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Comparison of organic and non organic farming systems in the DOK trial

Sammenligning af økologisk og konventionelt jordbrug i DOK-forsøget

Andreas Fliessbach (andreas.Fliessbach@fibl.org
Økologi-Kongres 2017
Kolding Denmark
30.11.2017

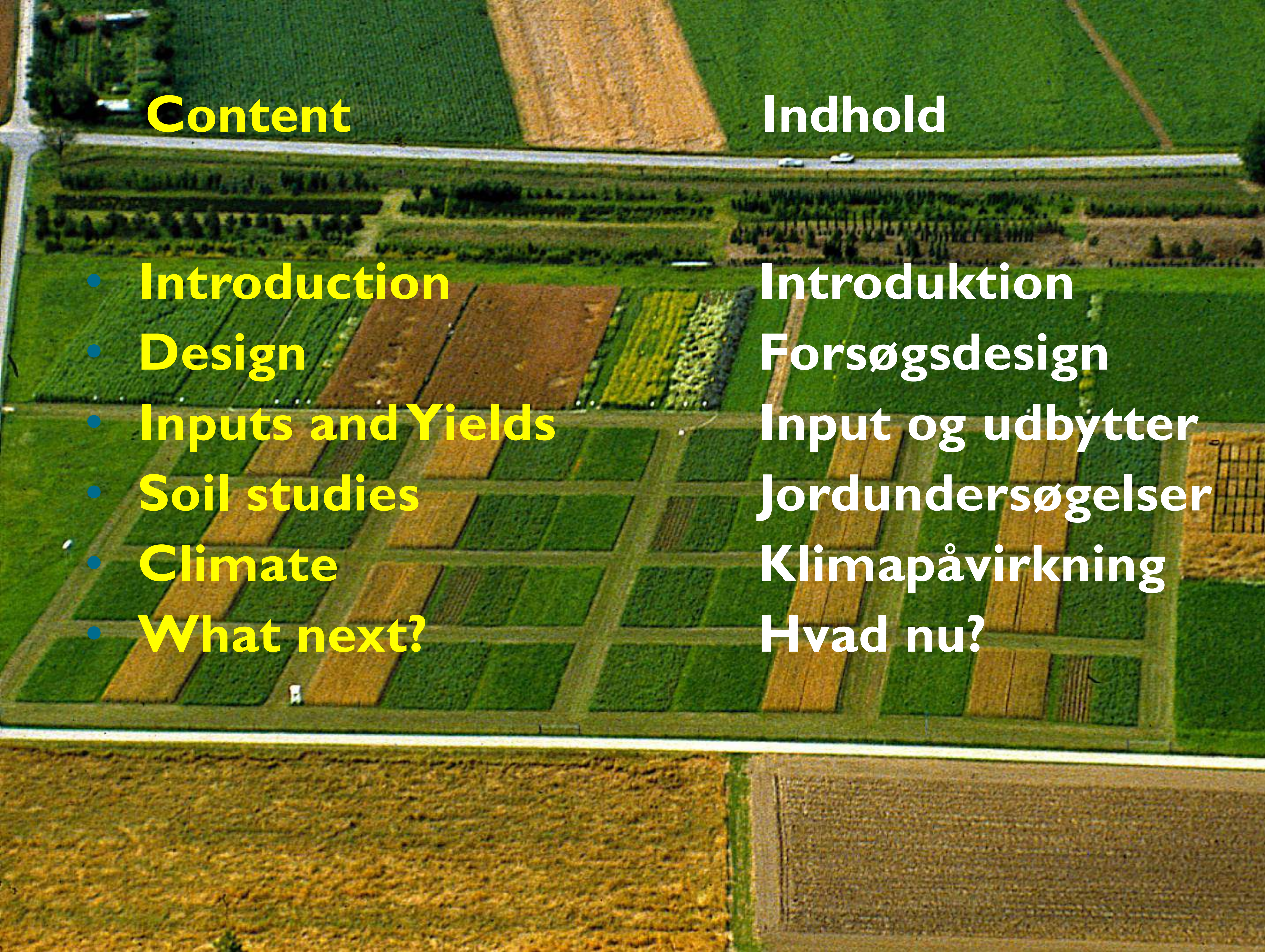
Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne:
Danmark og Europa investerer i landdistrikterne

Miljø- og Fødevareministeriet
Landbrugsstyrelsen

Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne

LDP 2020

Se EU-Kommissionen, Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne


Content
Indhold
• Introduction
• Design
• Inputs and Yields
• Soil studies
• Climate
• What next?
Introduktion
Forsøgsdesign
Input og udbytter
Jordundersøgelser
Klimapåvirkning
Hvad nu?

DOK-trial – farmers, researchers and politicians

DOK-forsøget – landmænd, forskere og politikere

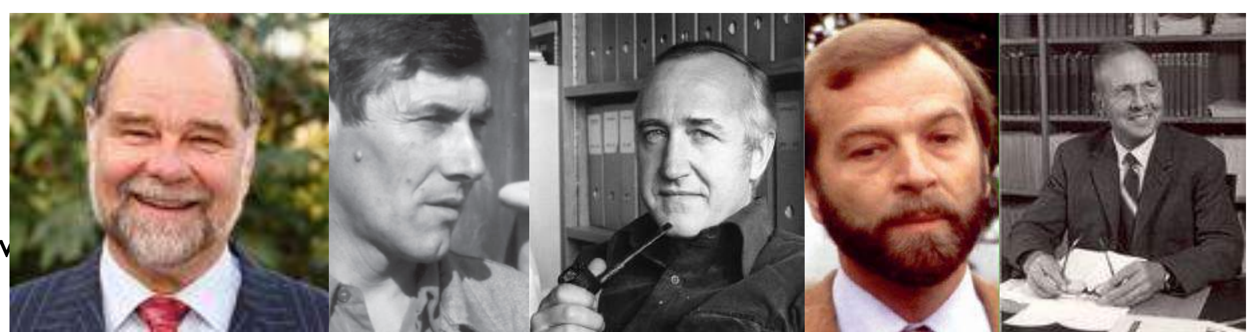
The initiative for a farming systems trial

- Pioneers of organic farming (*Hardy Vogtmann, Fritz Baumgartner*)
- Researchers at ETH (*Philippe Matile*) and Agroscope (*Jean Marc Besson*)
- Negotiations in the national assembly (*Heinrich Schalcher*)

Agroscope and FiBL were assigned to design and rule out a replicated field experiment to compare organic and conventional farming systems

Objective: Is organic farming feasible?

With time the objectives of projects in the DOK trial changed.



Farmers and Researchers work hand in hand

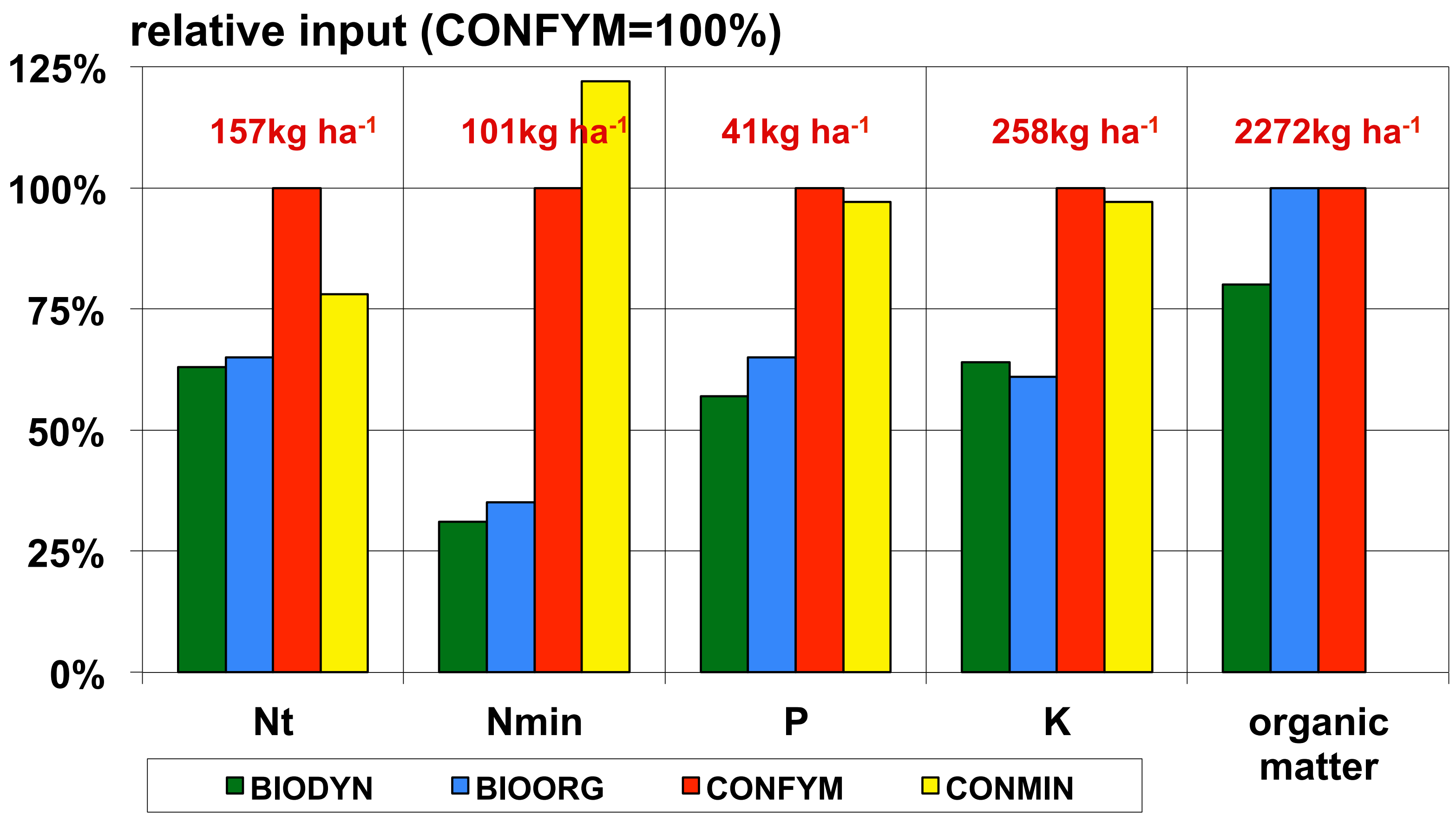
DOK experiment: system comparison since 1978

DOK-forsøget har sammenlignet dyrkningsformer siden 1978

	Organic		Conventional (integrated)	
	BIODYN	BIOORG	CONFYM	CONMIN
N	bio-**D**ynamic	bio-**O**rganic	**K**onventional	**M**ineral
	composted FYM and slurry	*rotted FYM and slurry*	*mixed FYM and slurry*	*Mineral*
		rockdust	*NPK*	*NPK*
	Mechanical weed control		*Herbicides (thresholds)*	
	Indirect disease control	*Fungicides (thresholds)*		
	Biocontrol for pests		*Insecticides (thresholds)*	
Biodynamic preparations		*copper-sulphate*	*plant growth regulators*	

DOK trial - Input of nutrients (Ø 1978-2005)

DOK forsøget – gødningstilførsel



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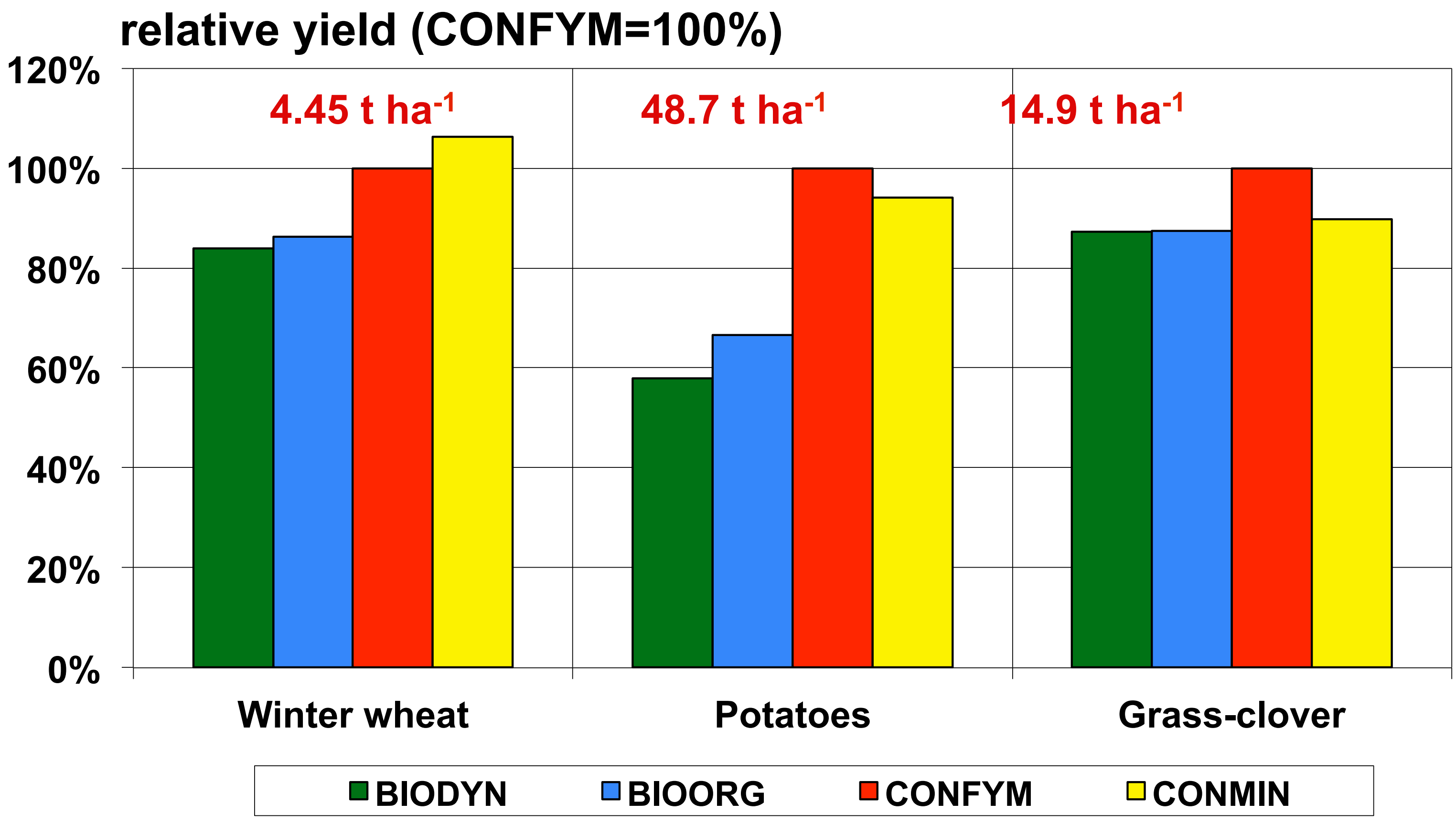
Mäder, P., et al. 2006 The DOK experiment (Switzerland). In: Long-term field experiments in organic farming. Raupp, J., Pekrun, C., Oltmanns, M., Köpke, U. (eds.). pp 41-58. Koester, Bonn.

DOK trial – Crop yield (Ø 1978-2005)

DOK-forsøget - udbytter



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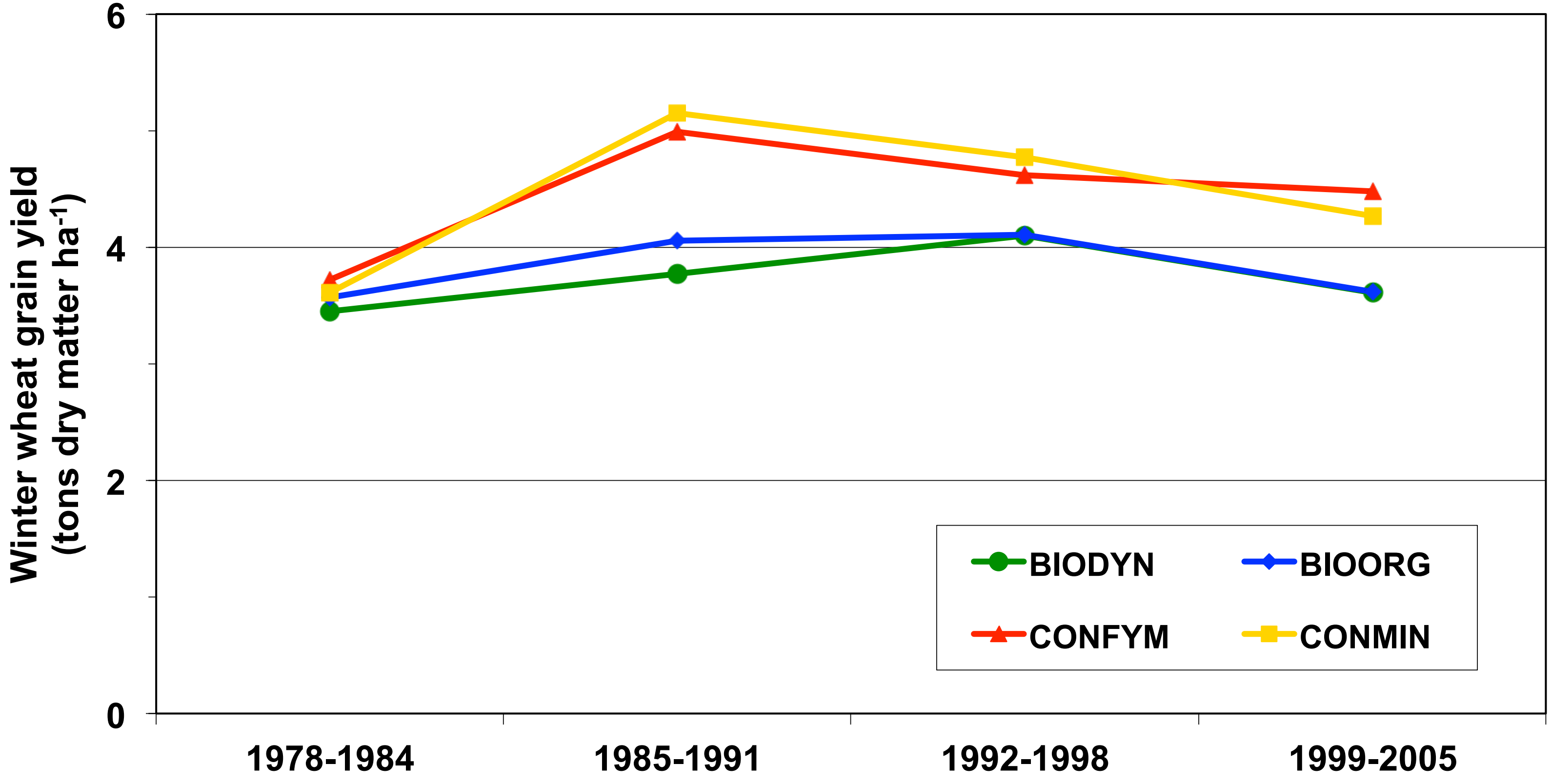
Development of winter wheat yield (n=6*4 per CRP)

