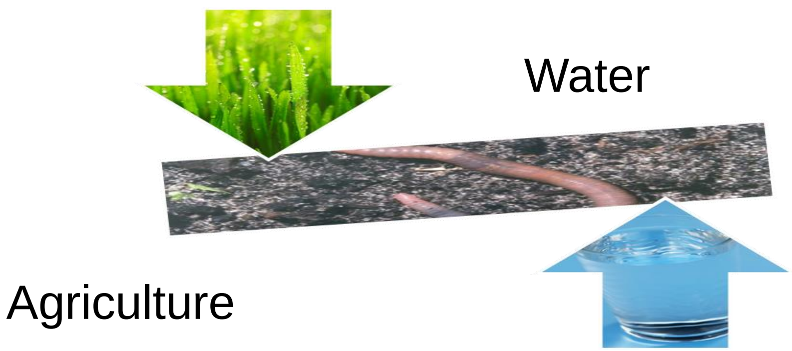
Working on soil quality a win-win for agriculture and water management



Nick van Eekeren

Content

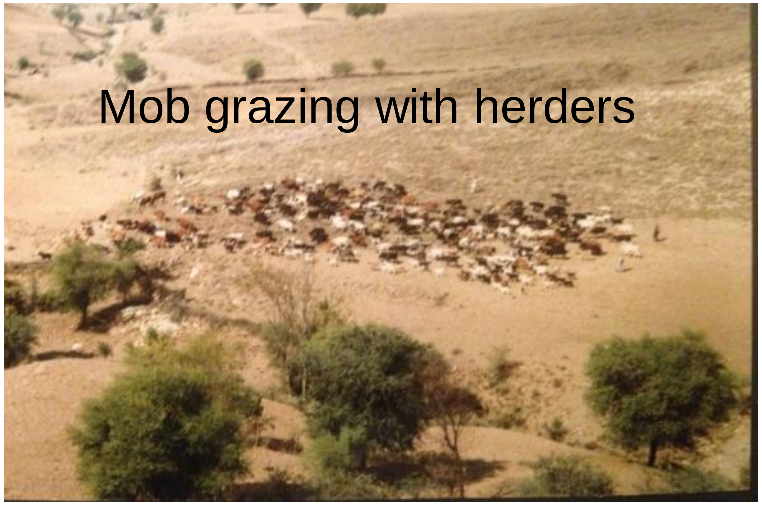
- Short introduction Louis Bolk Institute
- Risk management and resilience
- Importance of soil quality
- Measures for improvement soil quality
- Effect of measures

Louis Bolk Institute

- Independent research Institute on agriculture, human nutrition and human health
- Participatory research and systems approach ('making systems work', 'bottom-up')

Introduction

Small holder dairy farming



Mob grazing with herders

Agro-ecological intensification

Soil ecosystem services under grassland

Programme soil quality, grassland and ecosystem services

- Production (quantity and quality)
- Water (quantity and quality)
- Climate mitigation and adaptation
- Biodiversity and habitat


Its all about risk

Agriculture:

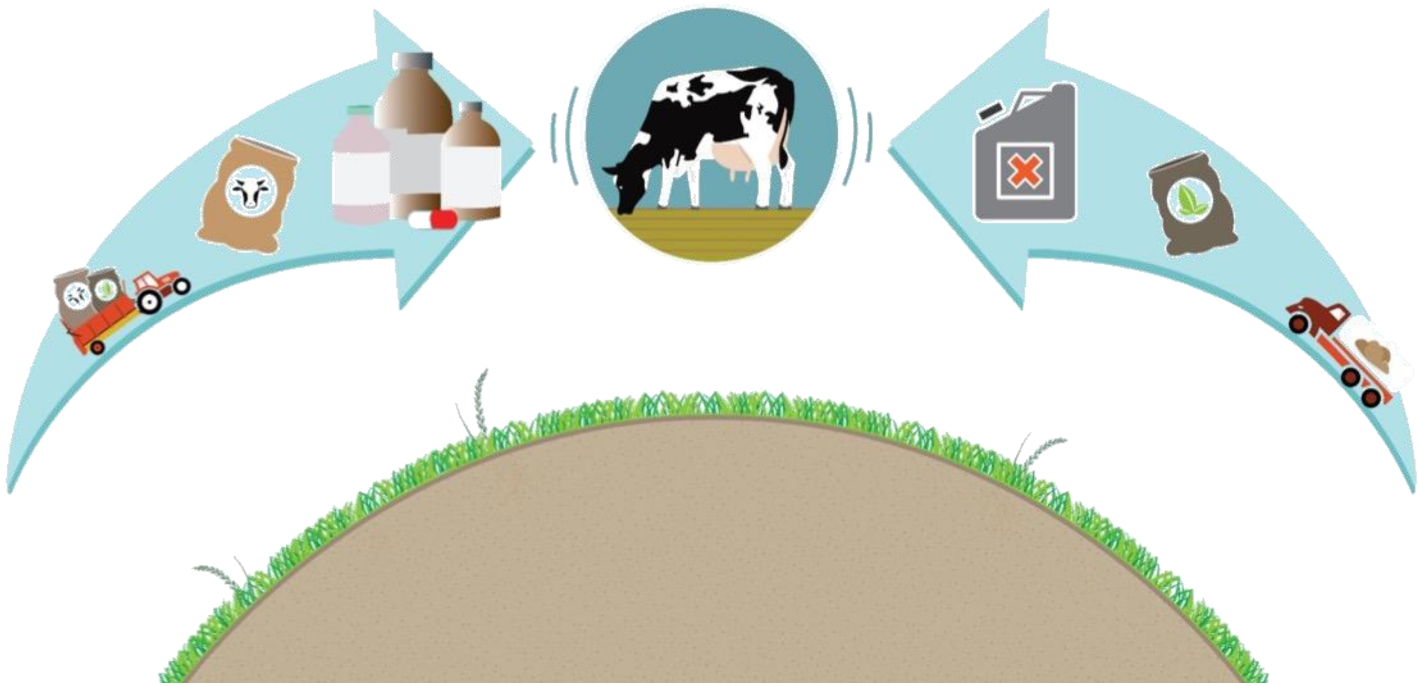
- Capital intensive
- High risk
- Relatively low return on investments

"Normal" economy

- With high risk, there is a chance for high return on investments

Van Eekeren & Bestman, 2012; Erisman et al., 2015

Current agricultural system



- Risk oriented
- Limited variability
- Continuous monitoring and direct intervention
- High use of external inputs
- Static equilibrium
- High long-term risk

After Ten Napel et al. 2006

Current risk management model leads to societal problems

Amongst others:

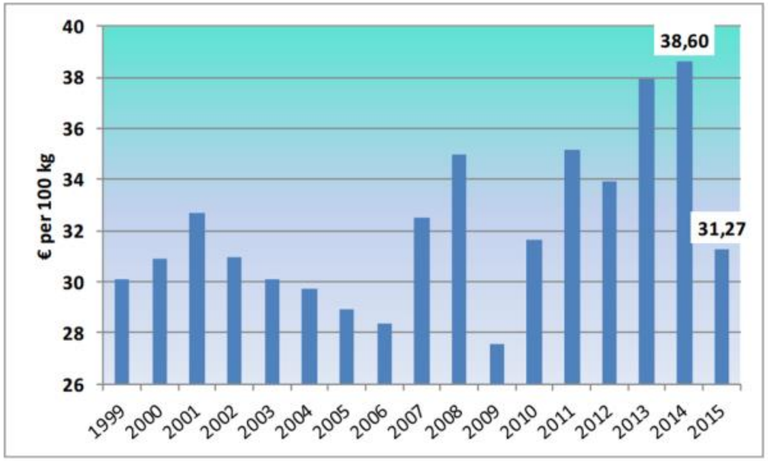
- Water quality
- Water quantity
- Resistance to antibiotics
- Loss of biodiversity and habitat

Combined with other developments risk only increases

Amongst others:

- Climate change
- Price fluctuation of inputs and milk

Grafiek 1. Gemiddelde melkprijzen 1999 t/m 2015



LTO Internationale Melkprijsvergelijking 2015

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Its all about risk

Agricult

- Capita
- High r
- Relati vestments

“Normal

- With h nance for high r s

COMMENT

COMMUNICATION How English became the lingua franca of science p.154

SUSTAINABILITY Primer from superstar academic is required reading p.156

REPRODUCIBILITY Curb poor conduct as well as misconduct p.158

OBITUARY Yves Chauvin, Nobel-winning chemist, remembered p.159

A Tuareg woman carries water through a sandstorm in drought-ridden Mali.

Put people at the centre of global risk management

An individual focus is needed to assess interconnected threats and build resilience worldwide, urge **Jan Willem Erisman** and colleagues.

Globalization is changing the nature of risk. Natural and social systems — from climate to energy, food, water and economies — are tightly coupled. Abrupt changes in one have a domino effect on others. Floods in Thailand in 2010, for example, led to a global shortage of computer hard disks as a result of factories closing, as well as more than US$330 million in damage and around 250 deaths.

