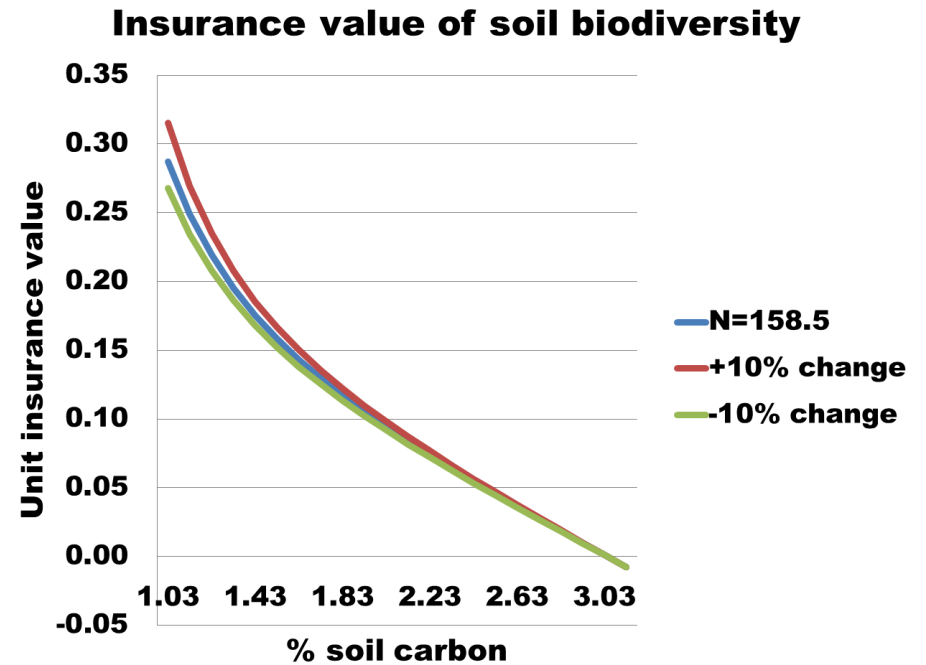


Insurance value of conserving soil-C

Variance in profits implies risk



Cost of insurance of reducing risk



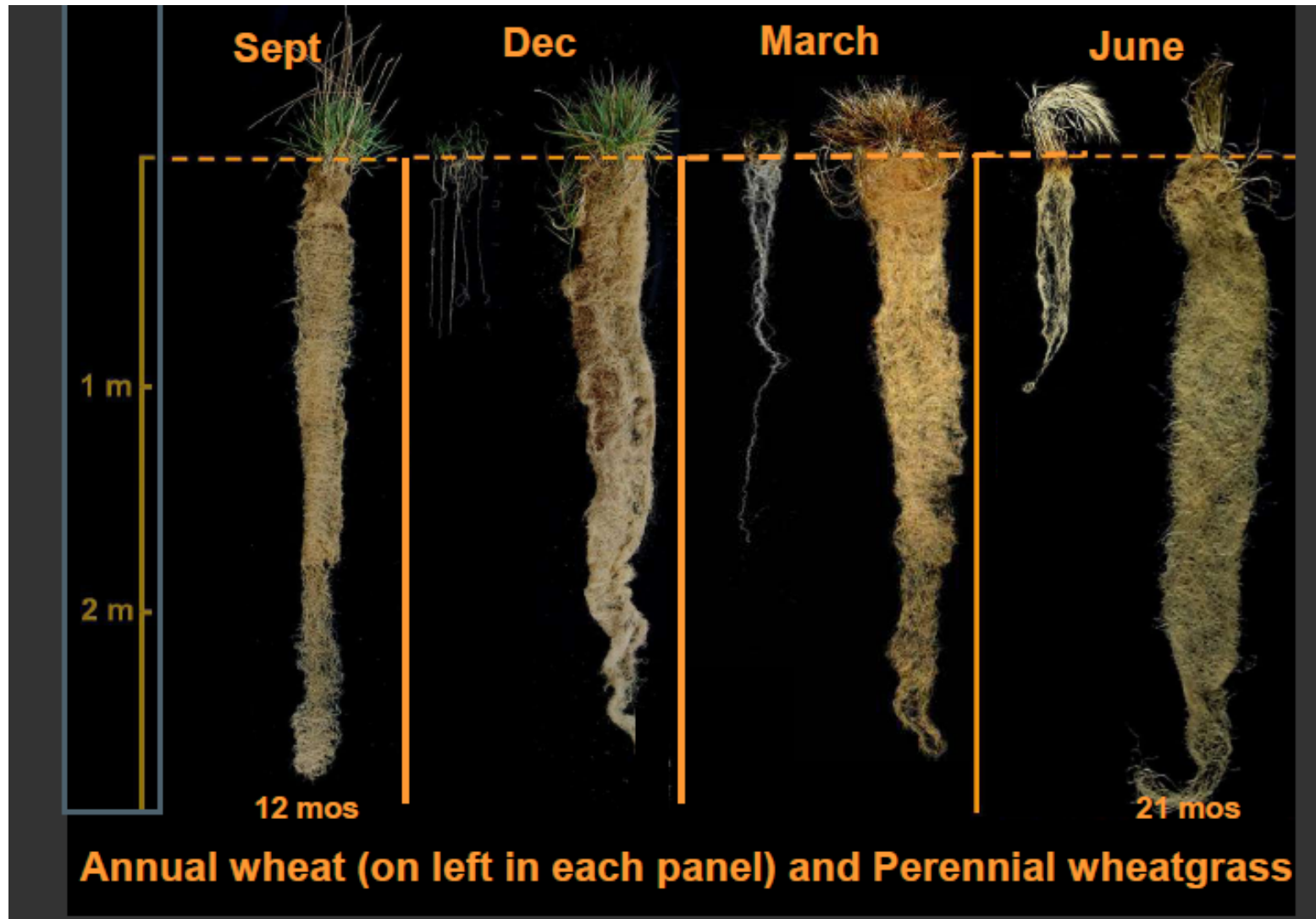


Soil a natural capital

- Promoting soil C means increasing soil biodiversity and soil ecosystem services
➡ sustainable agriculture
- Processes are long term and farmers economy will be affected in the future
➡ long term investments
- Soil ecosystem services reduce risk
➡ production and market risks



Ways forward – perennial crops?





Ways forward – bioenergy crops?



Miscanthus



Salix



Phalaris



Poplar



Information transfer