Udbytter i vinterhvede i 4 sædskifteperioder



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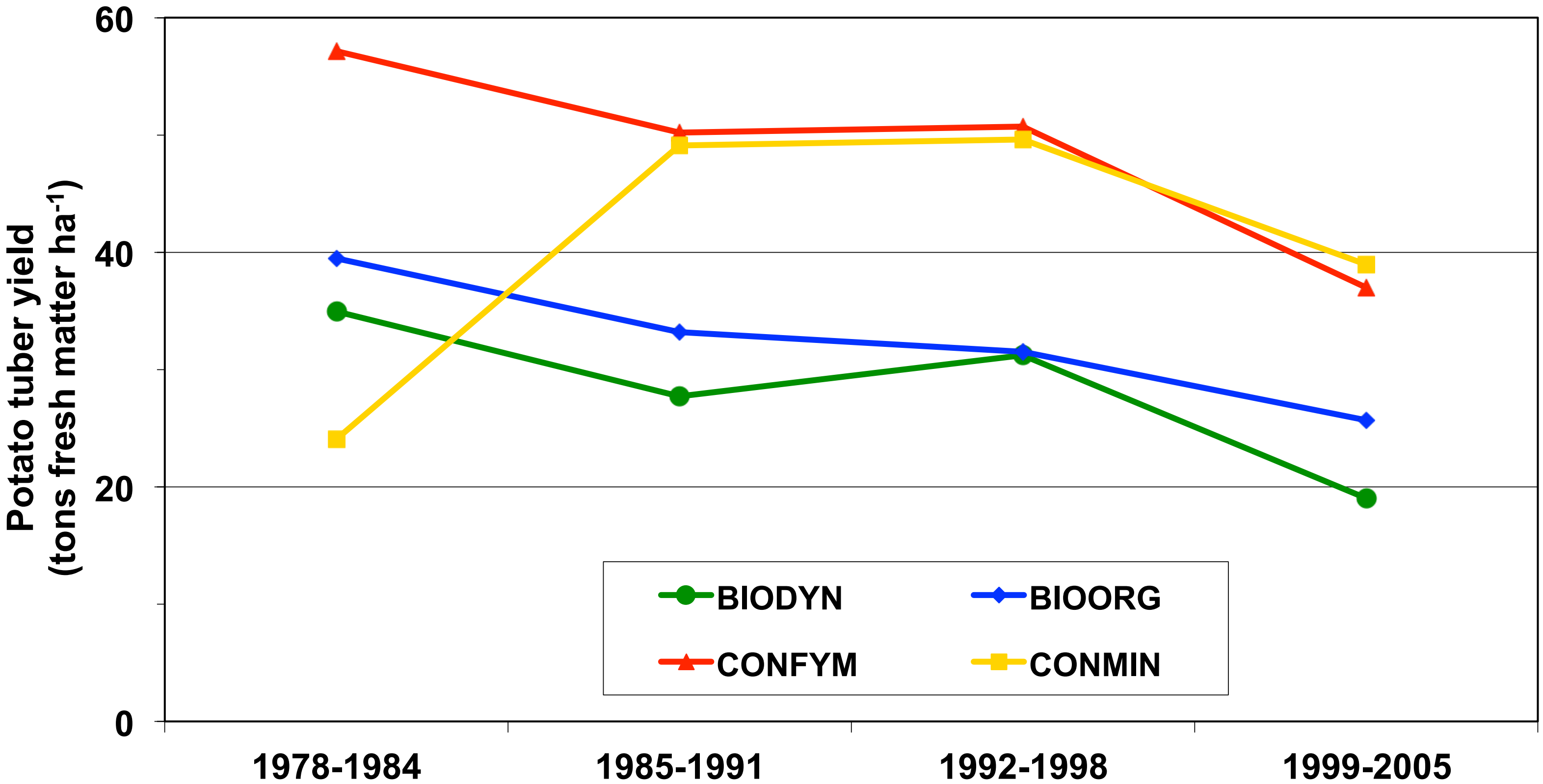
Development of potato yield (n=3*4 per CRP)

Udbytter i kartofler



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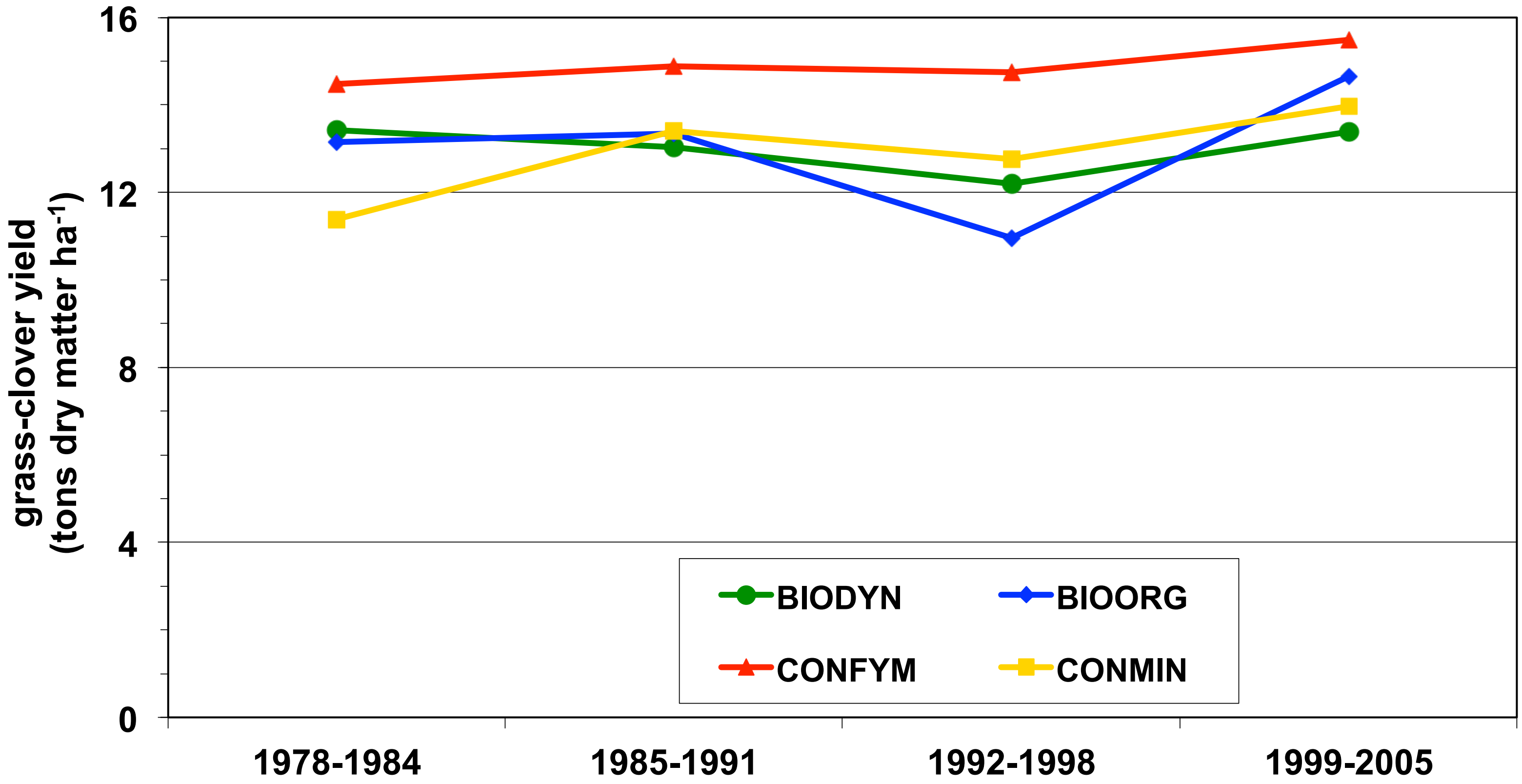
Mäder, P., et al. 2006 The DOK experiment (Switzerland). In: Long-term field experiments in organic farming. Raupp, J., Pekrun, C., Oltmanns, M., Köpke, U. (eds.). pp 41-58. Koester, Bonn.

Development of grass-clover yield

Udbytter i kløvergræs



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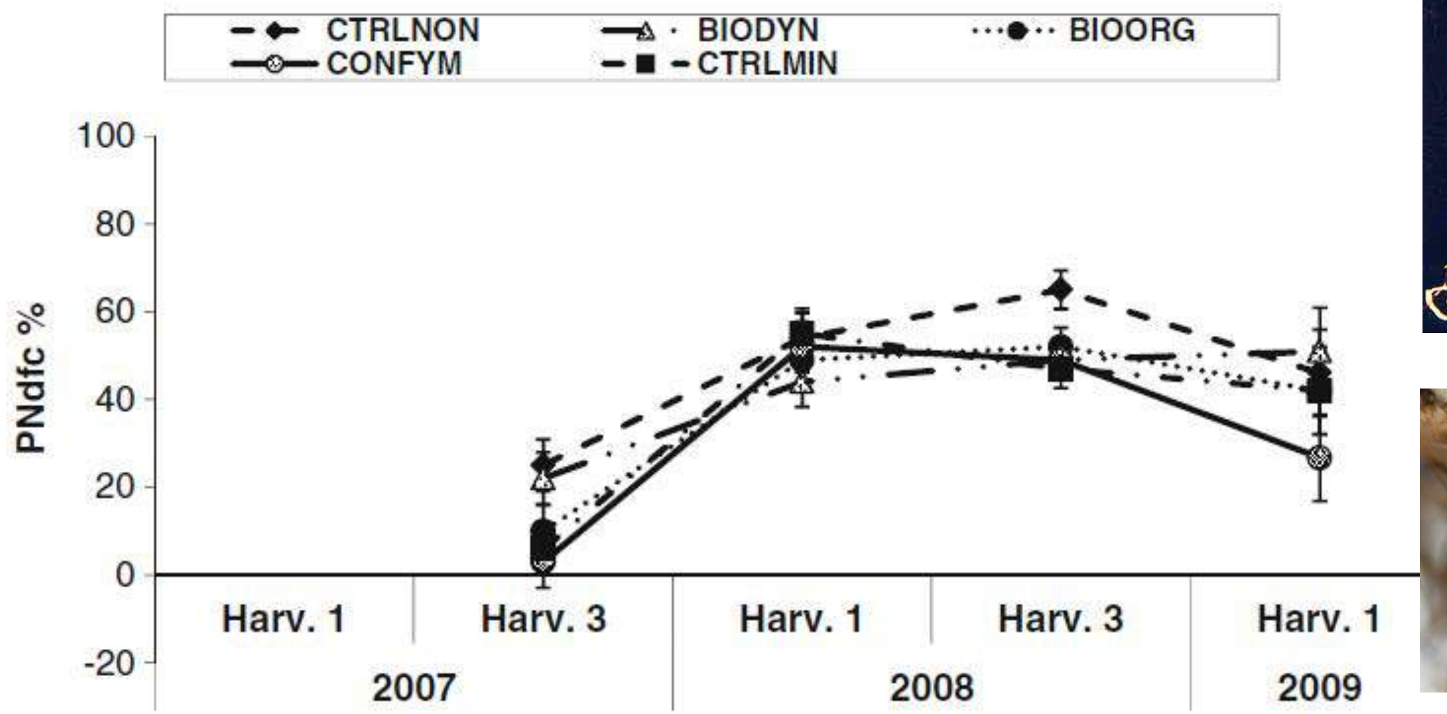
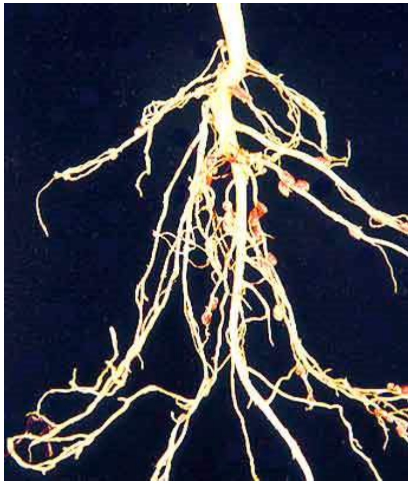
Mäder, P., et al. 2006 The DOK experiment (Switzerland). In: Long-term field experiments in organic farming. Raupp, J., Pekrun, C., Oltmanns, M., Köpke, U. (eds.). pp 41-58. Koester, Bonn.

Proportion of nitrogen fixed by clover in grass-clover leys

Kvælstoffiksering i kløvergræs





- In the 2nd grass-clover year 50% of the N is derived from clover
- This corresponds to 40 – 120 kg N ha^{-1}

Oberson, A., Frossard, E., Bühlmann, C., Mayer, J., Mäder, P., Lüscher, A., 2013. Nitrogen fixation and transfer in grass-clover leys under organic and conventional cropping systems. Plant Soil 371, 237-255.

The crop rotations changes over time

Sædskiftet ændrer sig med tiden

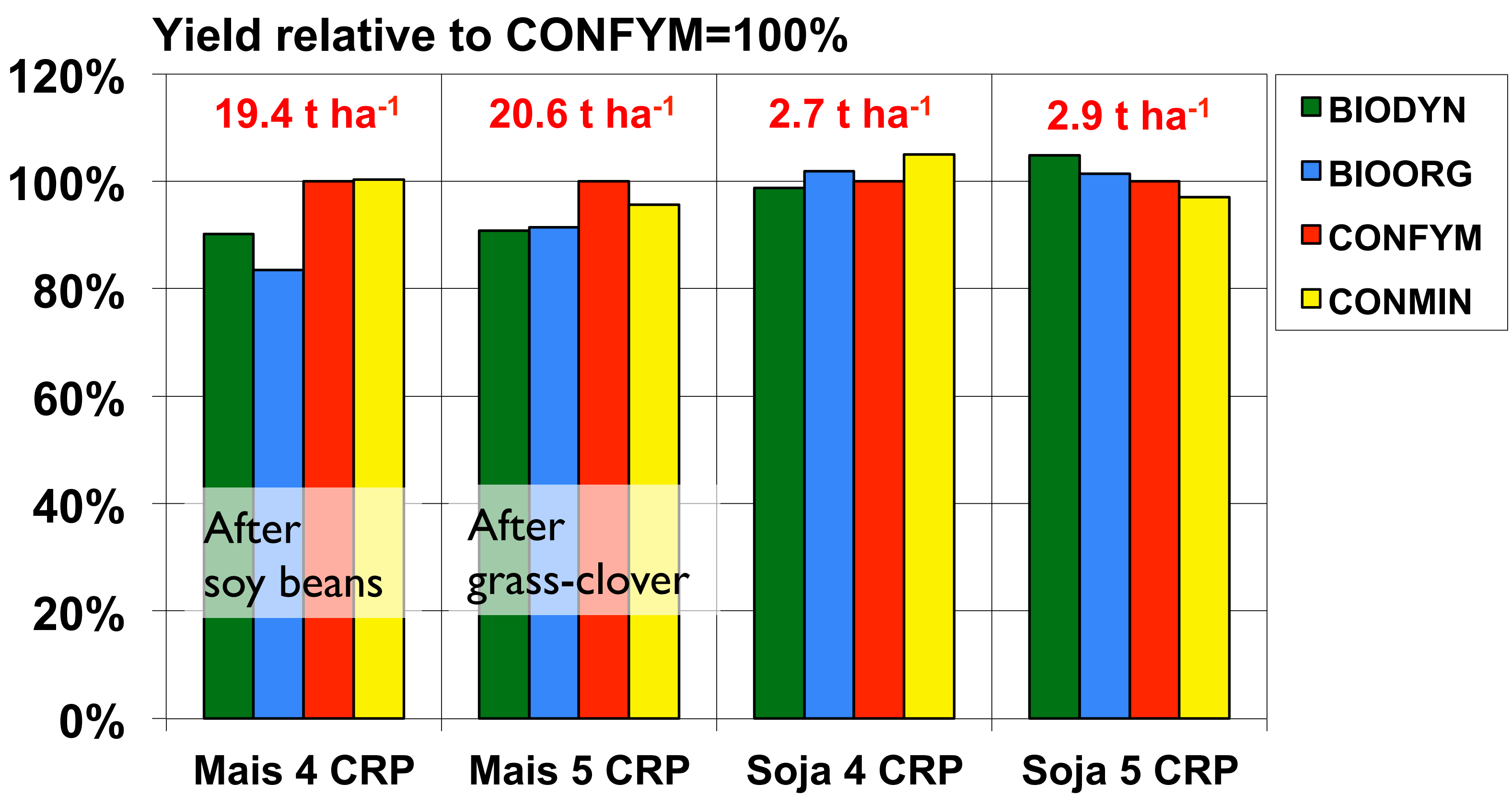
1. CRP (1978-1984)	2. CRP (1985-1991)	3. CRP (1992-1998)	4. CRP (1999-2005)	5. CRP (2006-2012)	6. CRP (2013-2019)
Potatoes Green manure	Potatoes Green manure	Potatoes	Potatoes	Maize	Maize Green manure
Winter wheat Green manure	Winter wheat Green manure	Winter wheat Green manure	Winter wheat Green manure	Winter wheat Green manure	Soy
Cabbage	Red beets	Red beets	Soy Green manure	Soy Green manure	Winter wheat Green manure
Winter wheat	Winter wheat	Winter wheat	Maize	Potatoes	Potatoes
Barley	Barley	Grass-clover 1	Winter wheat	Winter wheat	Winter wheat
Grass-clover 1	Grass-clover 1	Grass-clover 2	Grass-clover 1	Grass-clover 1	Grass-clover 1
Grass-clover 2	Grass-clover 2	Grass-clover 3	Grass-clover 2	Grass-clover 2	Grass-clover 2

CRP: Crop rotation period

CRP: Sædskifteperiode på 7 år

DOK trial – Maize and Soybeans

DOK-forsøget – majs og sojabønner



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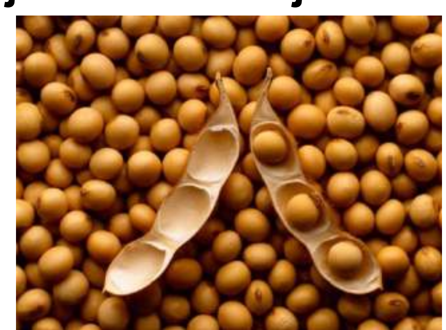
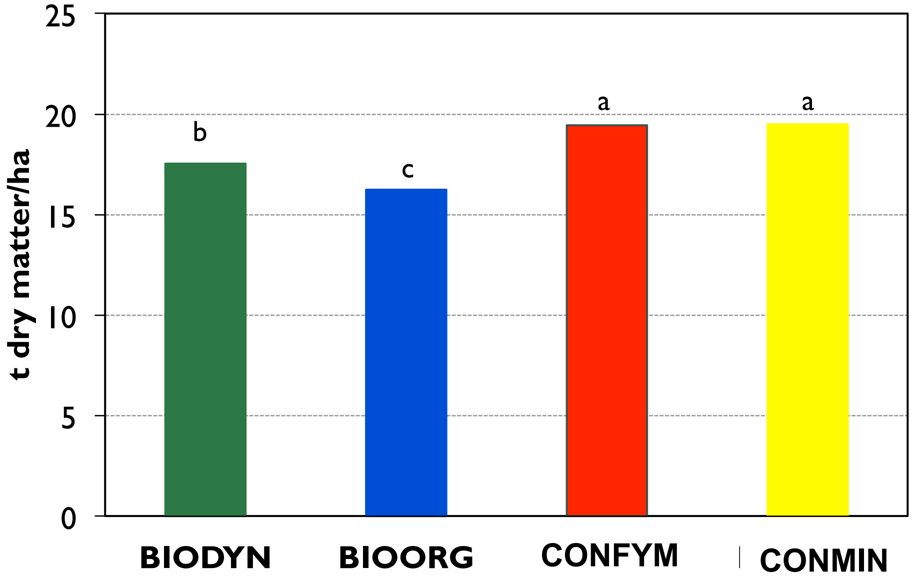