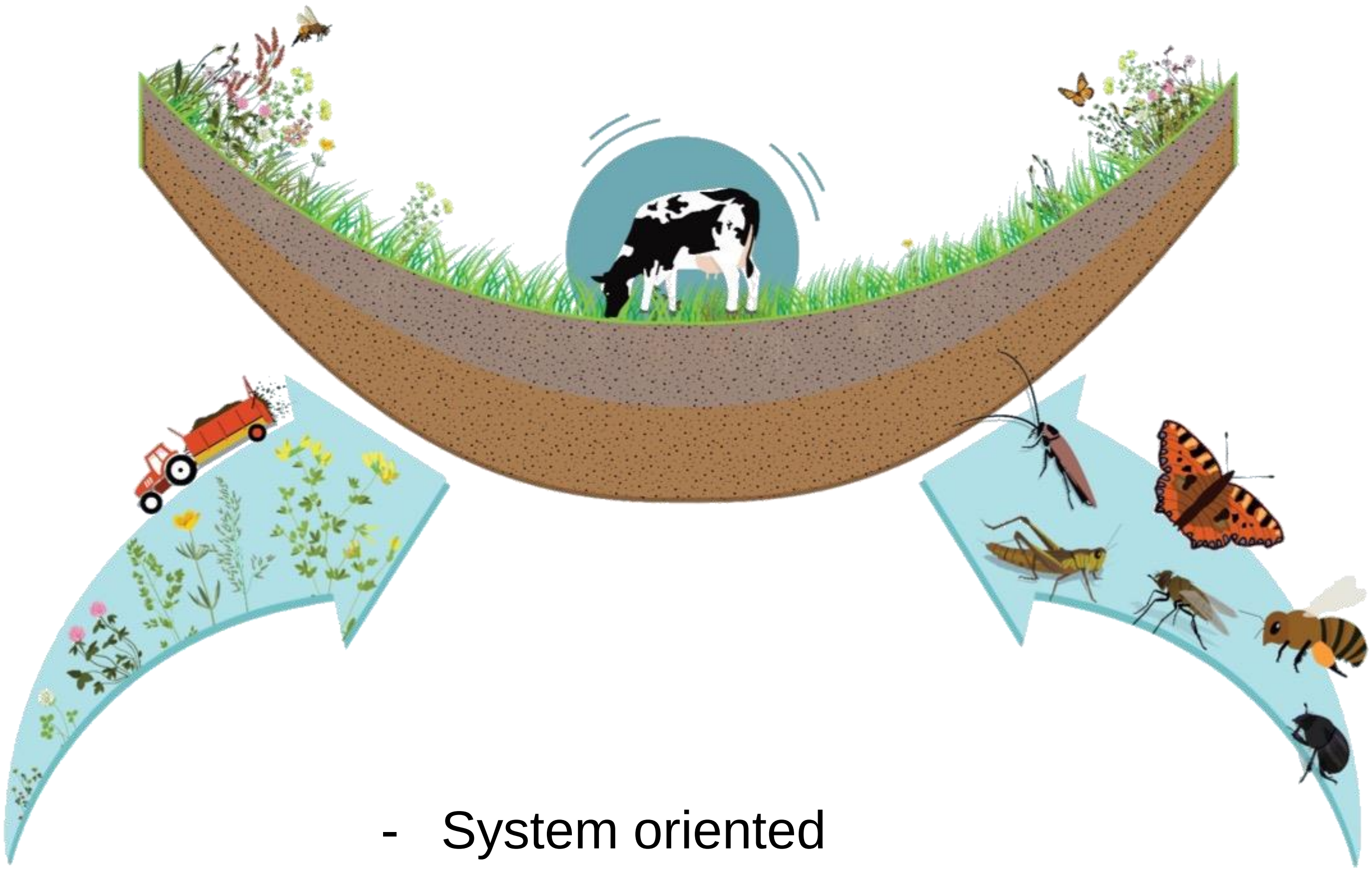
The exposure of people and assets to risks is increasing worldwide. From 1980 to 2012, annual economic losses from environmental disasters rose more than sevenfold, from about $20 billion to $150 billion a year[1].

Yet most risk assessments ignore networked threats[2,3]. The annual Global Risks report of the World Economic Forum considers risks qualitatively, based on the views of experts[4]. But global outlooks remain sectorial and too coarse to guide individuals, organizations, municipalities or nations.

Risk reports also neglect the collective impacts of personal choices[3]. For example, eating more beef causes deforestation and biodiversity loss in the Amazon. Local dams for hydropower or water storage alter sediment flows to fertile coastal regions. The movement of people from the

Van Eekeren & Bestman, 2012; Erisman et al., 2015

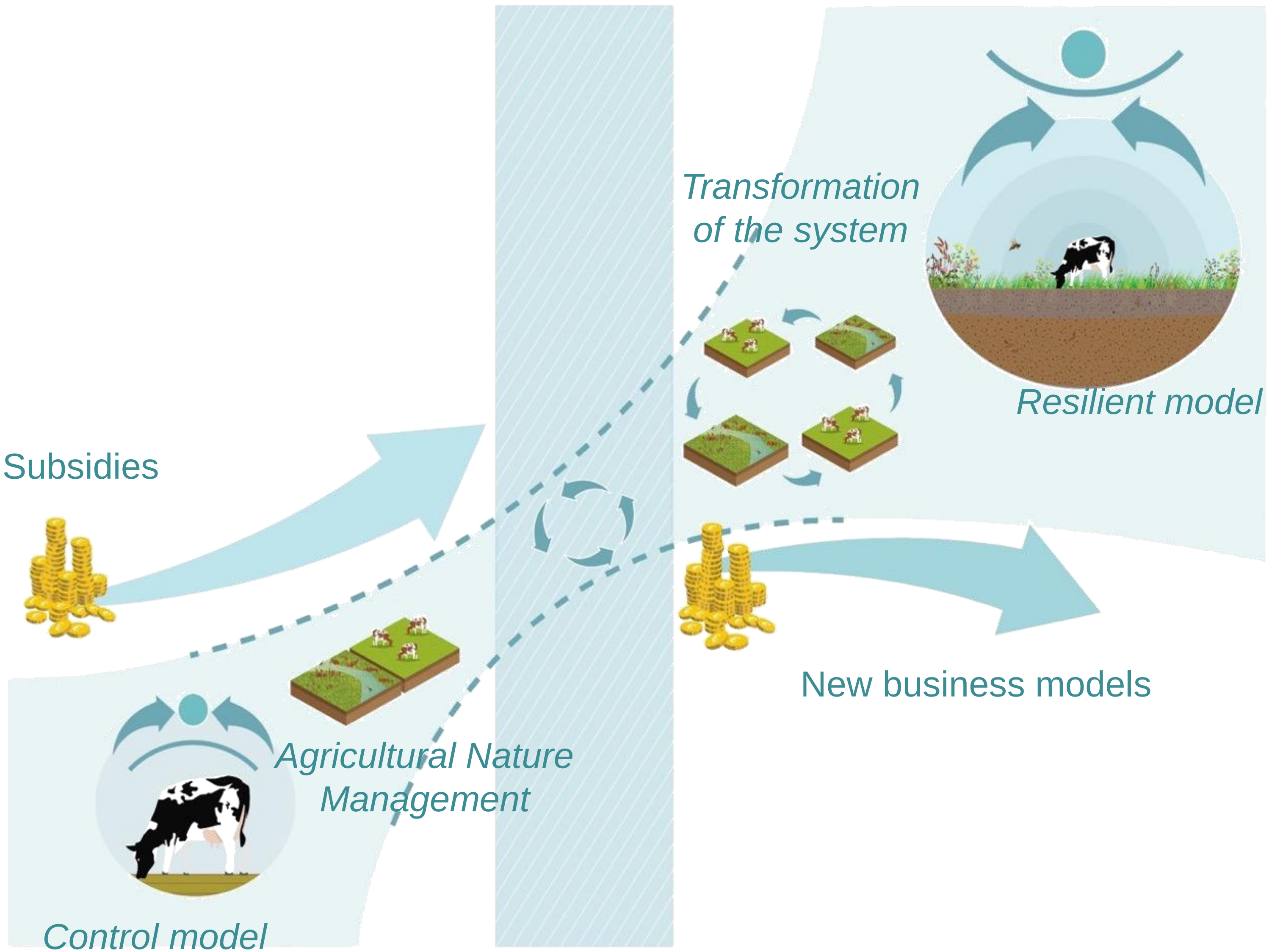
Resilient agricultural system



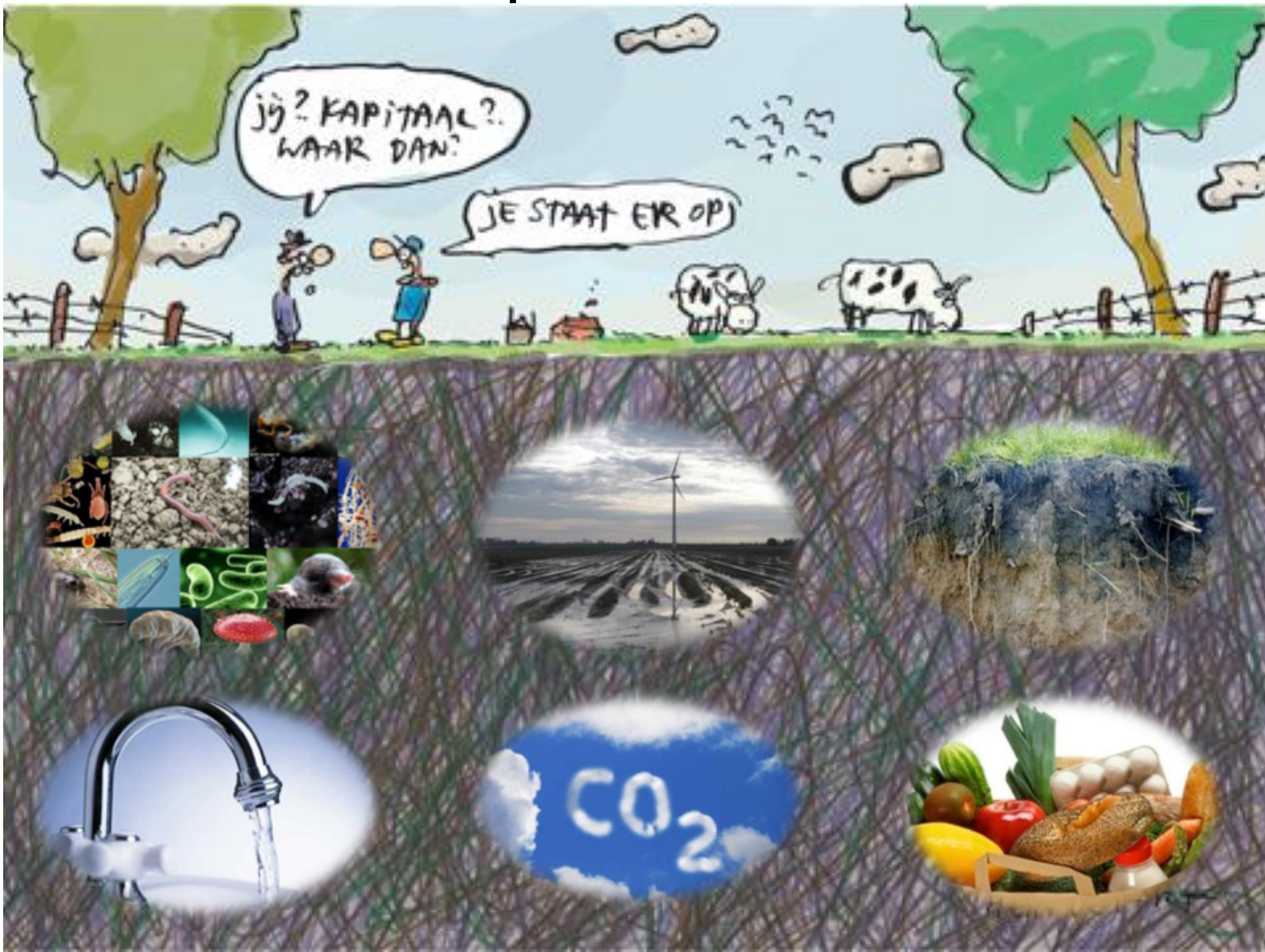
- System oriented
- Makes use of variability
- Enhances self-regulation - indirect management
- Dynamic equilibrium
- Low long-term risk

After Ten Napel et al. 2006

Transition towards a resilient agriculture



Soil important for resilience
Soil = Capital and buffer



Importance soil quality for agriculture and water management

Agriculture

- Production
  - Quantity
  - Quality
- Costs
- Controle of risk

Water management

- Water quantity
  - Water supply in drought
  - Peak discharge
- Water quality
  - Nutrients
  - Pesticides
  - Antibiotics

How?

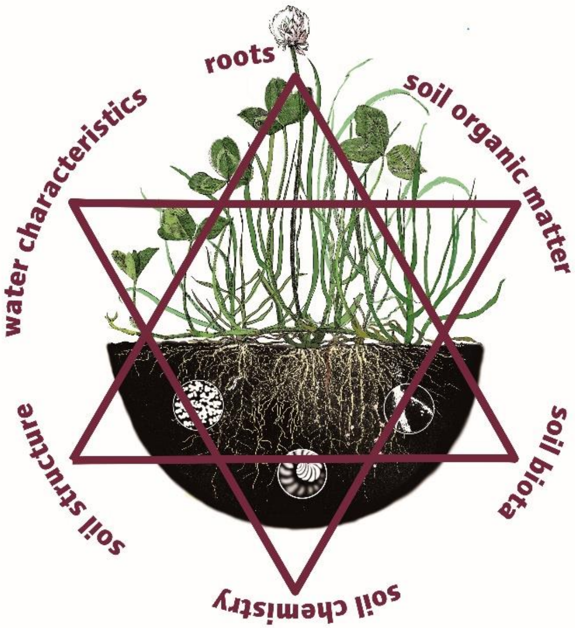
See....

Understand....

Act....

Working on water and soil quality is working on integral package of :

1. Water characteristics
2. Soil structure
3. Organic matter
4. Soil chemical
5. Roots
6. Soil biota



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Red line presentation

- Per element of soil quality
- Effect on water quantity and quality
- Which management
- Land-use (grassland and arable land)

Long-term crop rotation experiment in Belgium

Experiment established in 1966

Four treatments:

1. Permanent grassland since 1966;
2. 3 years temporary grassland in rotation;
3. 3 years temporary arable land in rotation;
4. Permanent arable land since 1966.

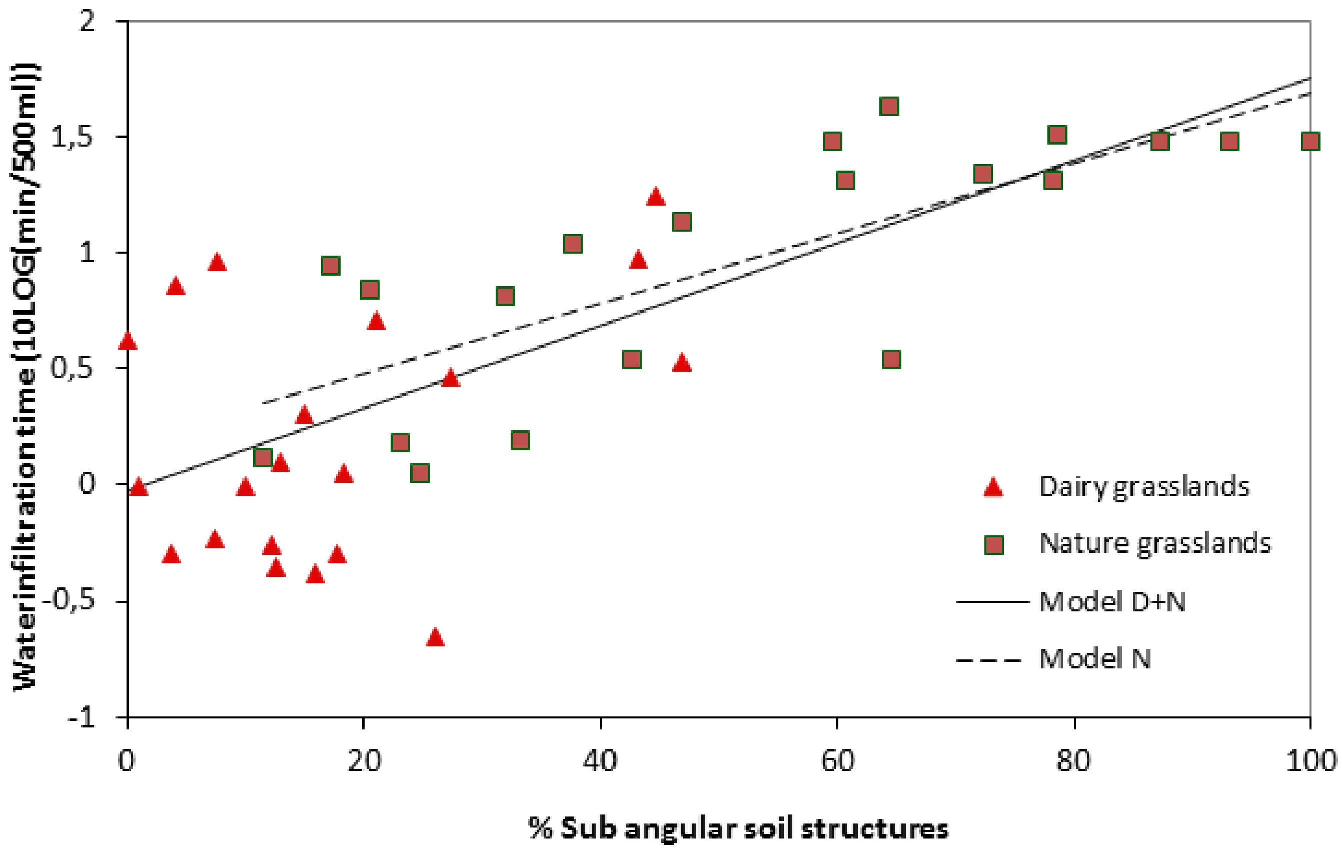
2. Working on soil structure

Soil structure works on water quantity and quality via:

- Improved water infiltration
- Improved water holding capacity
- Deeper rooting
- Reduced run off nutrients, antibiotics and pesticides
- Improved nutrient use