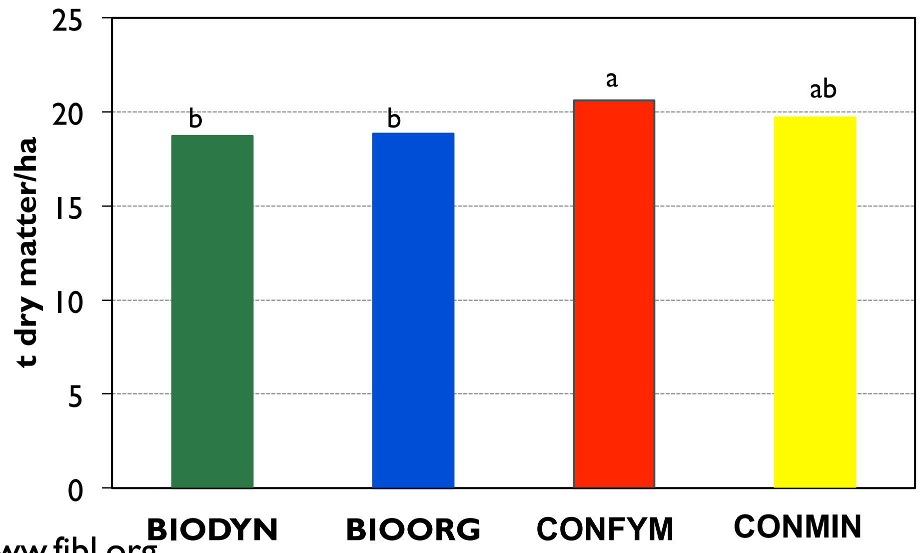
Maize yield in the 4th and 5th CRP (Ø 3 years)

Majsudbytter i 4. og 5. sædskifteperiode

4th CRP:
After soybeans



5th CRP:
After grass-clover



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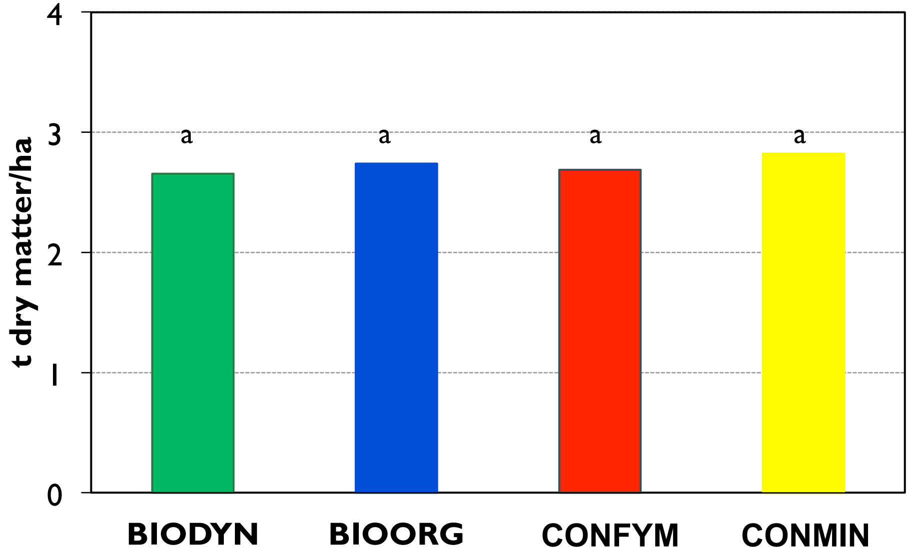
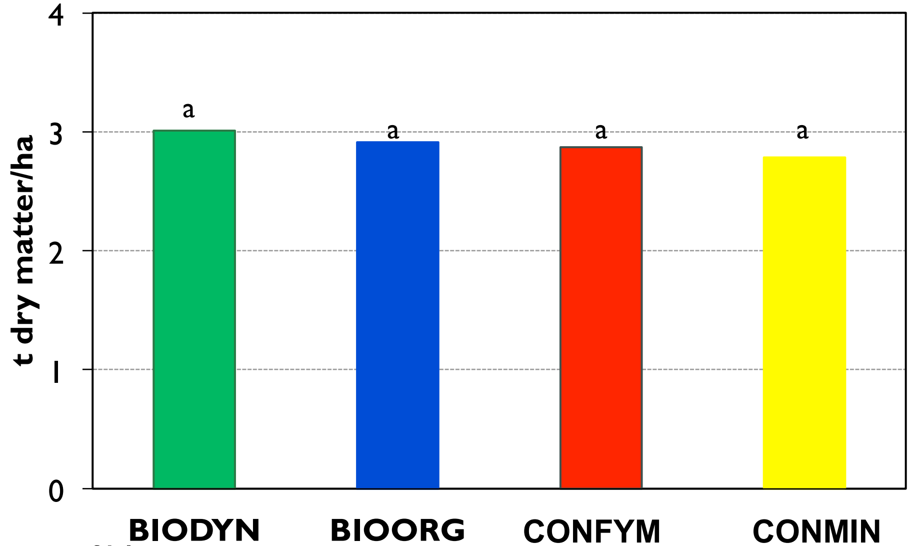
Soybean yield in the 4th and 5th CRP (Ø 3 years)

Sojabønneudbytter i 4. og 5. sædskifteperiode

4th CRP:

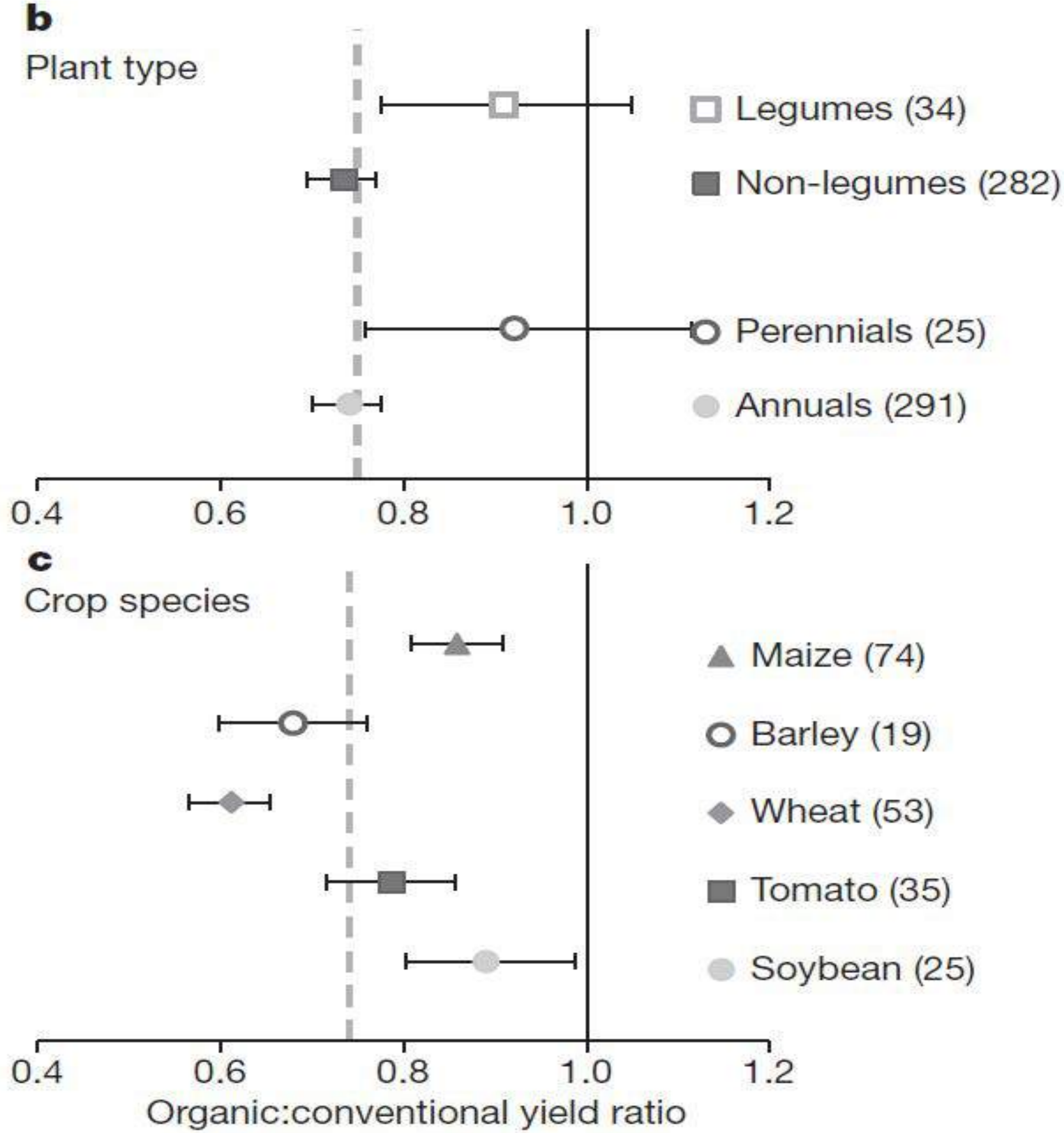


5th CRP:

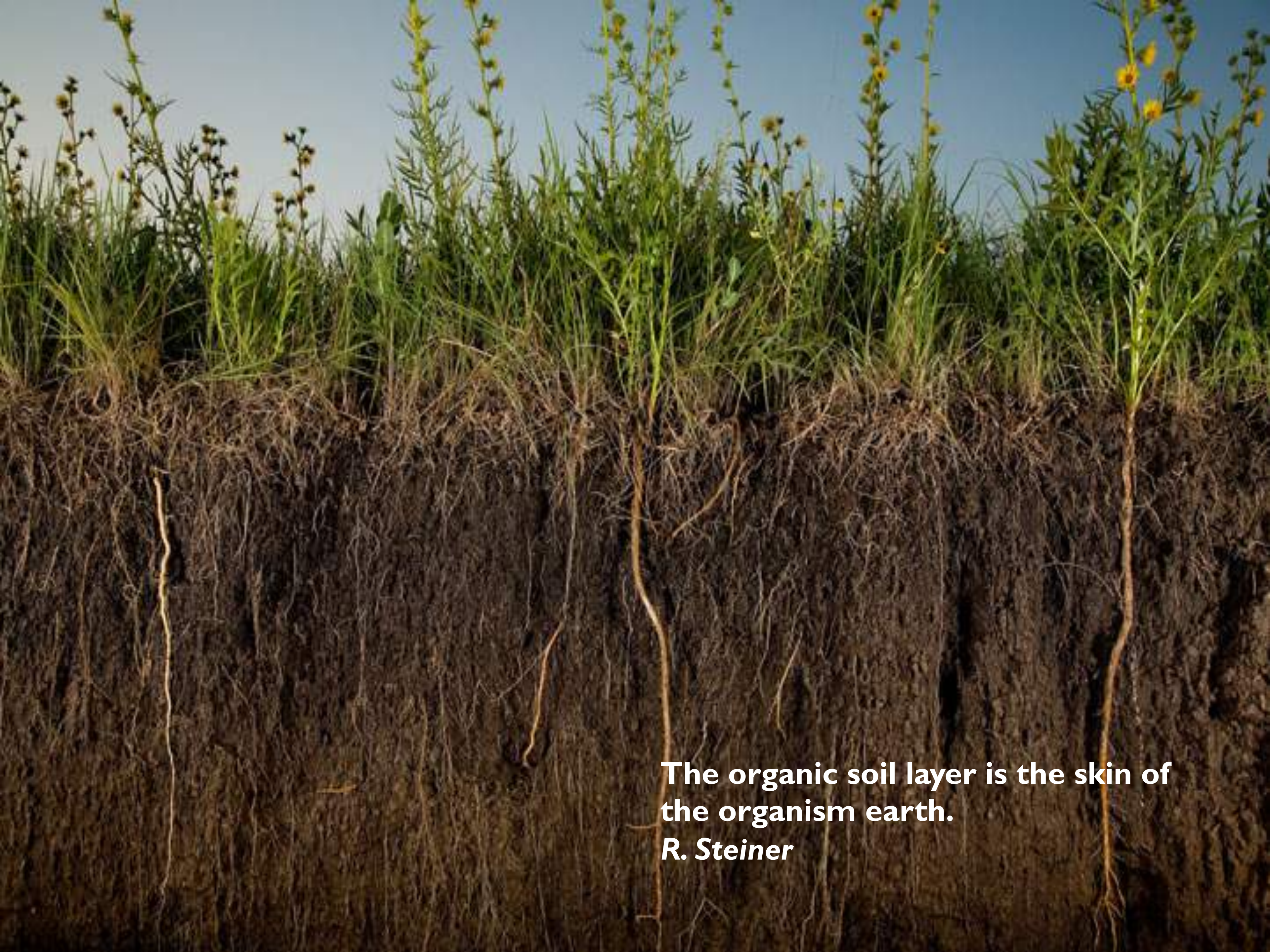


Crop yields in organic and conventional comparisons Meta-Analysis

Metaanalyse: Sammenligning af økologiske og konventionelle udbytter



Seufert, V., Ramankutty, N., Foley, J.A., 2012. Comparing the yields of organic and conventional agriculture. Nature 485, 229-232.


The organic soil layer is the skin of the organism earth.
R. Steiner

Soil properties in the DOK trial after 21 years ...

Jordens egenskaber i DOK-forsøget efter 21 år …

Biodynamic farming (BIODYN)

Conventional Mineral (CONMIN)

Soil structure without organic manure and with manure compost in the DOK trial

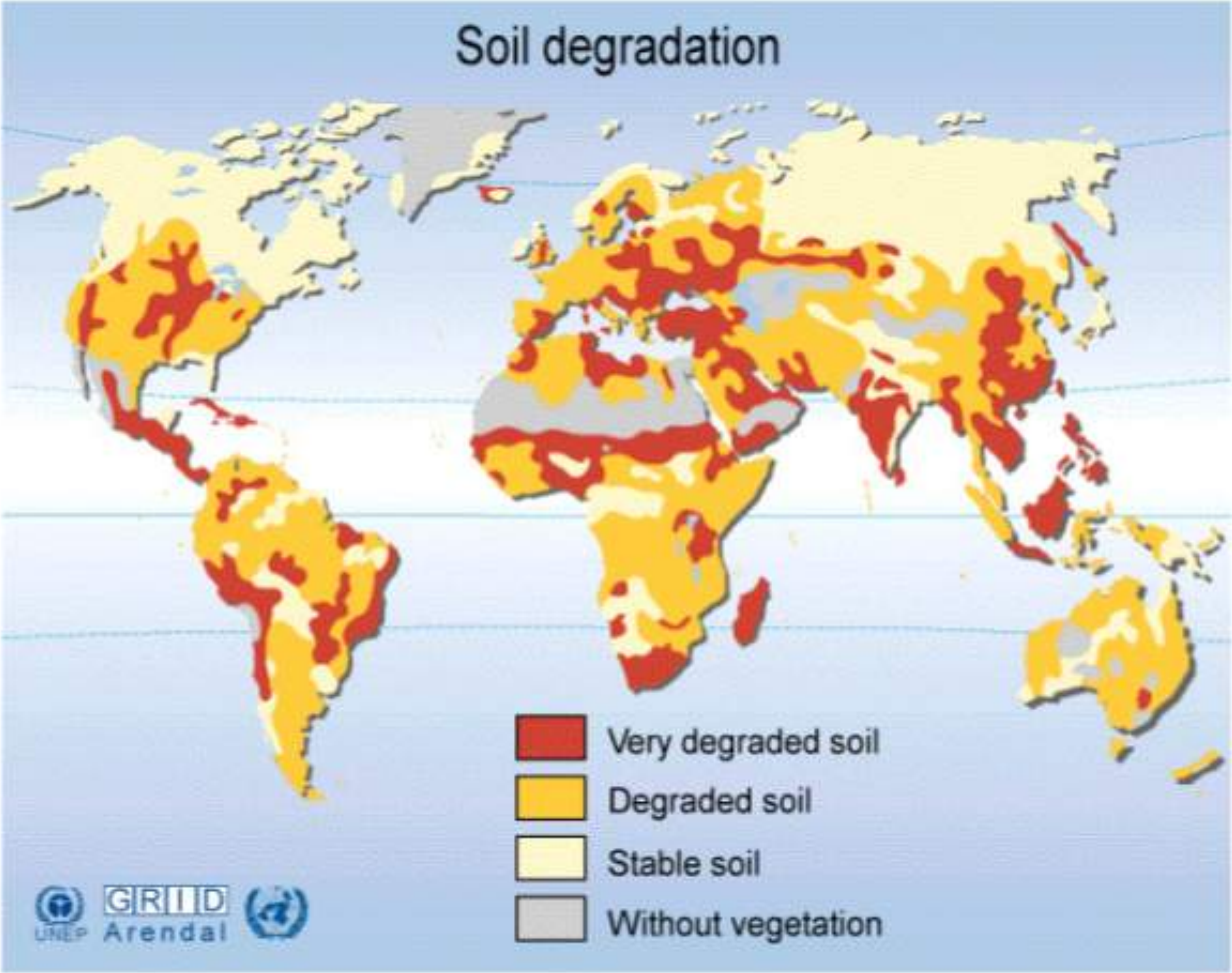
Jordstruktur
- uden organisk gødning

- med komposteret husdyrgødning

Fotos: Fliessbach Nov. 2002

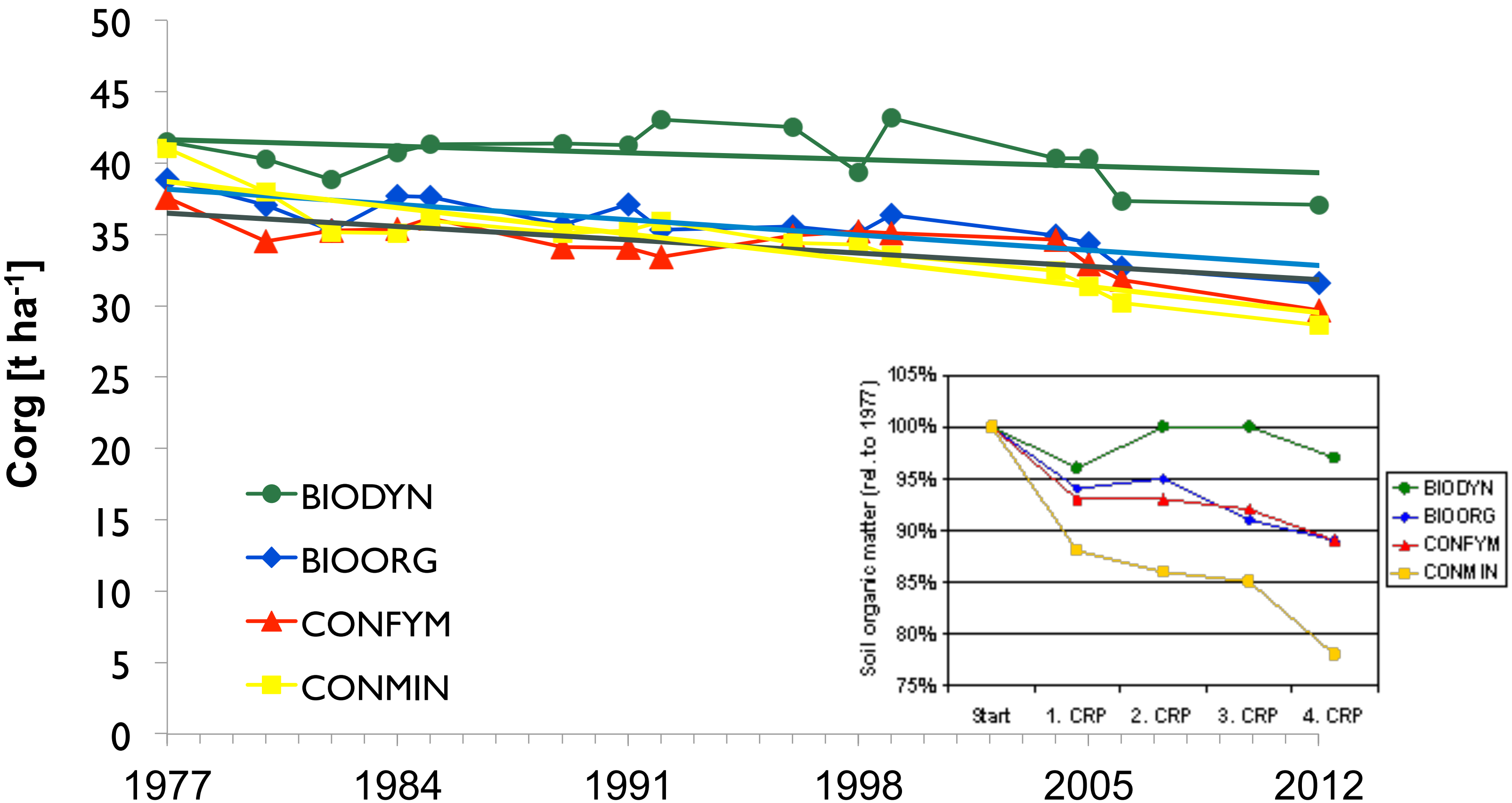
CONMIN

BIODYN


Soil degradation
Very degraded soil
Degraded soil
Stable soil
Without vegetation
UNEP
GRID
Arendal

Development of soil carbon stocks DOK experiment (high intensity plots only)

Udvikling i jordens indhold af kulstof (høj gødningsniveau)



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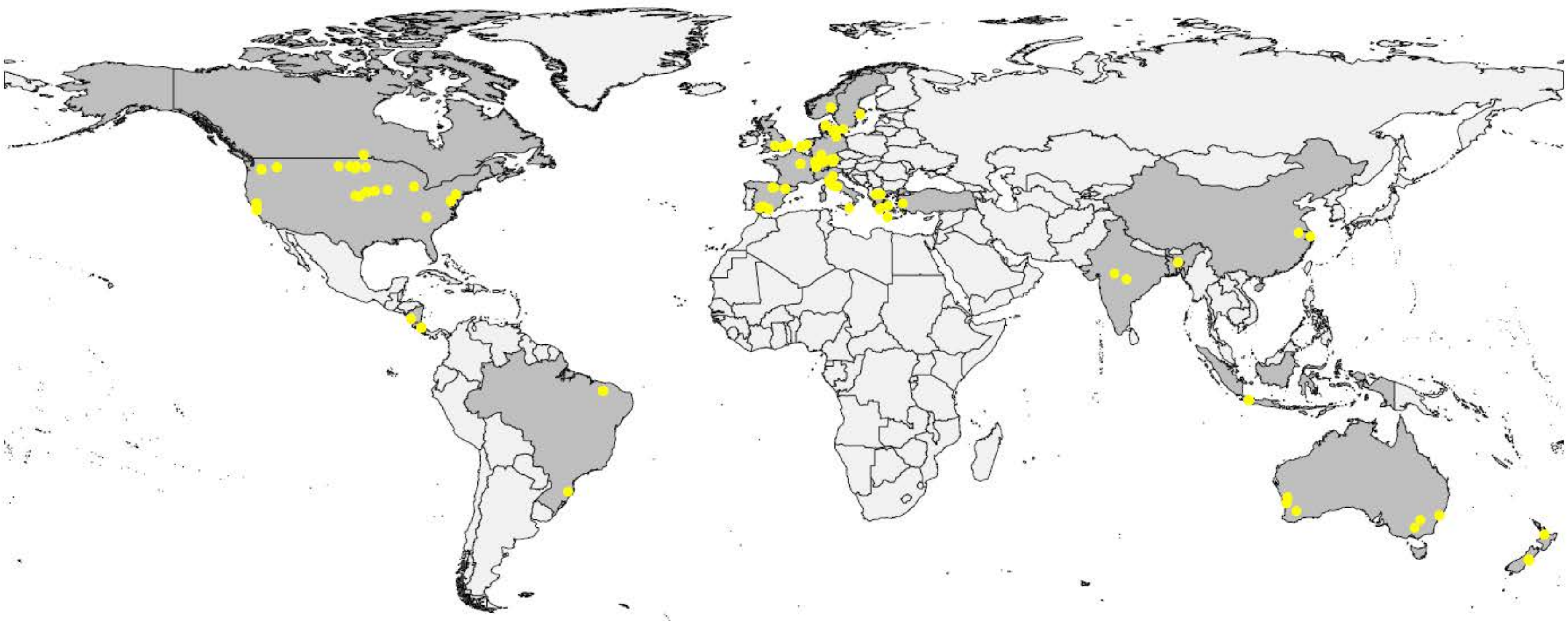
Fließbach, A. et al. 2007. Soil organic matter and biological soil quality indicators after 21 years of organic and conventional farming. Agric. Ecosys. Environ. 118, 273-284

Leifeld, J. et al. 2009. Consequences of Conventional versus Organic farming on Soil Carbon: Results from a 27-Year Field Experiment. Agron. J. 101, 1204-1218.

Meta-analysis:
Soil carbon in organic and conventional farming systems

Kulstof i økologiske og konvenitonelle landbrug

Geographic distribution of system comparison studies



74 comparisons with up to 211 compared pairs

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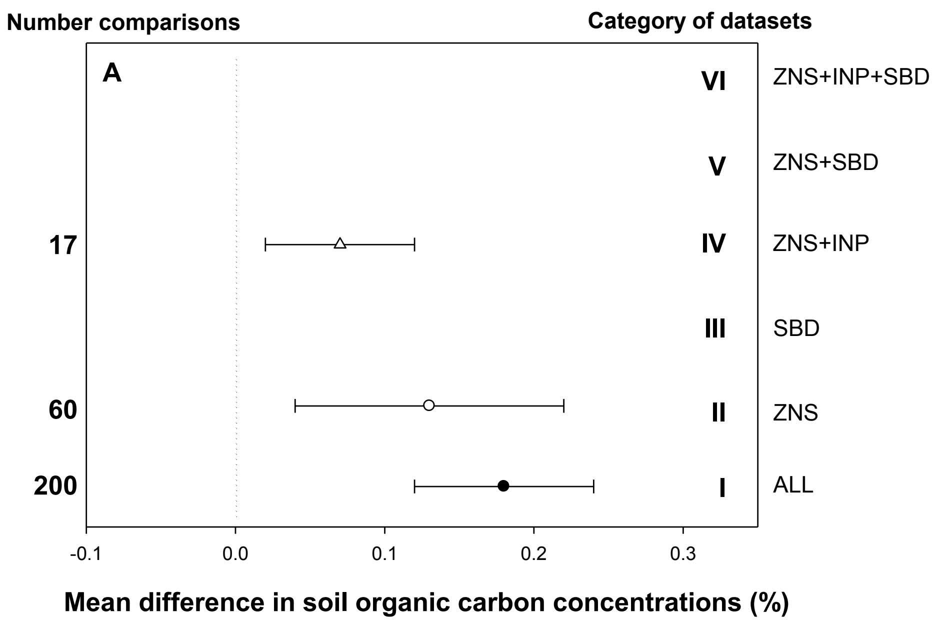
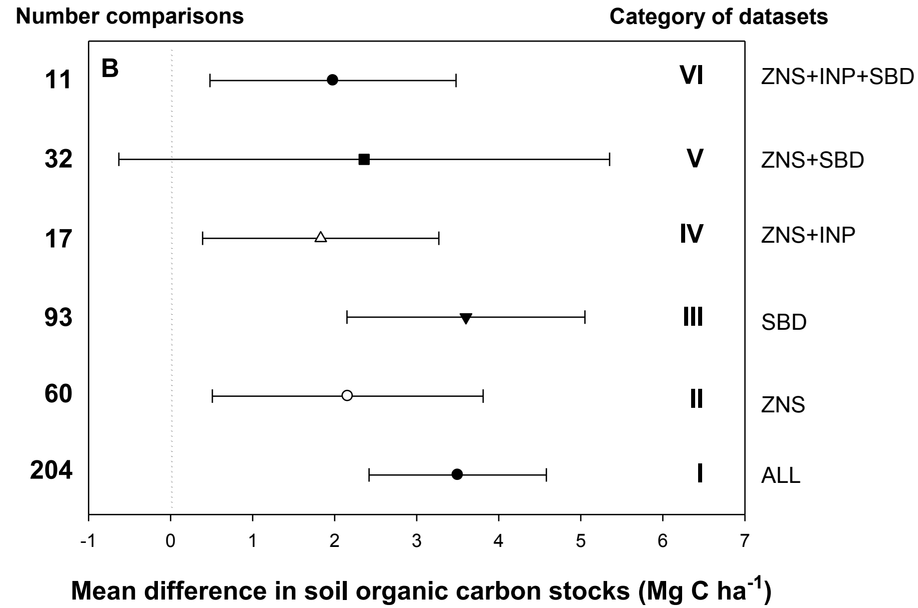
Gattinger, A. et al. 2012. Enhanced top soil carbon stocks under organic farming. Proc. Nat. Acad. Sci. USA 109, 18226-18231.

More carbon in organically managed soils?



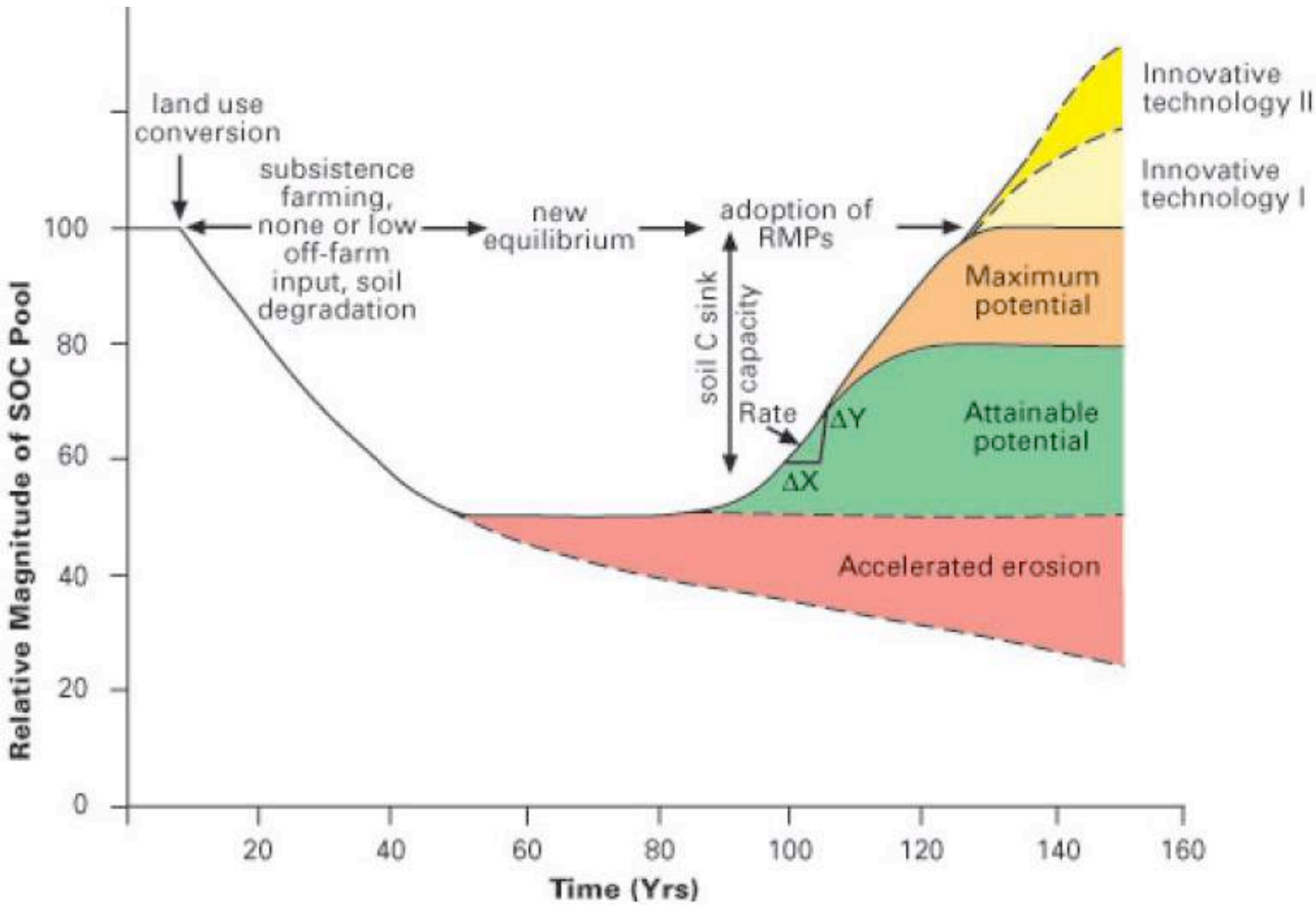


Higher carbon concentration (0,18±0,06 percent points Corg) and carbon stocks (3,50 ± 1,08 t Corg ha^{-1}) in top-soil (0-20 cm) under organic management.

Mere kulstof i topjorden (0-20 cm) ved økologisk dyrkning

Gattinger, A. et al. 2012. Enhanced top soil carbon stocks under organic farming. Proc. Nat. Acad. Sci. USA 109, 18226-18231.

Soil organic carbon (SOC) dynamics



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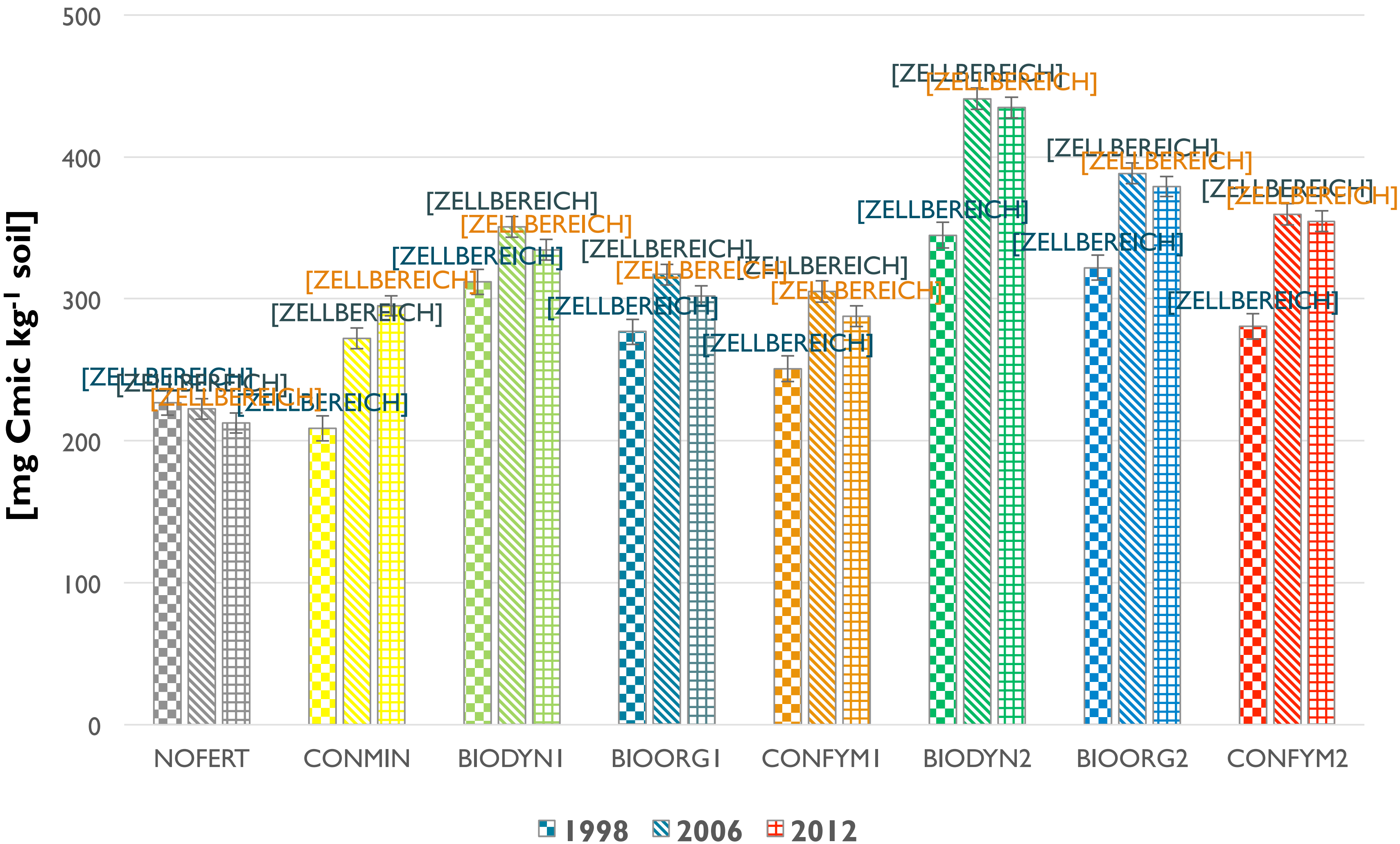
Lal, R., 2004. Soil carbon sequestration impacts on global climate change and food security. Science 304, 1623-1627.