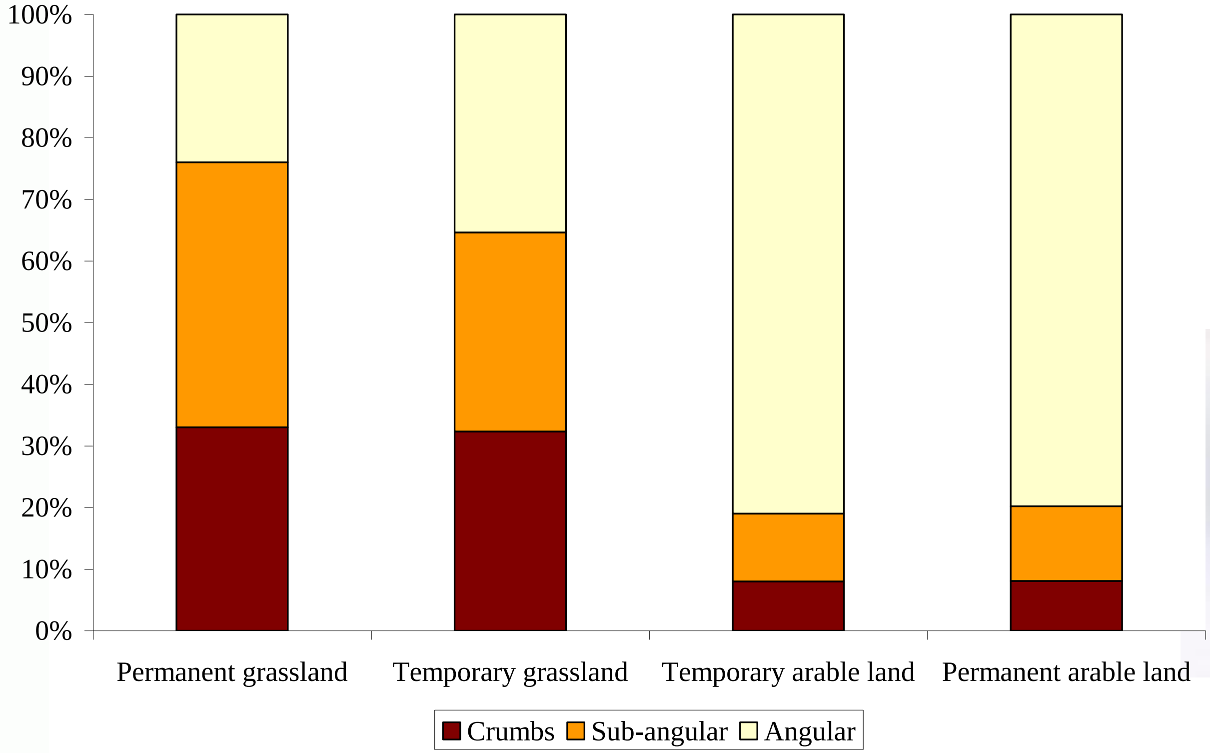
Win-win for agriculture and water management

Waterinfiltration and soil structure



Deru e.a., 2012

Effect land-use on soil structure



Angular

Sub-angular

Crumbs

Prevention soil compaction

- Drainage
- Ground water level
- Timing
- Machine choice
- Tyre choice
- Tyre pressure
- Etc.

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Reduction of soil compaction

3. Working on soil organic matter

SOM works on water quantity and quality via:

- Improved soil structure
- Improved water holding capacity
- Binding of nutrients, pesticides and antibiotics

Win-win for agriculture and water management

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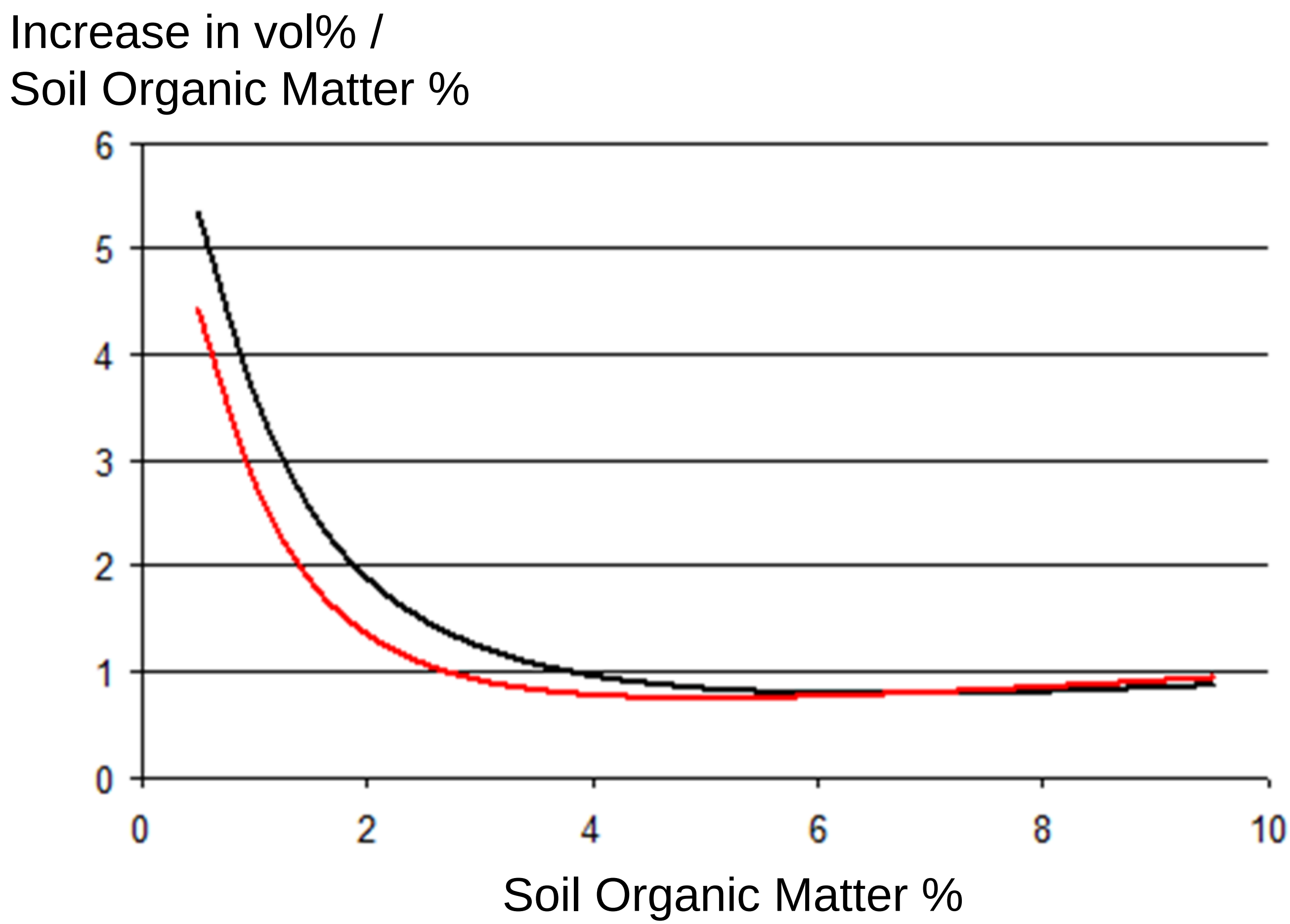
Soil organic matter and water



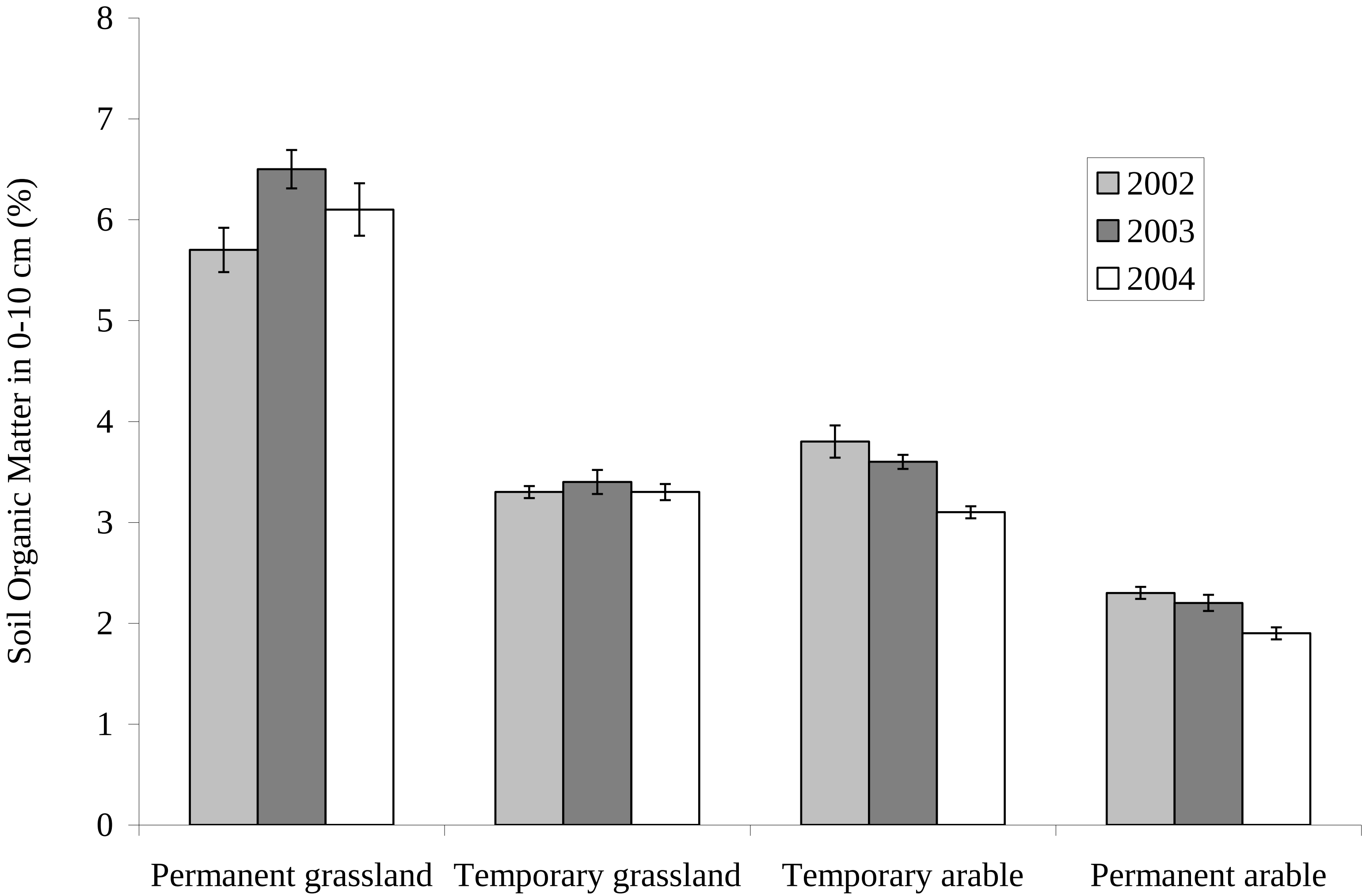
Wosten et al., 2016

Working on soil organic matter: Land use

Balance between Supply and Decomposition

	Supply	Decomposition
Arable land	Low	High
Grassland	High	Low

Effect land-use on Soil Organic Matter



On average 6.1% 3.3% 3.5% 2.1%

Reducing decomposition
Minimal tillage

Increasing supply

- Roots
- Crop residues (varieties, harvesting methods)
- Organic manure
- Compost
- Green manure crops