Soil microbial biomass in 1998, 2006 and 2012

Mængden af mikroorganismer i jorden i 1998, 2006 og 2012



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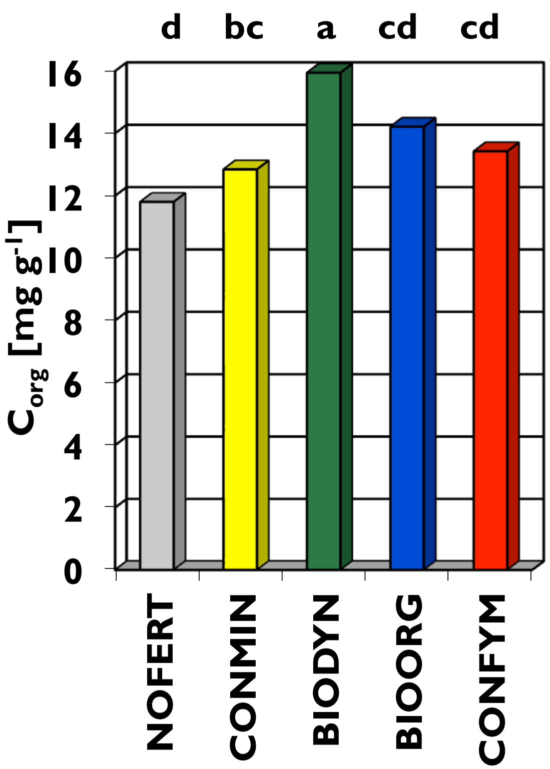
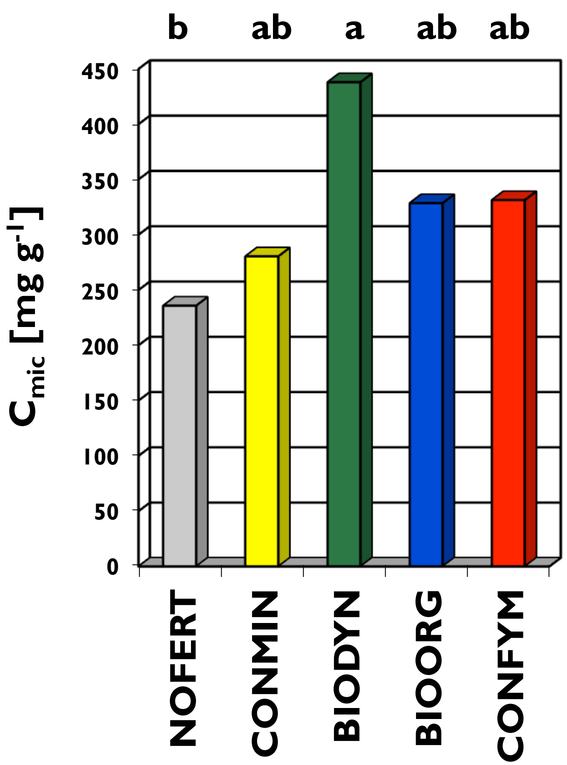
Sensitiveness of indicators (2004)

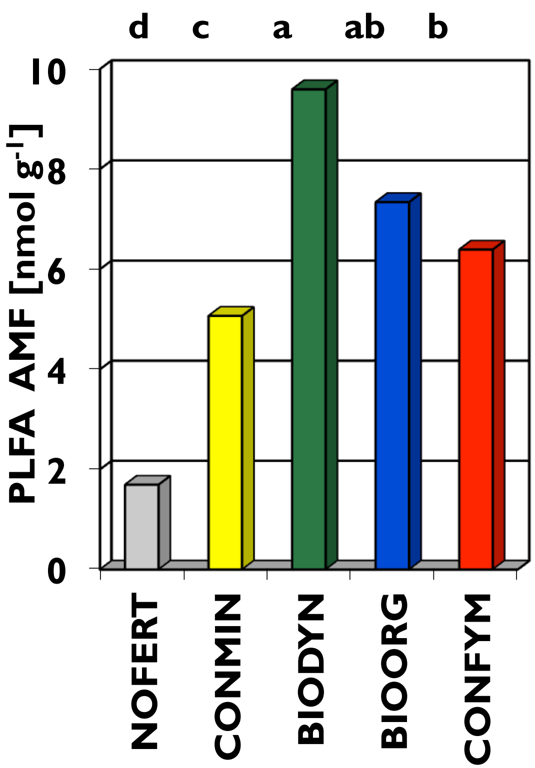
Soil organic carbon



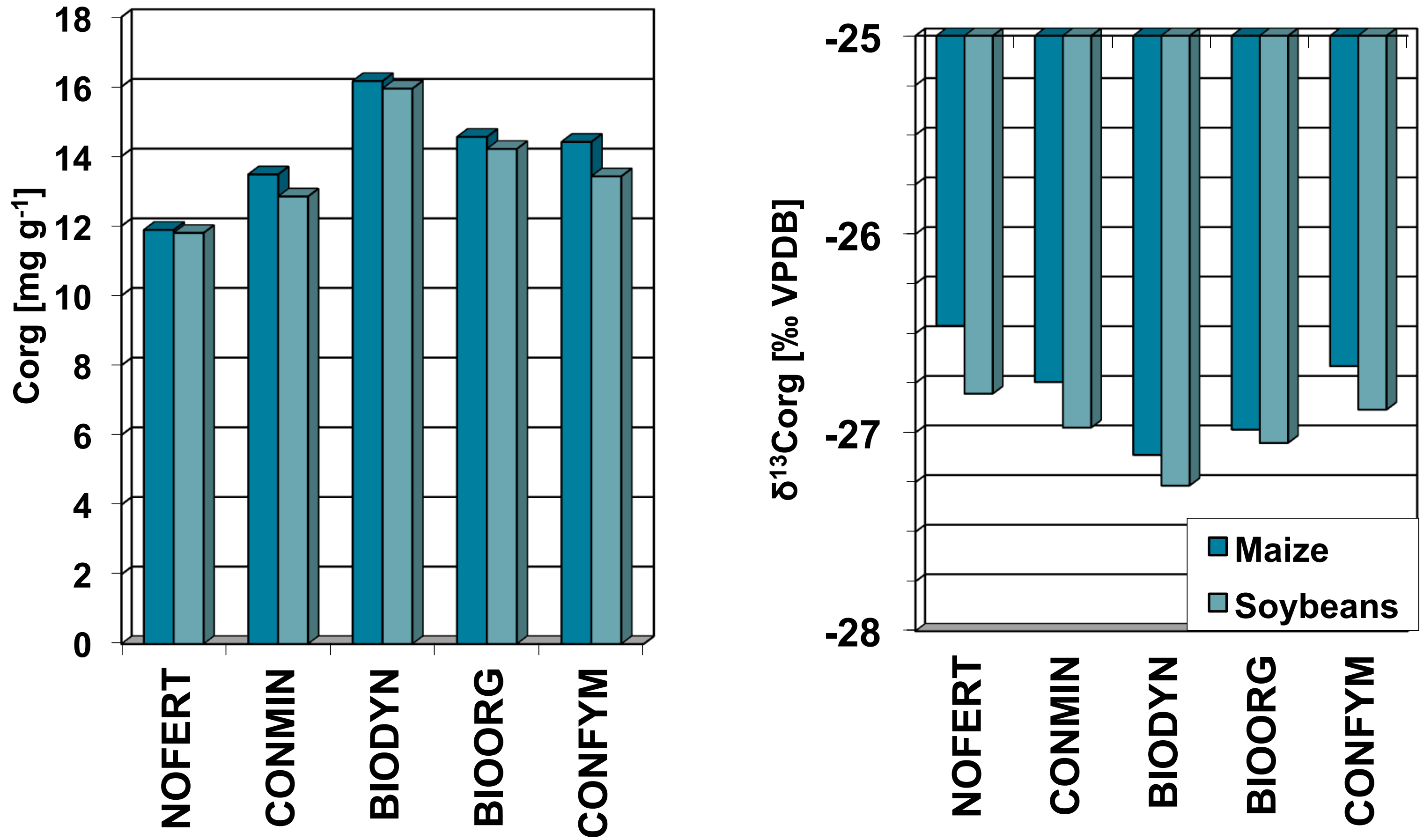
Soil microbial biomass



PLFA Mycorrhiza

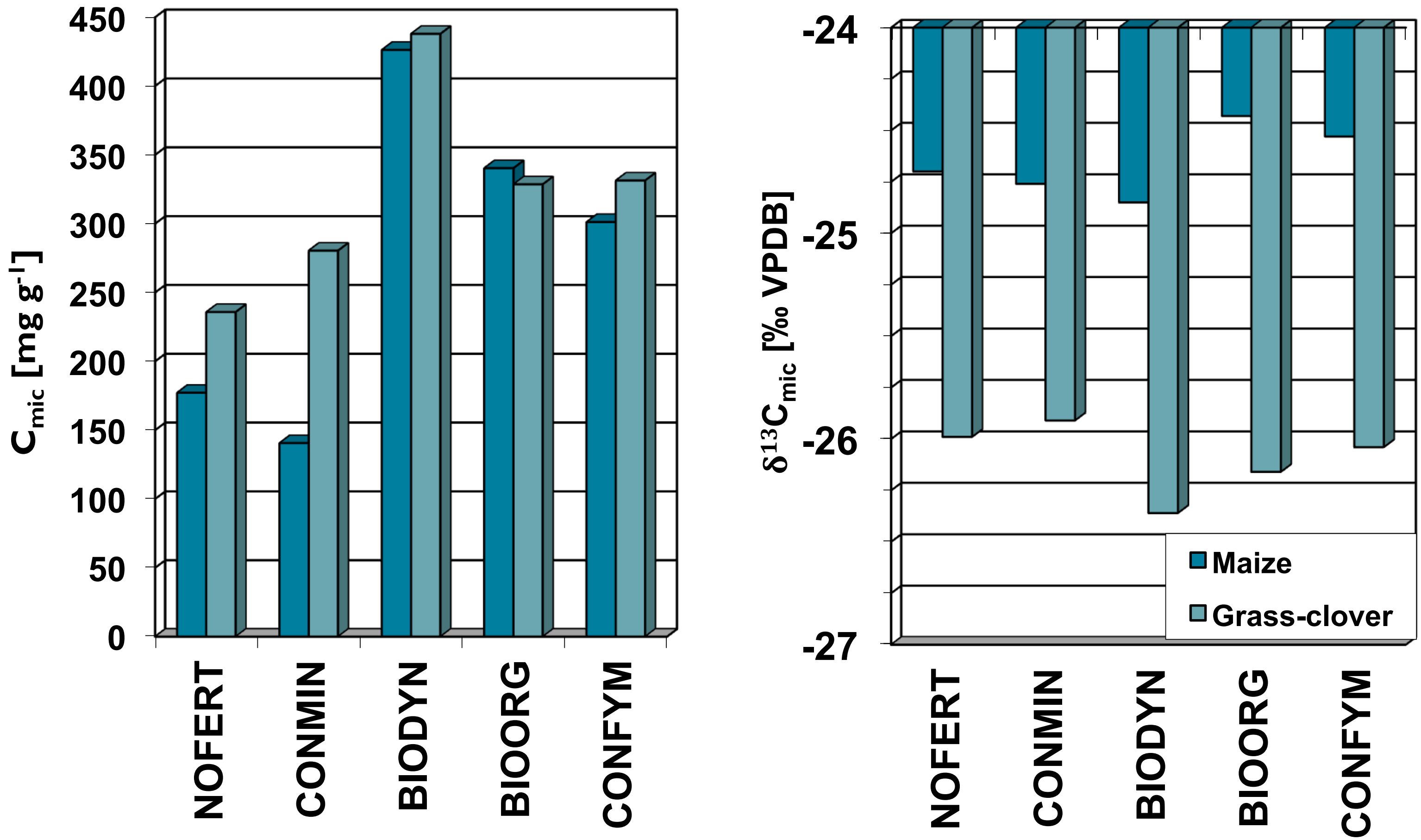


Soil organic carbon (C_{org}) in the farming systems of the DOK-trial under maize and soybeans



Microbial biomass (Cmic) in the farming systems of the DOK trial under maize and grass-clover

Mængden af mikroorganismer i jorden under majs og kløvergræs i DOK



Increased soil microbial biomass and activity under organic agriculture worldwide?

Er mængden af mikroorganismer større i økologisk jord, og er mikroorganismerne her mere aktive?

57 eligible studies globally with up to 148 pairwise comparisons

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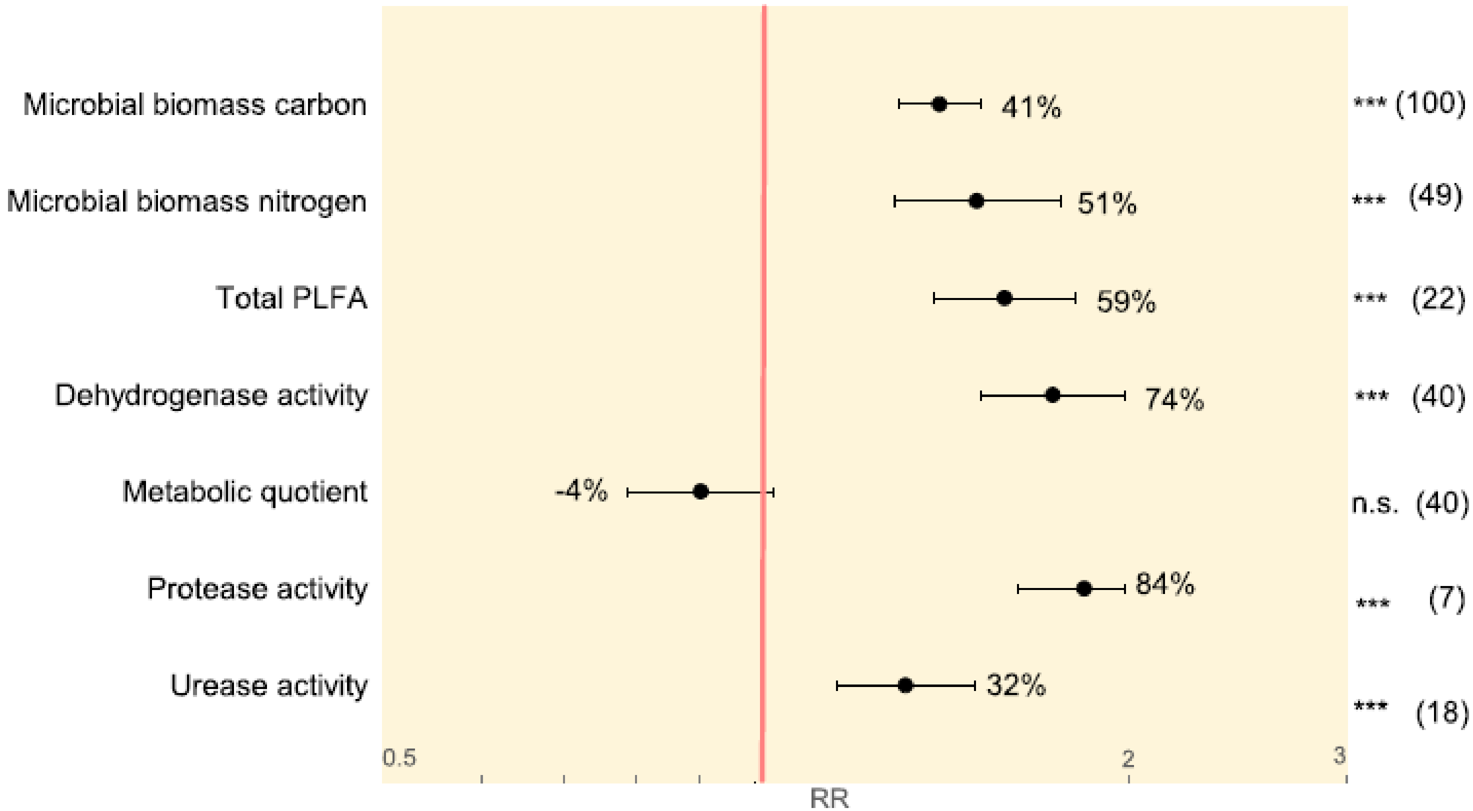
Lori, M. et al. 2017. Organic farming enhances soil microbial abundance and activity—A meta-analysis and meta-regression. PLOS ONE 12, e0180442

Increased soil microbial biomass and activity under organic agriculture worldwide?

Er mængden af mikroorganismer større i økologisk jord, og er mikroorganismerne her mere aktive?



Random effects model with a Z-Distribution and a 95 % confidence interval. Numbers in brackets display the number of pairwise comparisons included in each calculation. *≥0.05, **≥0.01, ***≥0.001, n.s.=not significant

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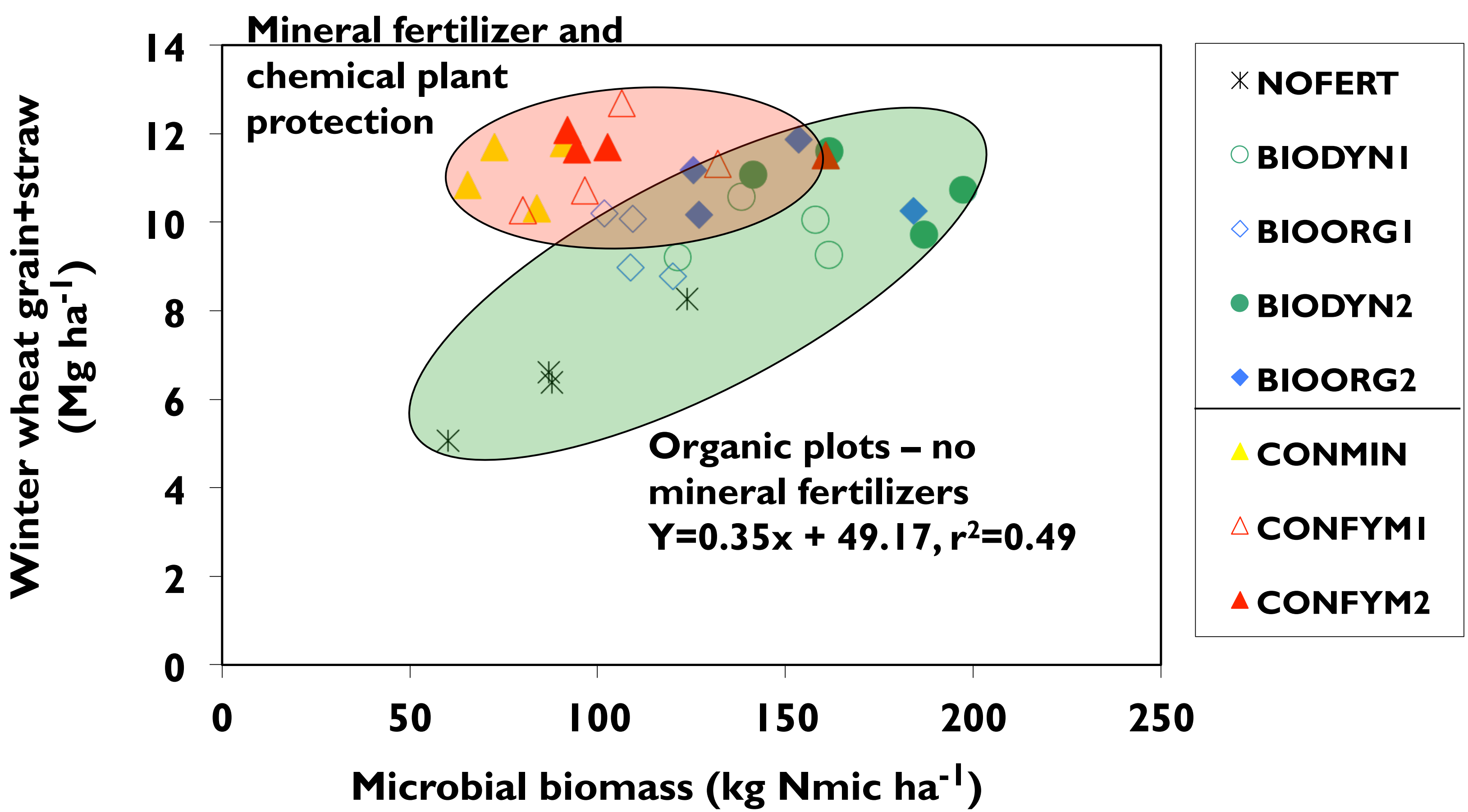
Lori, M. et al. 2017. Organic farming enhances soil microbial abundance and activity—A meta-analysis and meta-regression. PLOS ONE 12, e0180442