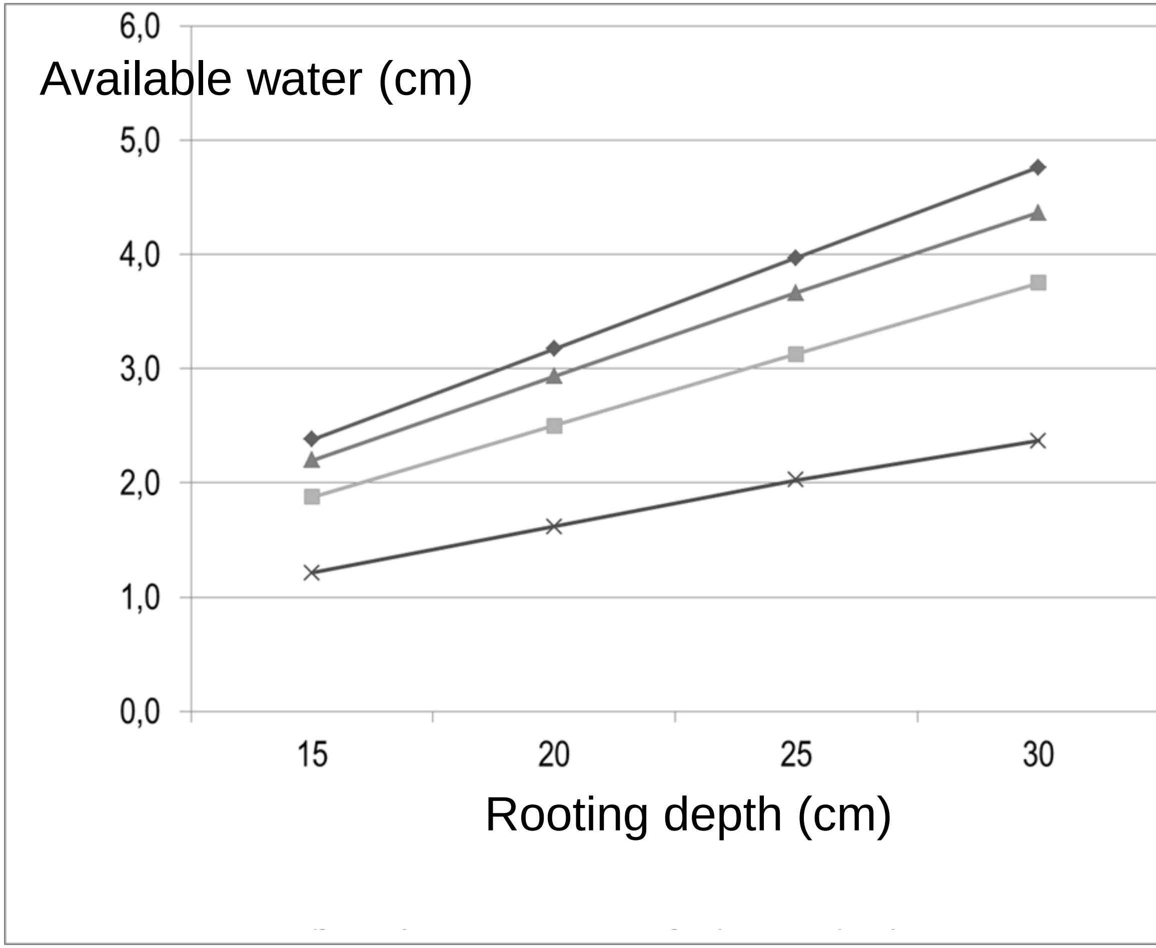
4. Working on roots

Roots work on water quantity and quality via:

- Improved soil structure
- Increase supply organic matter
- Food for soil biota
- Intensive rooting; P utilization
- Deeper rooting; N and water utilization

Win-win for agriculture and water management

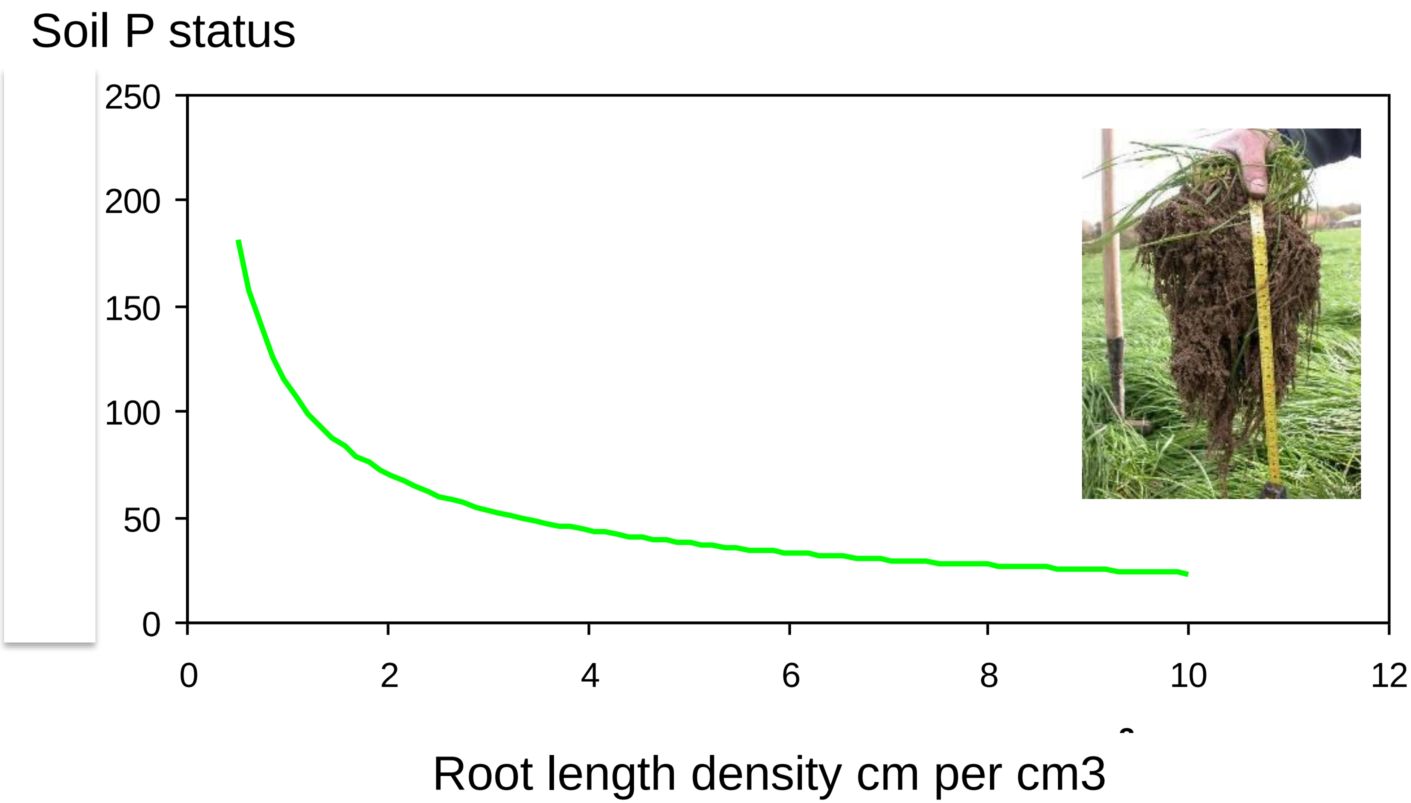
Deeper rooting more water available



In Australia rule of thumb:
Each 10 cm rooting depth, 0,5 ton grain production per ha

Faber, et.al. 2012.

Intensive rooting improved P utilization



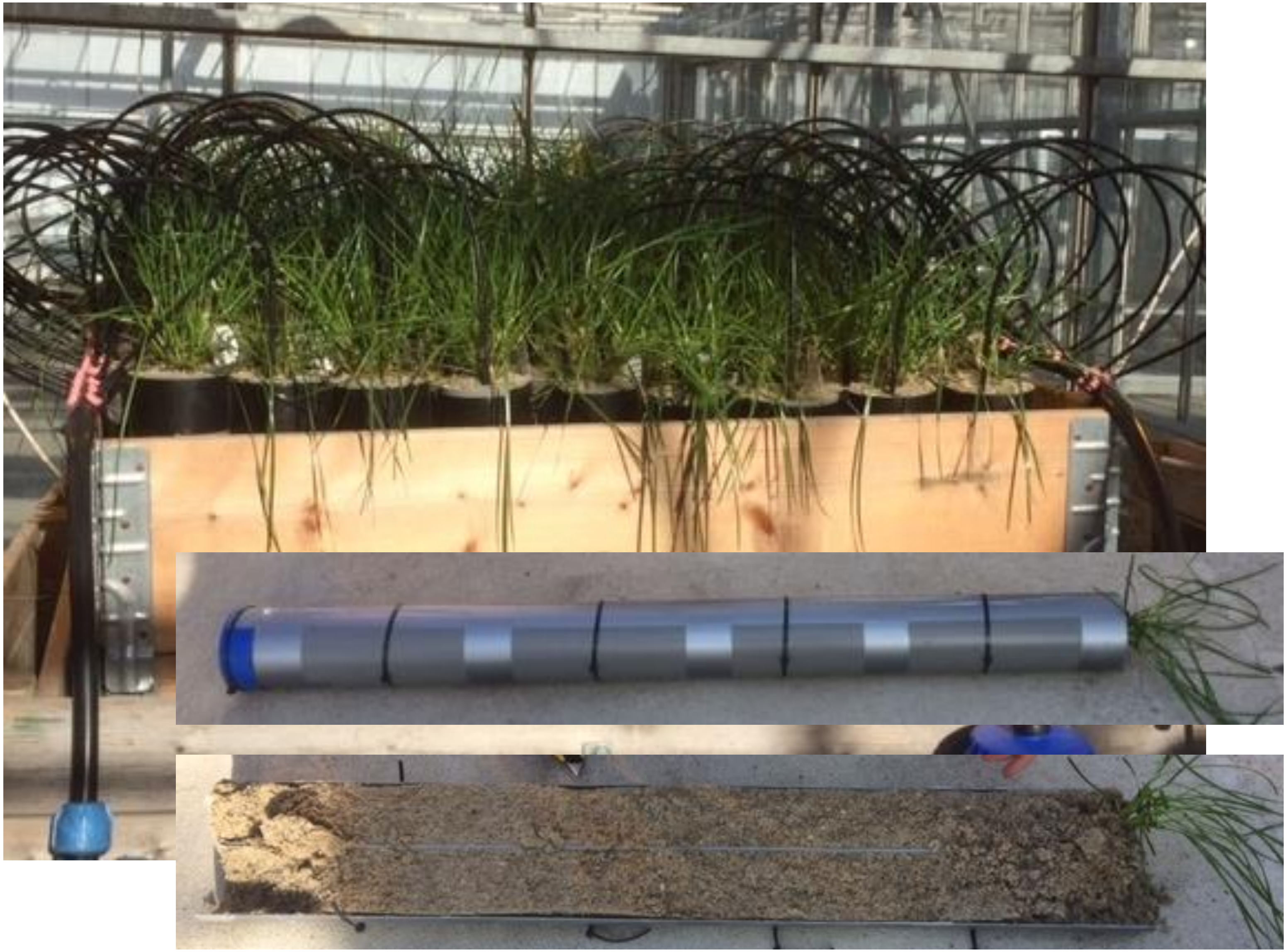
Work on roots: Agronomy

Improving rooting via:

- Species and cultivars
- Soil management
- Fertilisation etc.
- Others

Brochure: Back to the roots www.louisbolk.nl
Van Eekeren et al., 2011

Working on roots: Breeding



Two varieties of rye grass

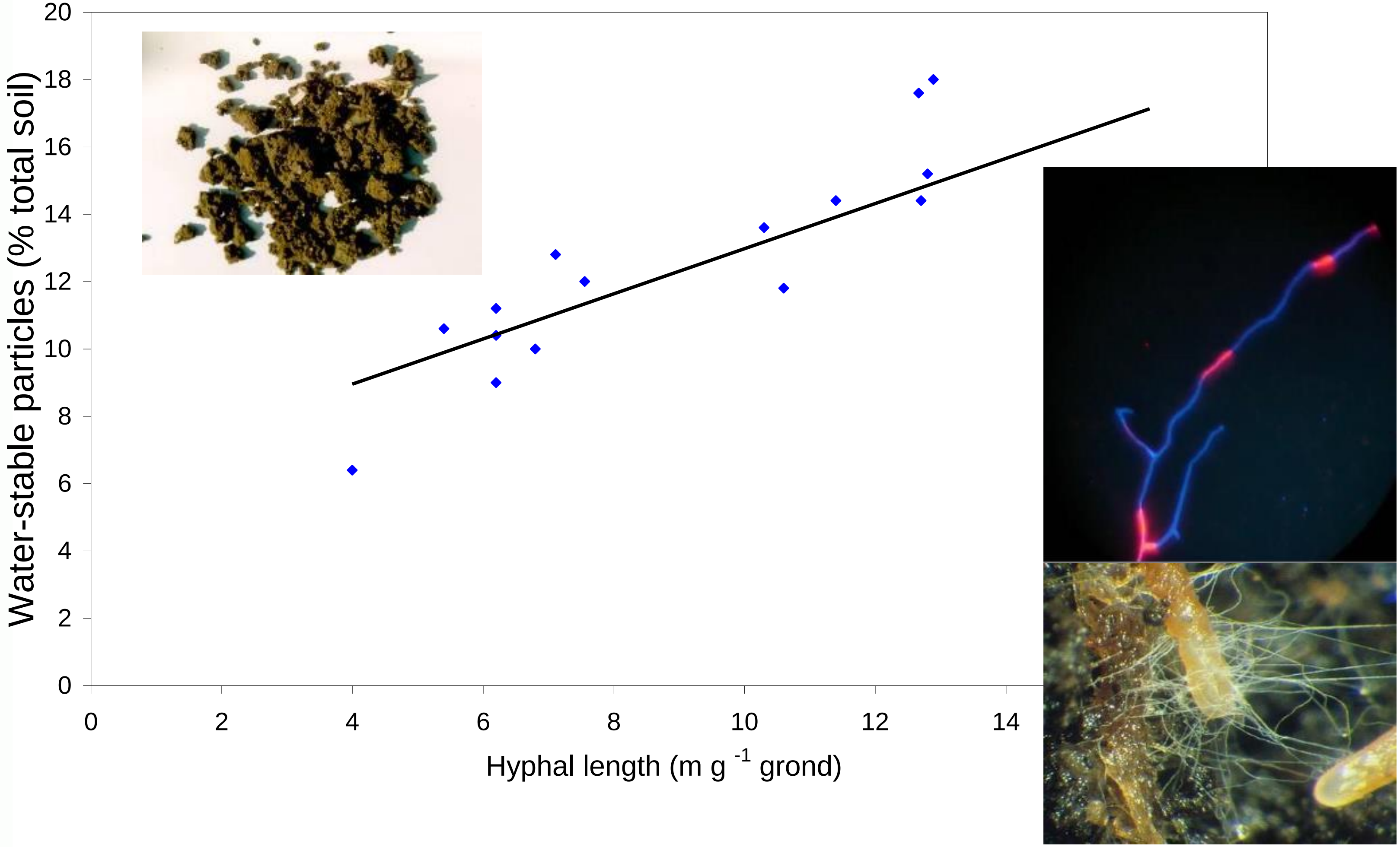
6. Working on soil biota

Soil biota work on water quantity and quality via:

- Improved soil structure
- Deeper rooting
- Direct relation with water infiltration
- Suppression of soil disease
- Decomposition of pesticides and antibiotics
- Capturing of nutrients

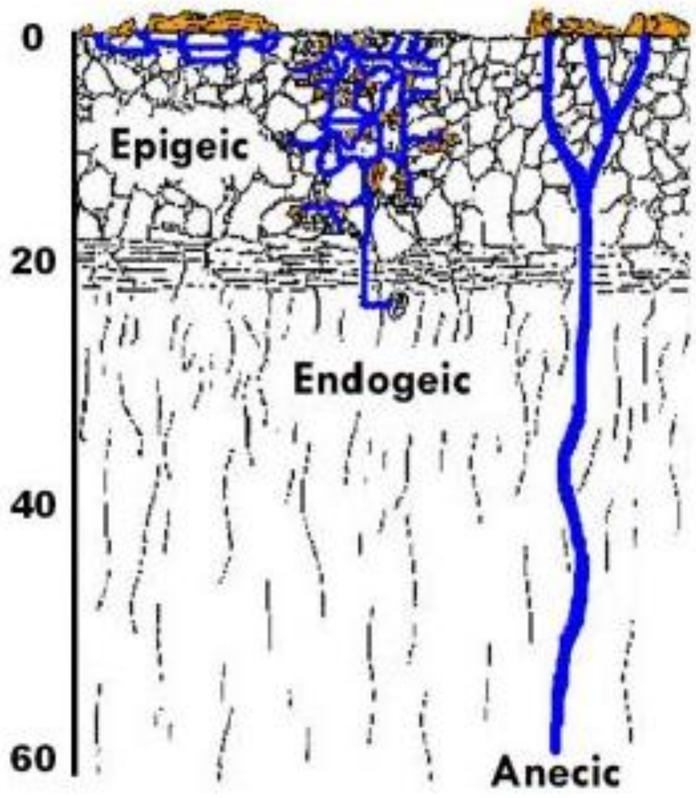
Win-win for agriculture and water management