Correlation soil microbial biomass – yield

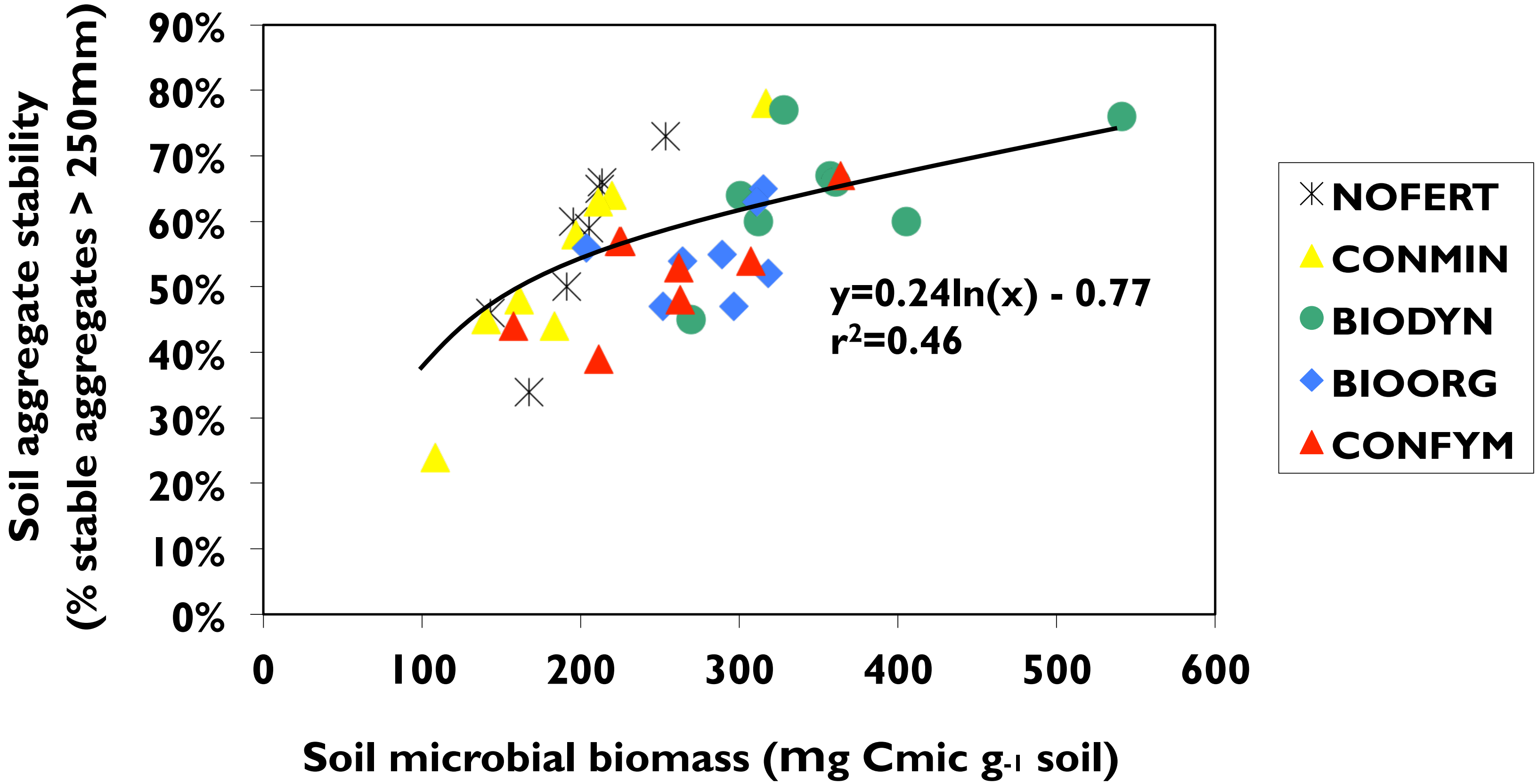
Sammenhæng mellem udbytter og mængden af mikroorganismer



Mäder et al., 2001

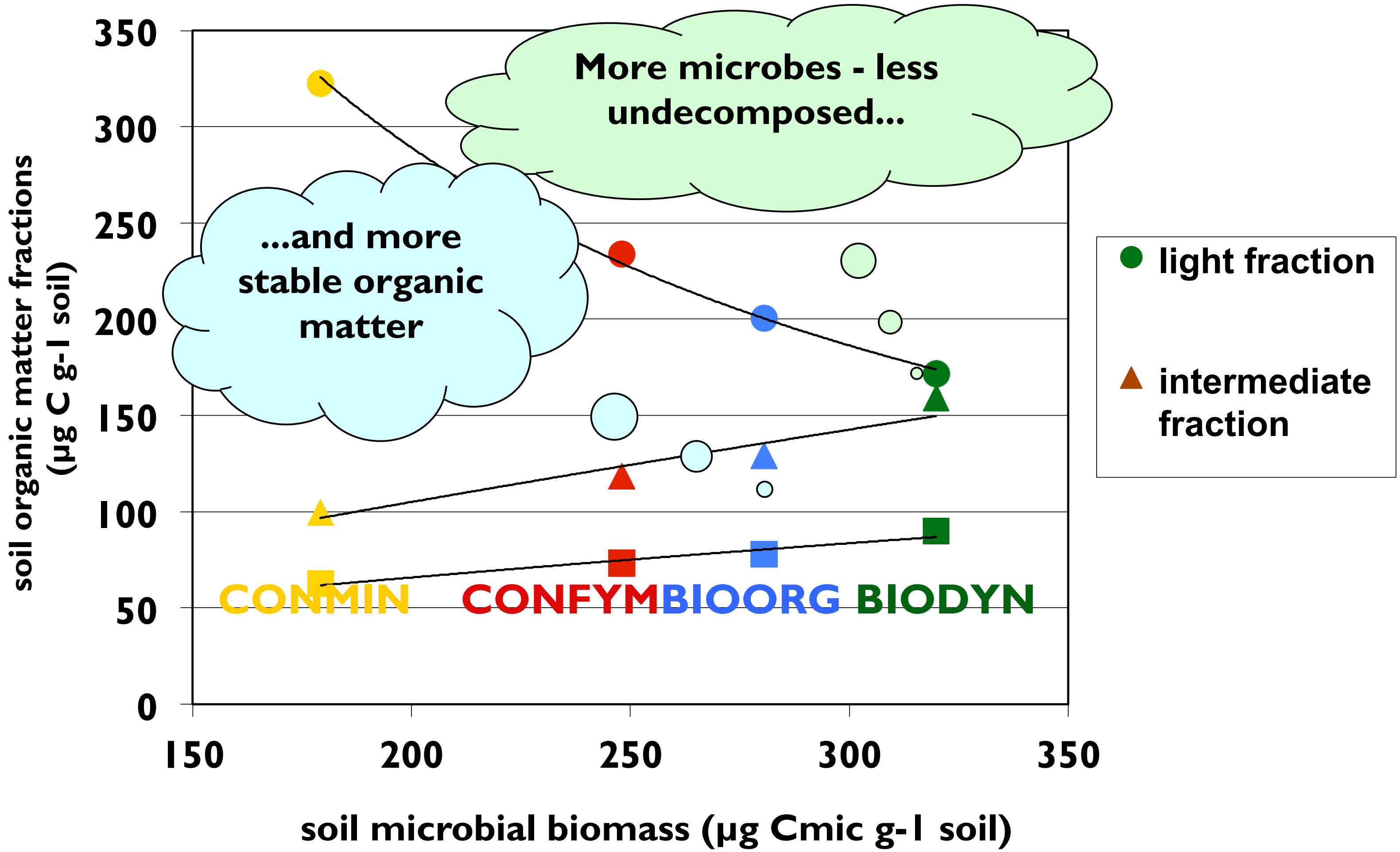
Correlation soil microbial biomass – aggregate stability

Sammenhæng mellem jordkrummernes styrke og mængden af mikroorganismer



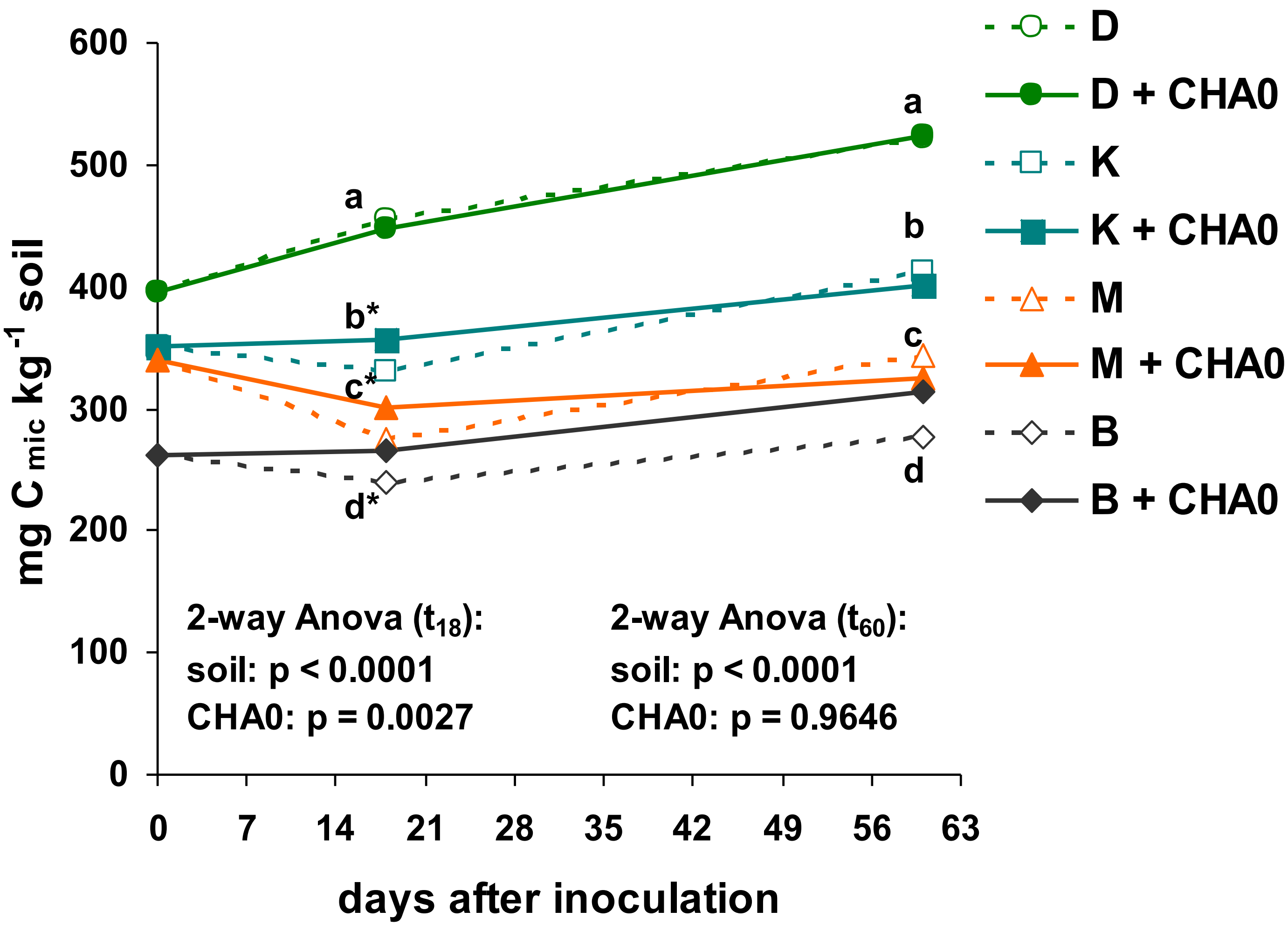
Fließbach, A., Hany, R., Rentsch, D., Frei, R., Eyhorn, F., 2000. DOC trial: soil organic matter quality and soil aggregate stability in organic and conventional soils. In: Alföldi, T., Lockeretz, W., Niggli, U. (Eds.), 13th International IFOAM Scientific Conference, IFOAM 2000 — The World Grows Organic, Basel, p. 762.

Density fractions



Fließbach, A., Mäder, P., 2000. Microbial biomass and size-density factions differ between soils of organic and conventional agricultural systems. Soil Biol. Biochem. 32, 757-768.

Resilience: Effect of soil amendment with *P. fluorescens* CHA0 on the microbial biomass (C_{mic})

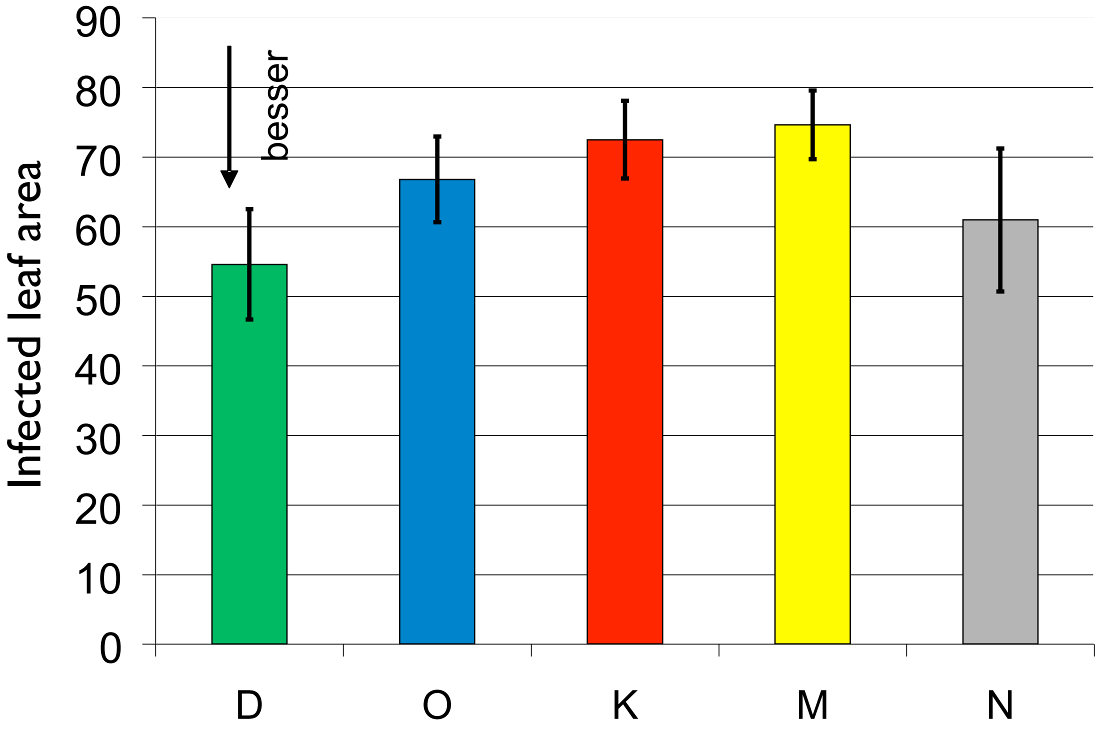


Fließbach, A., 2009. Soil amendment with Pseudomonas fluorescens CHA0: lasting effects on soil biological properties in soils low in microbial biomass and activity. Microb. Ecol. 57, 611-623.

Suppressiveness of soils towards plant diseases

Jordens evne til at modstå plantesygdomme

lav søjle = mindre sygdom



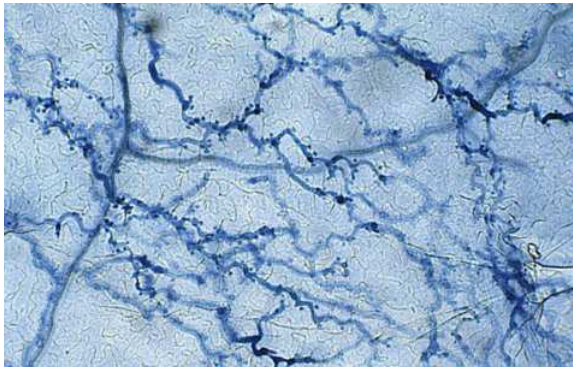


Foto: Barbara Thürig

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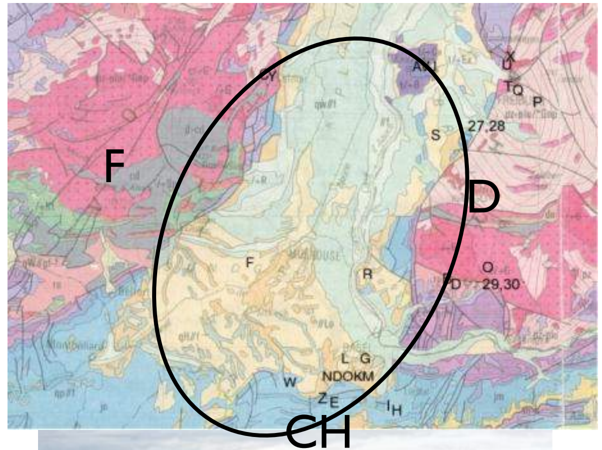
Tamm, L., et al. 2010. Soil type, management history, and soil amendments influence the development of soil-borne (Rhizoctonia solani, Pythium ultimum) and air-borne (Phytophthora infestans, Hyaloperonospora parasitica) diseases. Eur. J. Plant Pathol. 127, 465-481.

Influence of land use intensity on mycorrhiza communities in Central Europe

Betydningen af dyrkningsintensitet for mycorrhiza dannelse i Centraleuropa

Region: Upper Rhine Valley, Three country corner: France-Germany-Switzerland

Altitude: 250-400 m a.s.l.