Fungal hyphe for water stable particles

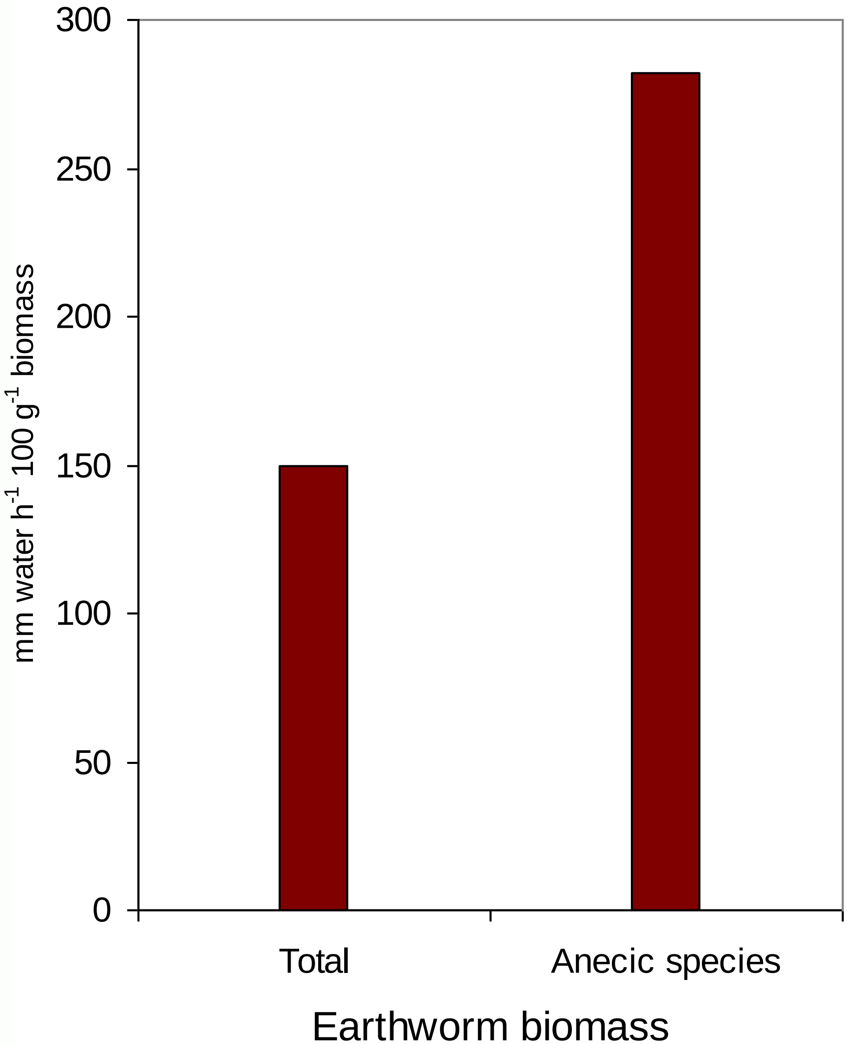


Tisdall and Oades, 1979

Ecological groups of earthworms

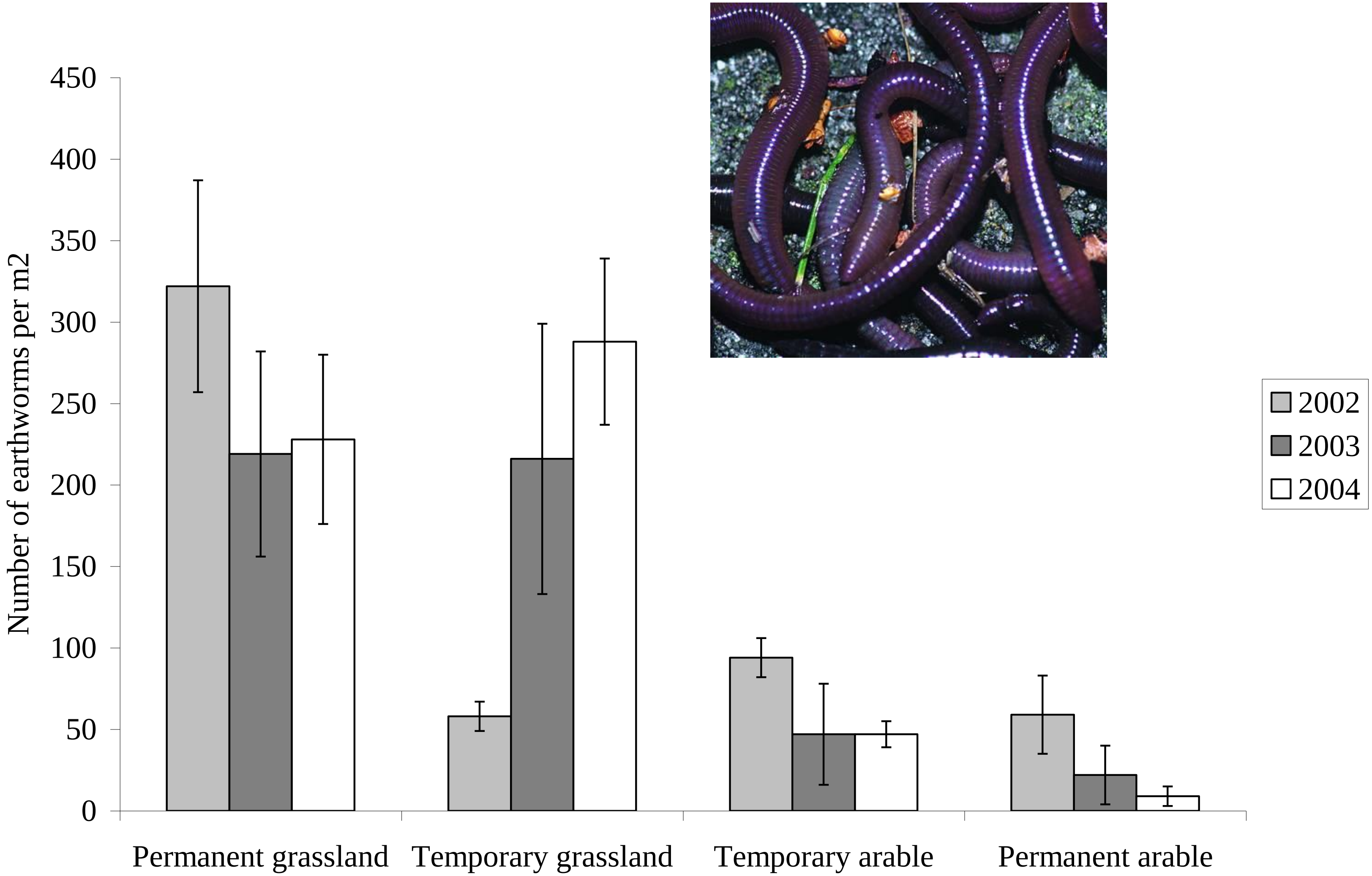


Especially anecic species increase water infiltration

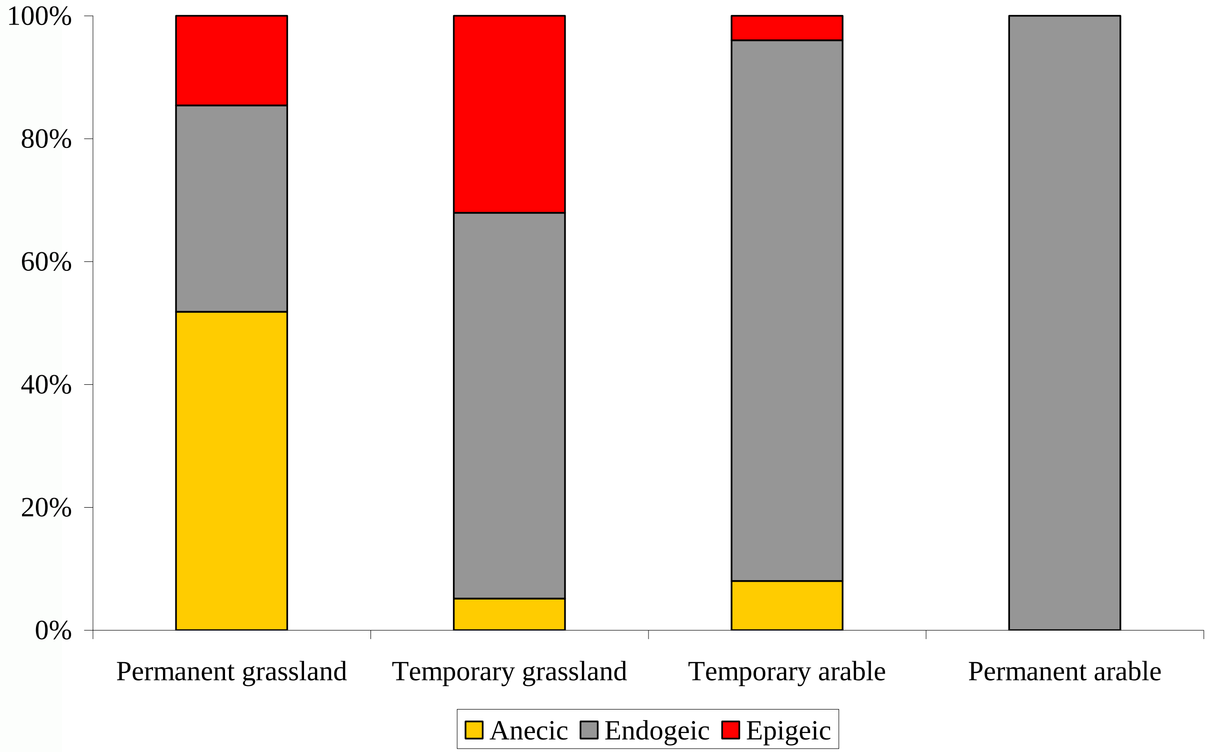


Bouche and Al-Addan,1997

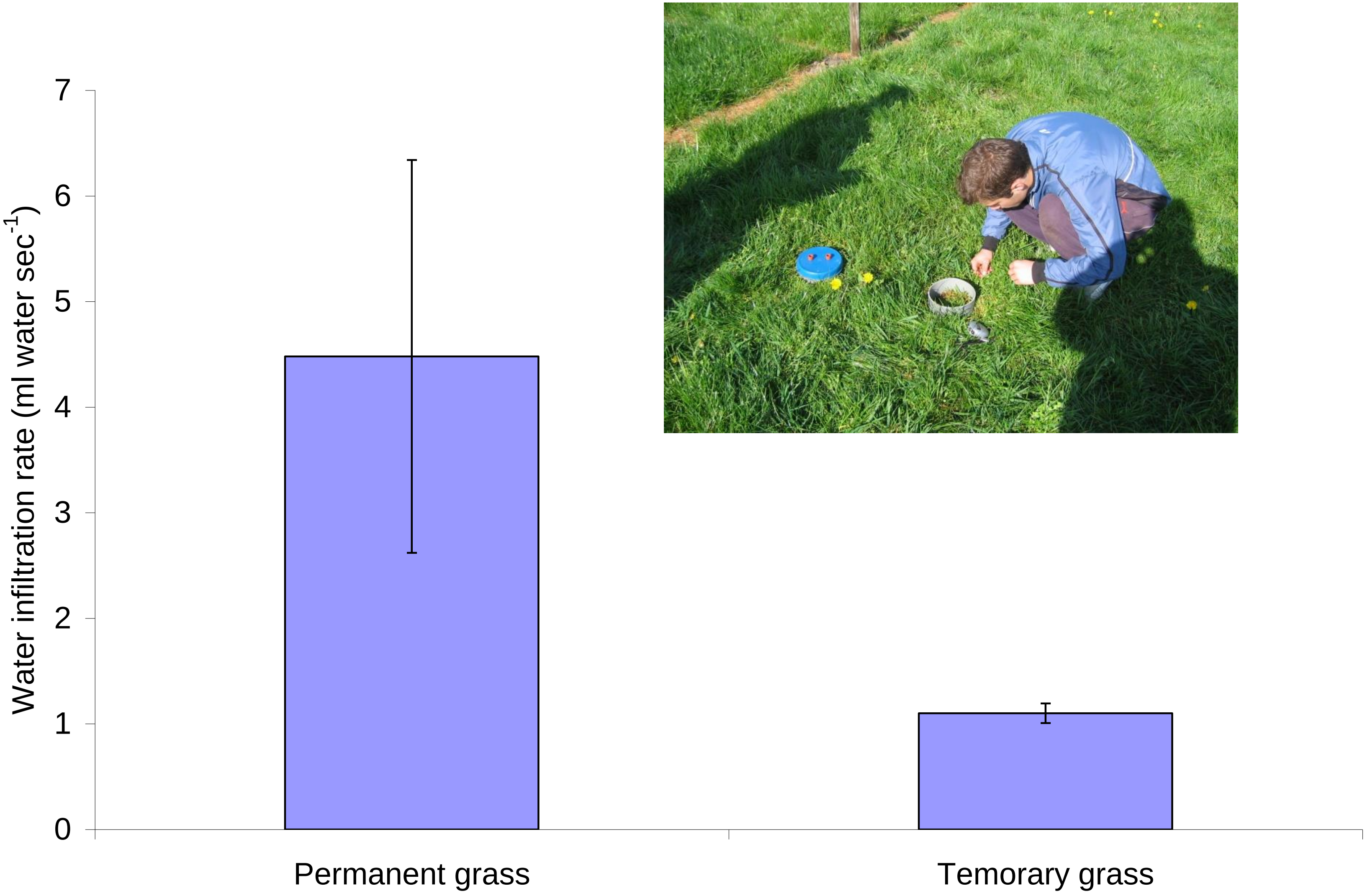
Effect on number of earthworms



Effect on ecological groups



Effect on water infiltration

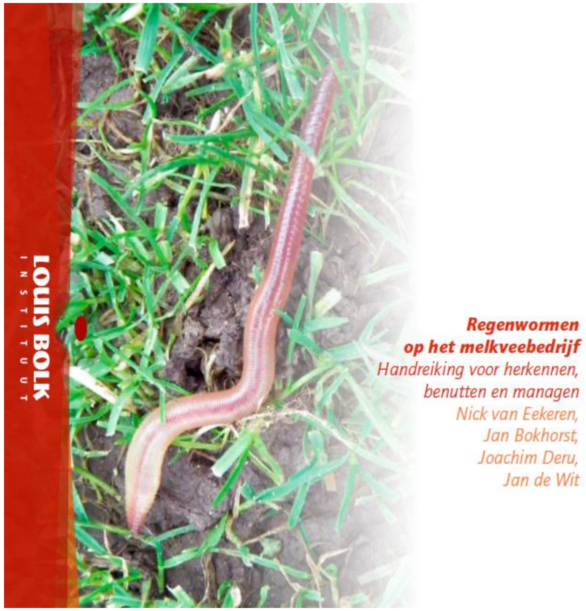


Van Eekeren et al, 2008

Working on soil biota for example earthworms

Measures for stimulating numbers and species:

- Minimising disturbance and tillage
- Quantity food
- Quality food
  - N for endogeic earthworms
  - C for epegeic earthworms
- Stability food



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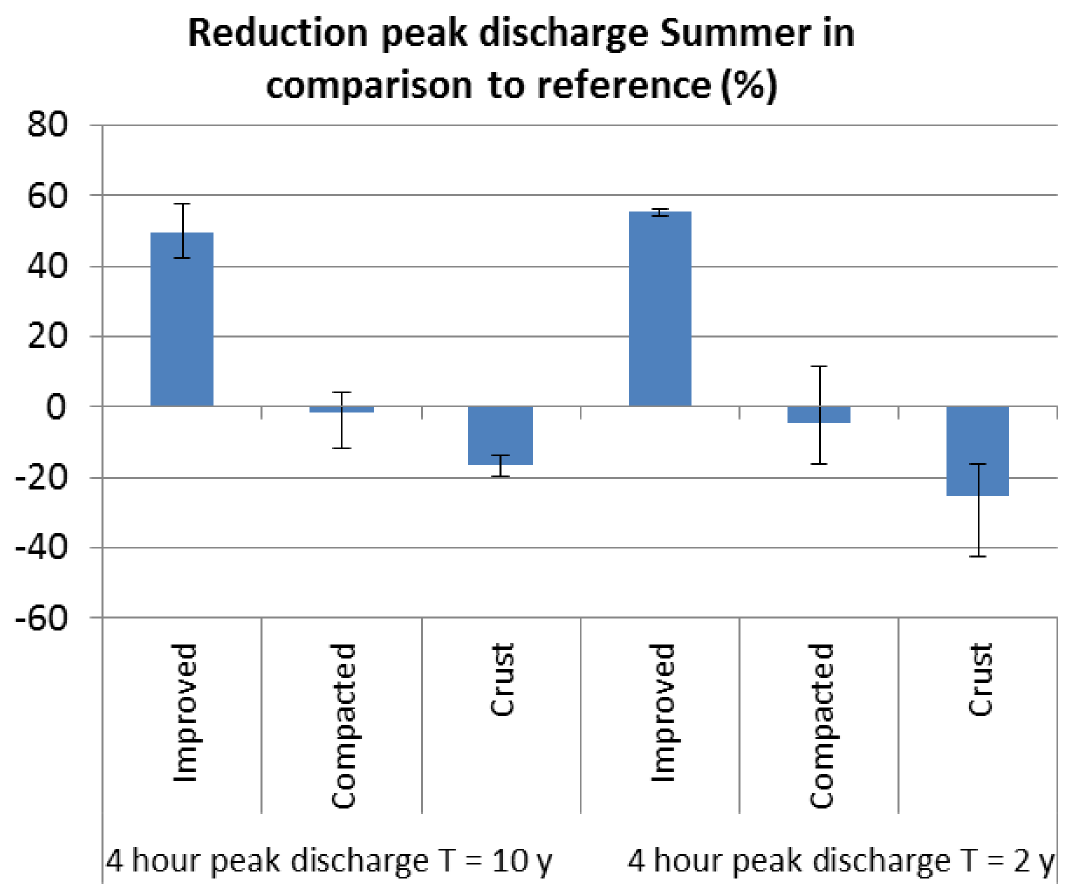
Summary of effect land-use on six elements of soil quality

		Permanent grass	3 years temporary grass-clover in rotation	3 years temporary arable in rotation	36 years arable
1.Organische matter	%	5,7	3,3	3,8	2,3
2. Soil structure	%	76	65	19	21
3.Roots	n/m2	1081	1813		
4. Soil biota	helling	0,26	0,50	0,53	0,63
5. Water characteristics	Mm/s	2,7	1,1		
6. Soil chemical	Kg N/ha	159	93	102	55

Van Eekeren et al. 2008

Results improvement soil quality



Groenendijk et al. 2015

Conclusions working on soil quality and water

- Most measures win-win for agriculture and water management
- Measures often are linked to each other (for example: improved rooting stimulates soil biota, improves soil structure, increases soil organic matter and improves water and nutrient utilisation)
- Land-use (grassland, arable and crop rotation) and than further prioritisation of measures on basis effect agriculture, water quality and water quantity is necessary

Stop burying your head in the sand but rather look more often under the grass sward