Geology: periglacial Loess sediments (~12'000 years)

Soil types: Calcaric Regosols, Haplic Luvisols

Dyrkningsintensitet

Ekstensiv græsning | Økologi | Sædskifte | Integreret | Monokultur

Extensive Grasslands | Swiss Organic Farming | Rotations | Swiss Integrated Production | Mono-Cropping Maize

Land use intensity

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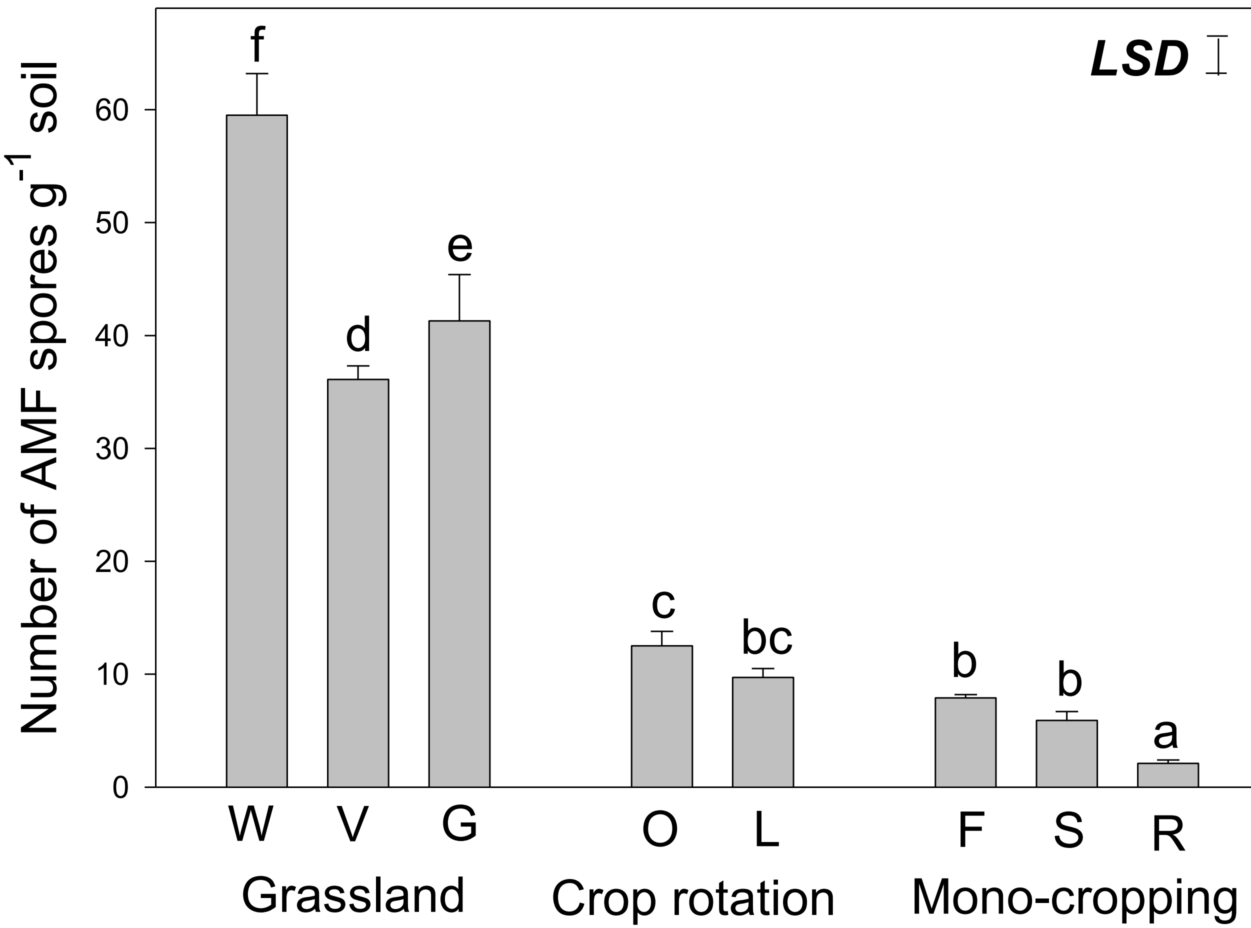
Source: Fritz Oehl, Agroscope IUL

Mycorrhiza spore numbers in agricultural soils

Antallet af mycorrhiza svampesporer i landbrugsjord

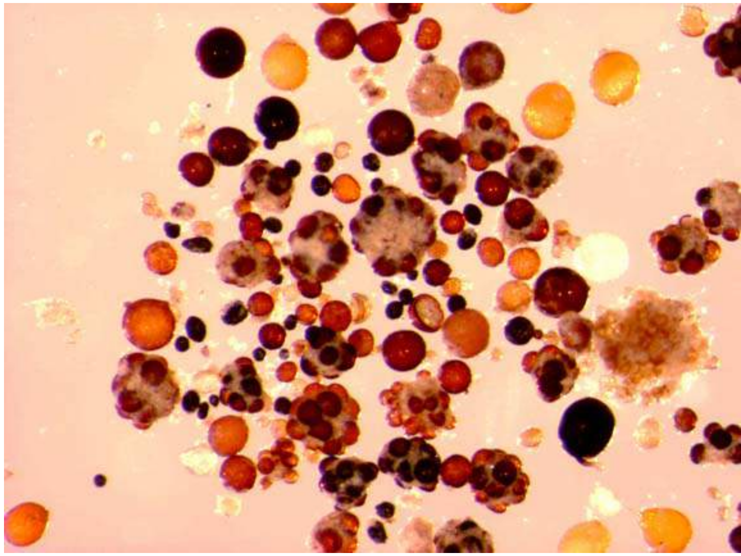


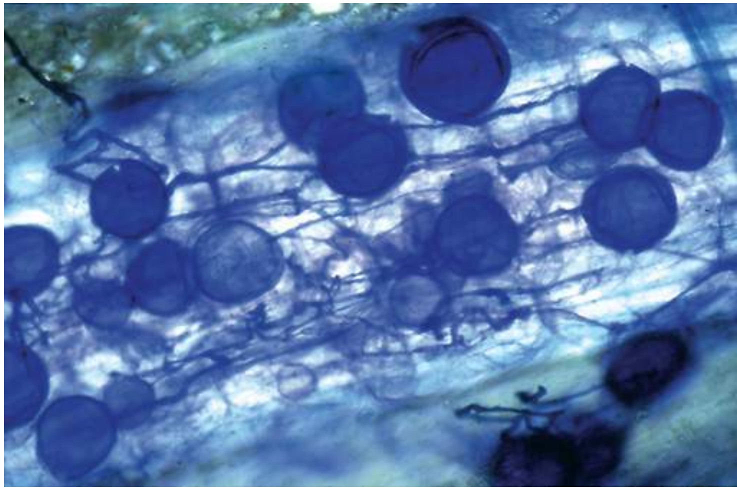
Oehl, F., Sieverding, E., Ineichen, K., Mäder, P., Boller, T., Wiemken, A., 2003. Impact of land use intensity on the species diversity of arbuscular mycorrhizal fungi in agrooecosystems of central Europe. Appl. Environ. Microbiol. 69, 2816-2824.

Mycorrhiza species (microscopy)

Mycorrhiza arter

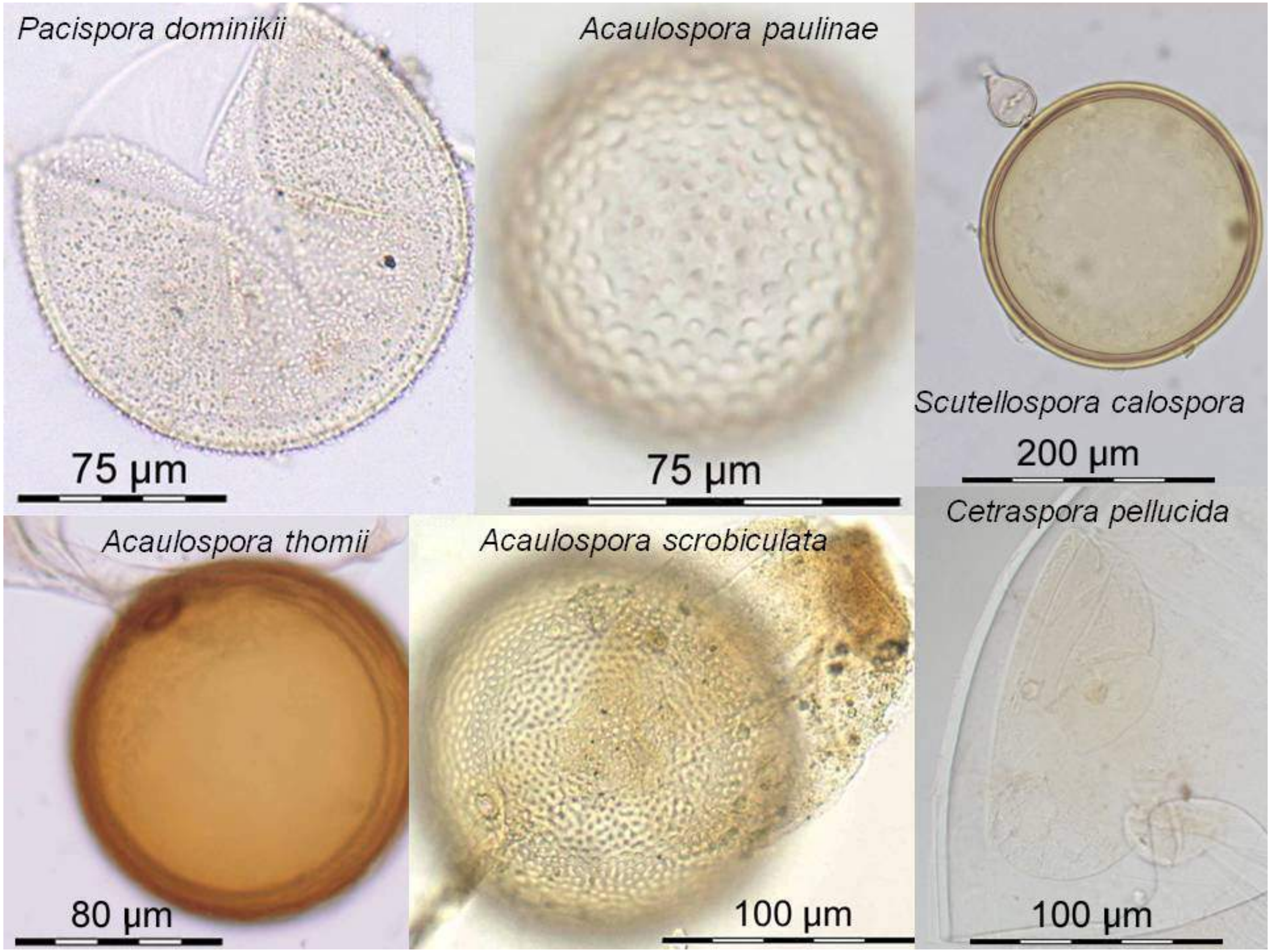
Mycorrhiza on loess sites in the DOK region:	Site	Nr of spore types
Grassland	1	26
	2	27
	3	26
Crop rotation	organic	26
	integrated	18
Monocropping maize	1	13
	2	10
	3	8





Oehl, F., Sieverding, E., Ineichen, K., Mäder, P., Boller, T., Wiemken, A., 2003. Impact of land use intensity on the species diversity of arbuscular mycorrhizal fungi in agrooecosystems of central Europe. Appl. Environ. Microbiol. 69, 2816-2824.

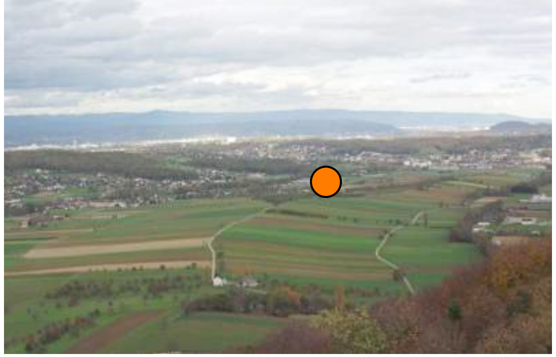
Indicator mycorrhiza species for intensive agriculture
Indikator arter af mycorrhiza i intensivt landbrug



Oehl et al, 2011; Agrarforschung Schweiz, 304-311

Mycorrhiza as affected by organic and conventional farming

Hvordan mycorrhiza påvirkes af øko og konventionelt landbrug



Geology: periglacial Loess

Soil type: Haplic Luvisol

Site: DOK field trial, Therwil (BL)

Land use intensity

Organic Farming — Integrated convent. Production

BIO-Dynamic | BIO-Organic | Manure-Conventional | Mineral-Conventional

More *Scutellospora-*, *Acaulospora* species in organic systems

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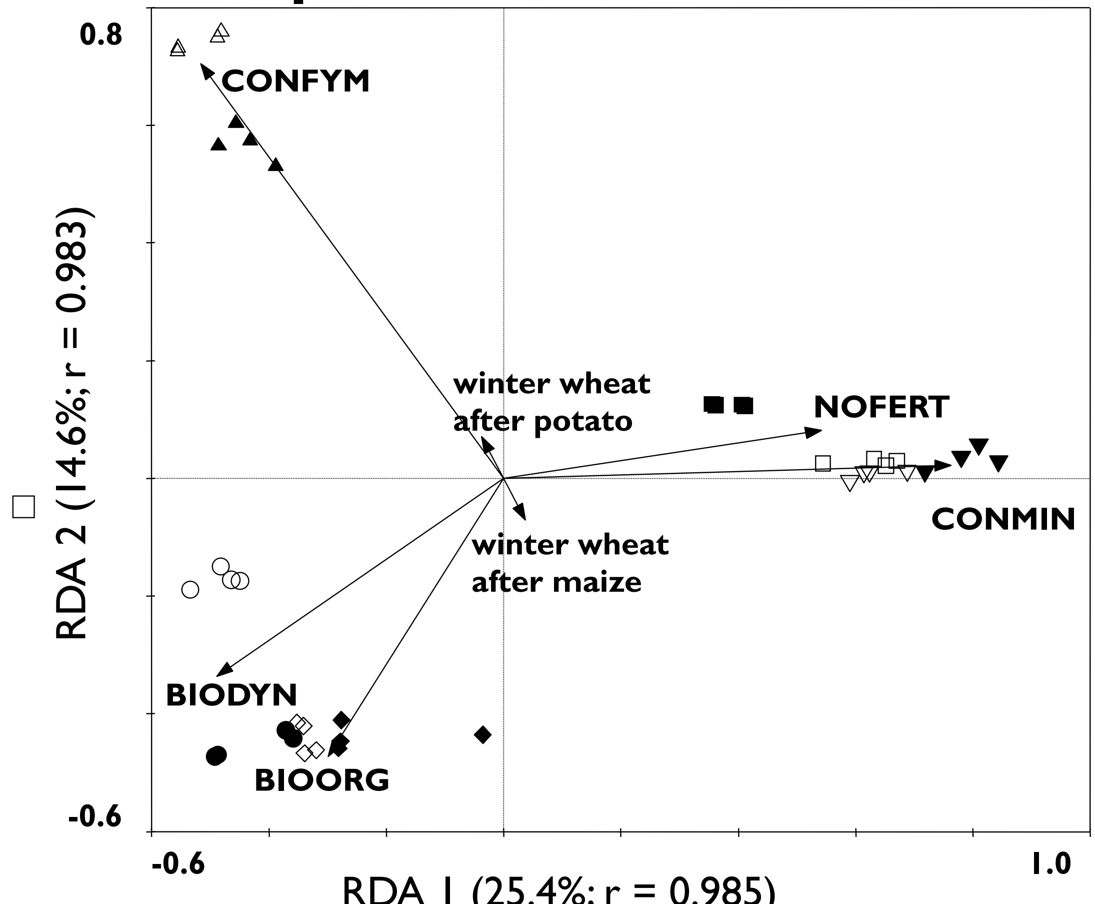
Oehl et al., 2004, Oecologia

Molecular phylotype diversity of AM fungi in arable soils

Field	Acaulospora-ceae	*Archaeospora/ Paraglomus*	Gigasporaceae	*Glomus* group A	*Glomus* group B
maize monoculture (R)	-	-	-	**GLOM-A1, GLOM-A3, GLOM-A5**	-
organic leek field (U)	-	-	-	**GLOM-A1, GLOM-A3, GLOM-A4**	-
maize, conventional/Swiss integrated (K62)	-	**PARA-1**	**GIGA-1**	**GLOM-A1, GLOM-A2, GLOM-A3**	**GLOM-B1**
wheat, conventional/Swiss integrated (K64)	**ACAU-1**	**PARA-1**	**GIGA-1**	**GLOM-A1, GLOM-A2, GLOM-A3 GLOM-A4**	-
maize, mineral fertilization (M)	-	**PARA-1**	**GIGA-1**	**GLOM-A1, GLOM-A3, GLOM-A4**	-
maize, organic (O)	**ACAU-2**	**PARA-1**	**GIGA-1 GIGA-2**	**GLOM-A1, GLOM-A3**	-

Hijri, I., Sykorova, Z., Oehl, F., Ineichen, K., Mäder, P., Wiemken, A., Redecker, D., 2006. Communities of arbuscular mycorrhizal fungi in arable soils are not necessarily low in diversity. Mol. Ecol. 15, 2277-2289.

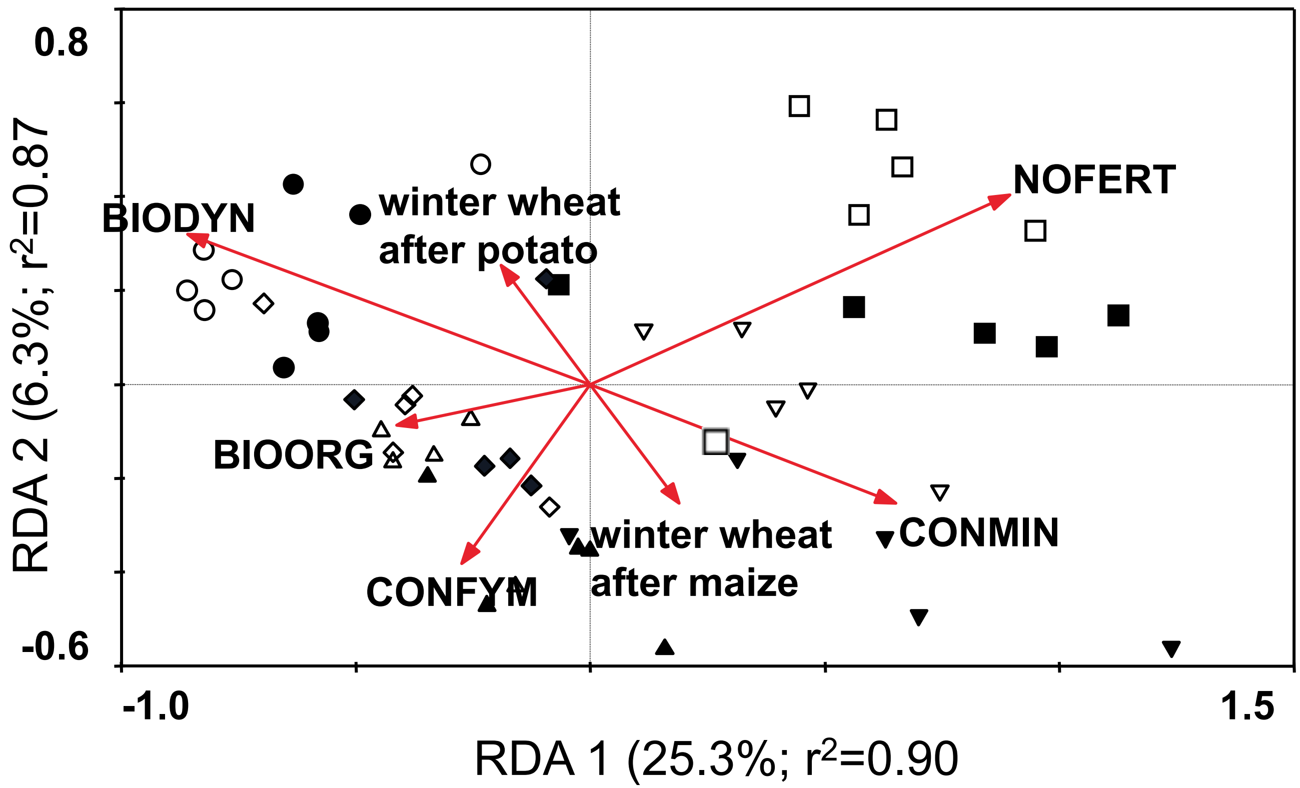
Phosphopholipid fatty acid fingerprints: Redundancy analysis of PLFA profiles



Constrained ordination of PLFA profiles in soils under winter wheat after potatoes (empty symbols) and after maize (filled symbols) in the DOK farming systems (□, ■ : NOFERT; ▽, ▼ : CONMIN; ○, ● : BIODYN; ◇, ◆ : BIOORG; △, ▲ : CONFYM)

Esperschütz, J. et al. 2007. Response of soil microbial biomass and community structures to conventional and organic farming systems under identical crop rotations. FEMS Microbiology Ecology 61, 26-37

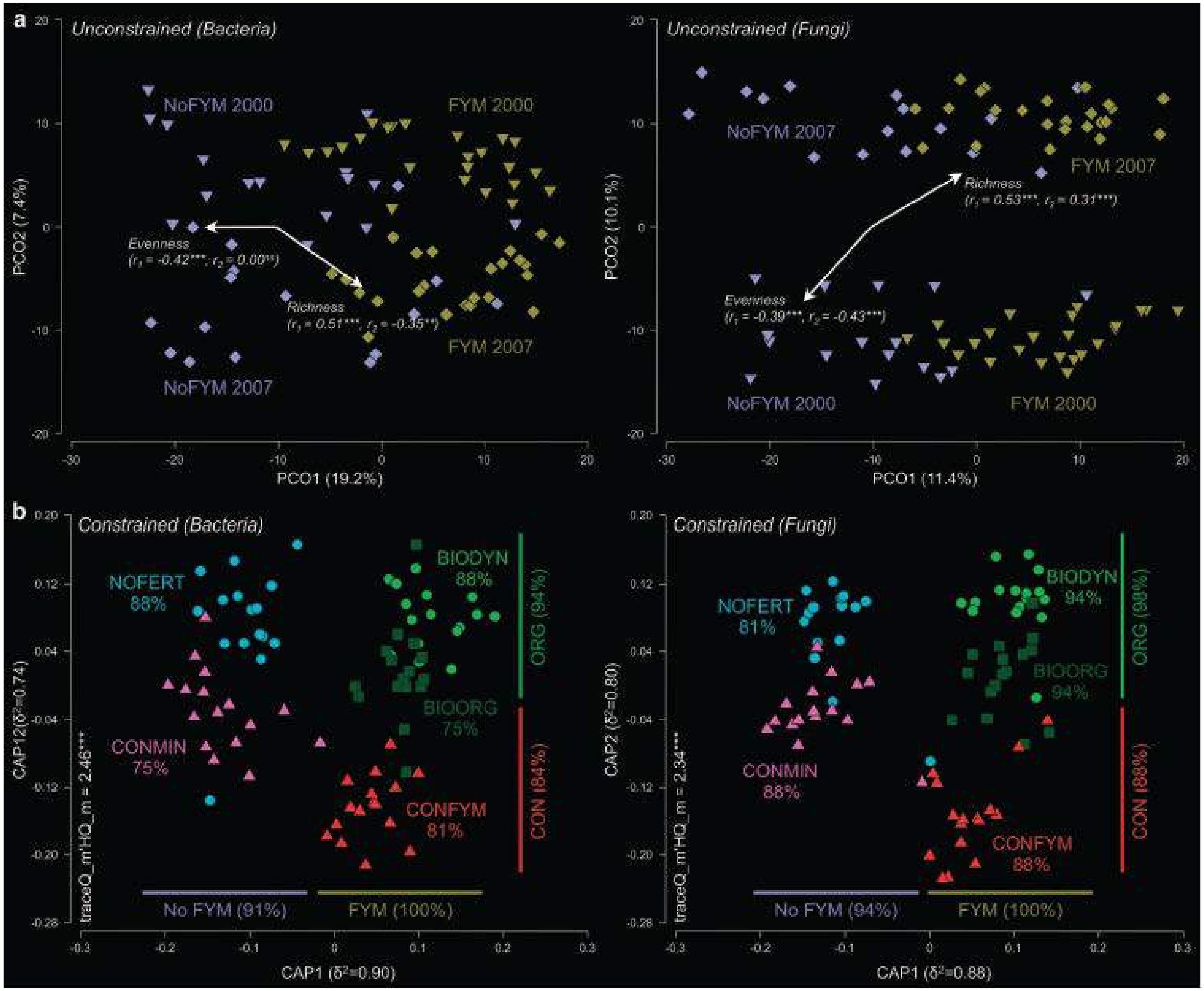
Redundancy analysis of bacterial T-RFLP profiles



Constrained ordination of T-RFLP profiles in soils under winter wheat after potatoes (empty symbols) and after maize (filled symbols) in the DOK farming systems

Hartmann, M., Fließbach, A., Oberholzer, H.-R., Widmer, F., 2006. Ranking the magnitude of crop and farming system effects on soil microbial biomass and genetic structure of bacterial communities. FEMS Microbiol. Ecol. 57, 378-388.

Effects of farming systems and year on bacterial and fungal communities



Hartmann, M., Frey, B., Mayer, J., Mader, P., Widmer, F., 2014. Distinct soil microbial diversity under long-term organic and conventional farming. ISME J.

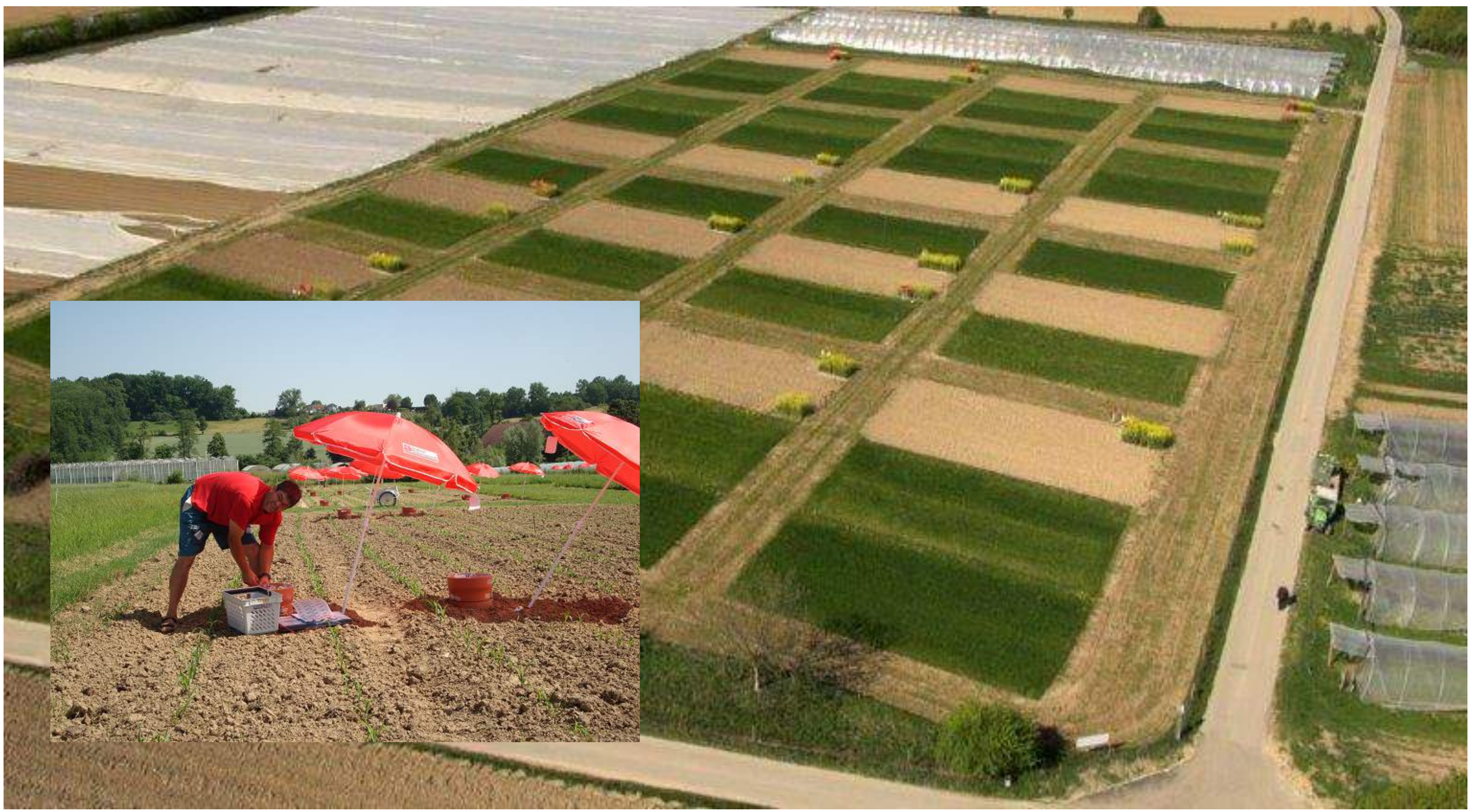
Greenhouse gas emissions 2012 – 2015

Udslip af klimagasser 2012 - 2015

Aug. 2012 | Dez. 2012 | April 2013 | Aug. 2013 | Dez. 2013 | April 2014 | Aug. 2014 | Dez. 2014 | April 2015 | Aug. 2015

a: Kunstwiese 2011/12 — Silomais 2013 — Gründünger — (Soja 2014) — Winterweizen 2015 (Soja)

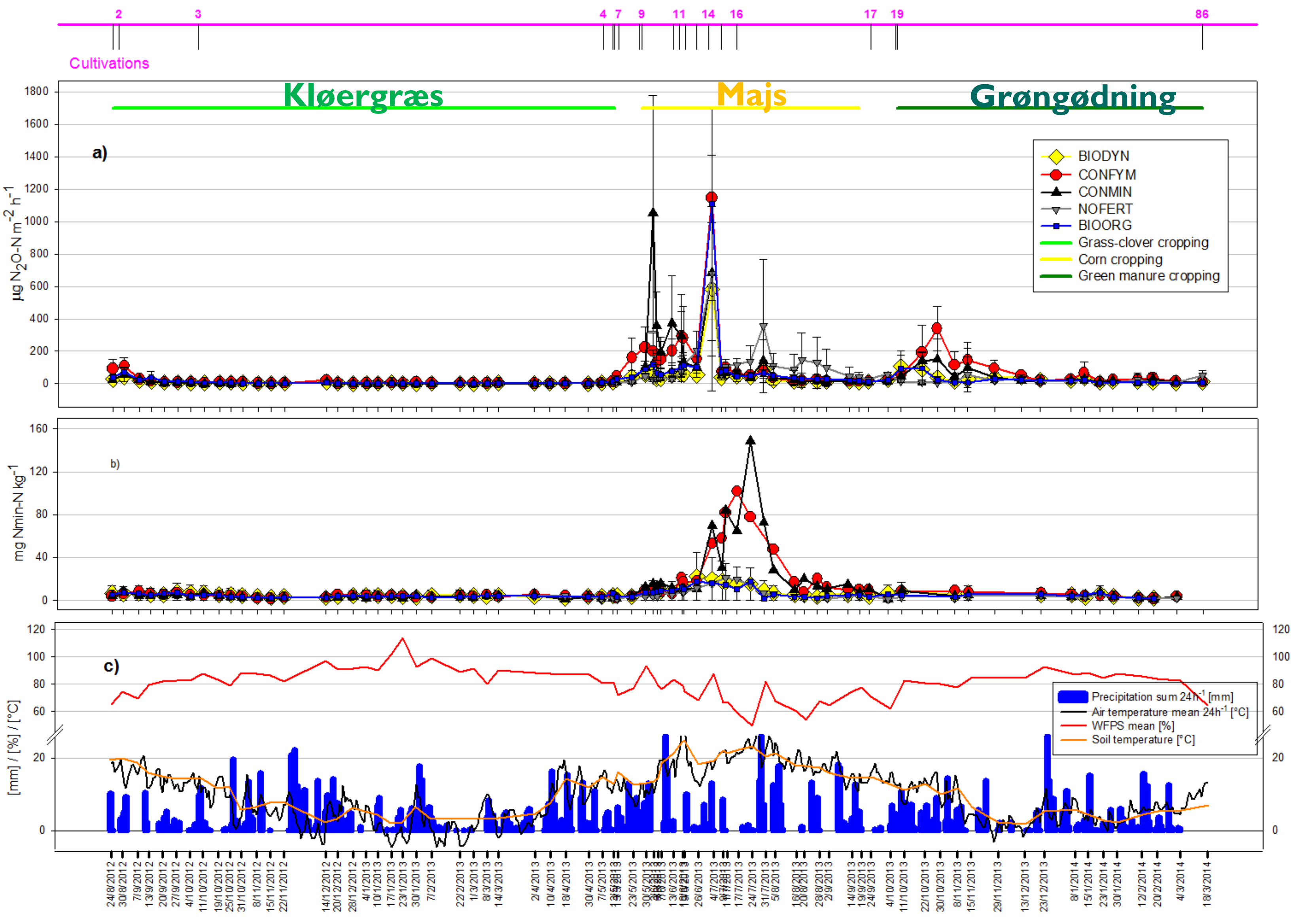
(a **Kleinparzellen**): Winterraps 2013/14 — (Gründünger) — Winterweizen 2015 (Raps)



14.4.14

DOK-trial: N_2O-fluxes between 8.2012 and 3.2014

Udslip af lattergas i DOK-forsøget fra aug 2012 til marts 2014



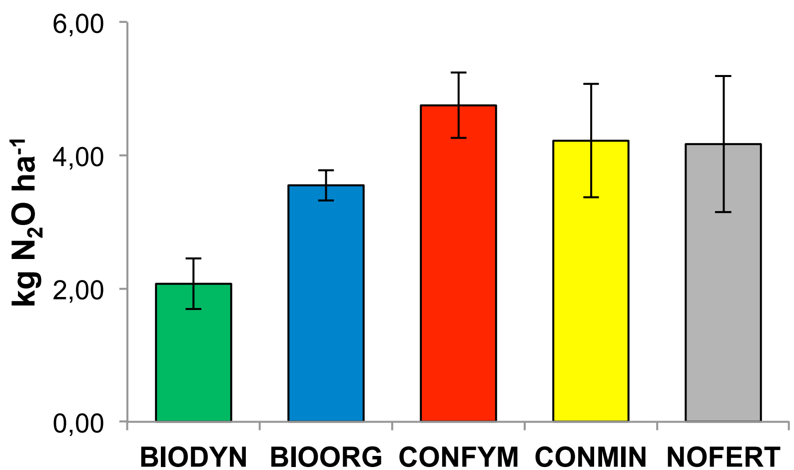
Skinner et. al, manuscript in preparation

Nitrous oxide emissions under maize (114 days)

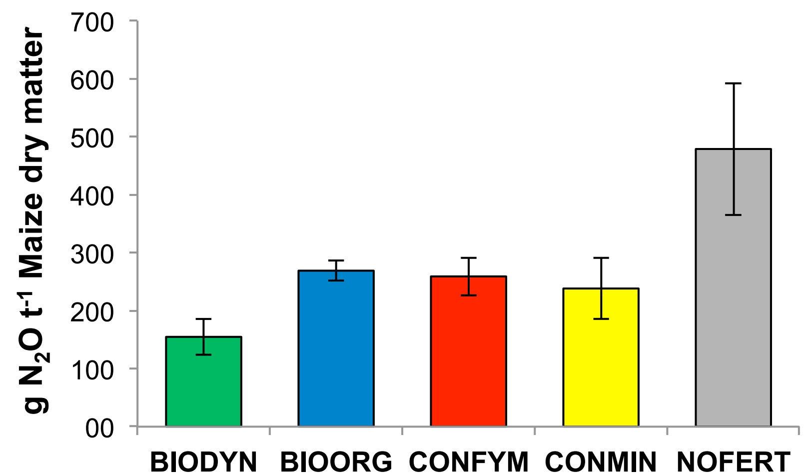
Udslip af lattergas under majs hen over 114 dage

Area and yield scaled N_2O emissions in biodynamic system are lower

Udslip er både lavere pr areal og pr udbytte ved biodynamisk dyrkning



Udslip pr areal



Udslip pr udbytte

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Skinner et. al, manuscript in preparation

Hundreds of publications at the scientific and the farmer level

Soil Fertility and Biodiversity in Organic Farming

Paul Mäder,[1*] Andreas Fließbach,[1] David Dubois,[2] Lucie Gunst,[2] Padruot Fried,[2] Urs Niggli[1]

PLOS | ONE

RESEARCH ARTICLE

Organic farming enhances soil microbial abundance and activity—A meta-analysis and

Plant Soil (2007) 290:69–83
DOI 10.1007/s11104-006-9122-3

ORIGINAL PAPER

Symbiotic N_2 fixation by soybean in organic and conventional cropping systems estimated by ^{15}N dilution and ^{15}N natural abundance

A. Oberson · S. Nanzer · C. Bosshard · D. Dubois · P. Mäder · E. Frossard

FEMS

Response of soil microbial biomass and community structures to conventional and organic farming systems under identical crop rotations

Jürgen Esperschütz[1], Andreas Gattinger[2], Paul Mäder[3], Michael Schloter[1] & Andreas Fließbach[3]

[1]GSF-National Research Centre for Environment and Health, Institute of Soil Ecology, Neuherberg, Germany; [2]Technical University of Munich, Chair of Soil Ecology, Oberschleissheim, Germany; and [3]Research Institute of Organic Agriculture Ackerstrasse, Frick, Switzerland

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European

"Productivity, quality and sustainability of winter wheat under long-term conventional and organic management in Switzerland"

Jochen Mayer[a,*], Lucie Gunst[a], Paul Mäder[b], Marie-Françoise Samson[c], Marina Carcea[d], Valentina Narducci[d], Ingrid K. Thomsen[e], David Dubois[a]

Agriculture Ecosystems & Environment

www.elsevier.com/locate/agee

Soil organic matter and biological soil quality indicators after 21 years of organic and conventional farming

Andreas Fließbach[a,*], Hans-Rudolf Oberholzer[b], Lucie Gunst[b], Paul Mäder[a]

Enhanced top soil carbon stocks under organic farming

Andreas Gattinger[a,1], Adrian Muller[a], Matthias Haeni[a,b], Colin Skinner[a], Andreas Fliessbach[a], Nina Buchmann[b], Paul Mäder[a], Matthias Stolze[a], Pete Smith[c], Nadia El-Hage Scialabba[d], and Urs Niggli[a]

Journal of the Science of Food and Agriculture — *J Sci Food Agric* 87:1826–1835 (2007)

sci

Wheat quality in organic and conventional farming: results of a 21 year field experiment

Paul Mäder,[1*] Diana Hahn,[1,2] David Dubois,[3] Lucie Gunst,[3] Thomas Alföldi,[1] Hans Bergmann,[2] Michael Oehme,[4] Renato Amadò,[5] Hanna Schneider,[5] Ursula Graf,[6†] Alberta Velimirov,[7‡] Andreas Fließbach[1] and Urs Niggli[1]

Publications – Agronomy

Agronomy:

- Mäder, P. et al. 2002. Soil fertility and biodiversity in organic farming. *Science* 296, 1694-1697.
- Oberson, A. et al. 2007. Symbiotic N2 fixation by soybean in organic and conventional cropping systems estimated by 15N dilution and 15N natural abundance. *Plant Soil* 290, 69-83.
- Mayer, J. et al.., 2015. Productivity, quality and sustainability of winter wheat under long-term conventional and organic management in Switzerland. *European Journal of Agronomy* 65, 27-39.
- Skinner, C. et al. 2014. Greenhouse gas fluxes from agricultural soils under organic and non-organic management — A global meta-analysis. *Sci. Total Environ*. 468–469, 553-563.
- Mäder, P. et al. 2006. The DOK experiment (Switzerland). In: Raupp, J. et al. (Eds.), *Long-term field experiments in organic farming*. Koester, Bonn, pp. 41-58.

Product quality:

- Langenkämper, G. et al. 2006. Nutritional quality of organic and conventional wheat. *Journal of Applied Botany and Food Quality* 80, 150-154.
- Arncken, C.M. et al. 2012. Sensory, yield and quality differences between organically and conventionally grown winter wheat. *J. Sci. Food Agric*. 92, 2819-2825.
- Mäder, P. et al. 2007. Wheat quality in organic and conventional farming: Results of a 21-year old field experiment. *J. Sci. Food Agric*. 87, 1826-1835.

Publications – Soil – Climate

Soil quality:

- Fließbach, A. et al. 2007. Soil organic matter and biological soil quality indicators after 21 years of organic and conventional farming. *Agric. Ecosys. Environ.* 118, 273-284.
- Leifeld, J. et al. 2009. Consequences of Conventional versus Organic farming on Soil Carbon: Results from a 27-Year Field Experiment. Agron. J. 101, 1204-1218.
- Lori, M. et al. 2017. Organic farming enhances soil microbial abundance and activity—A meta-analysis and meta-regression. PLOS ONE 12, e0180442.

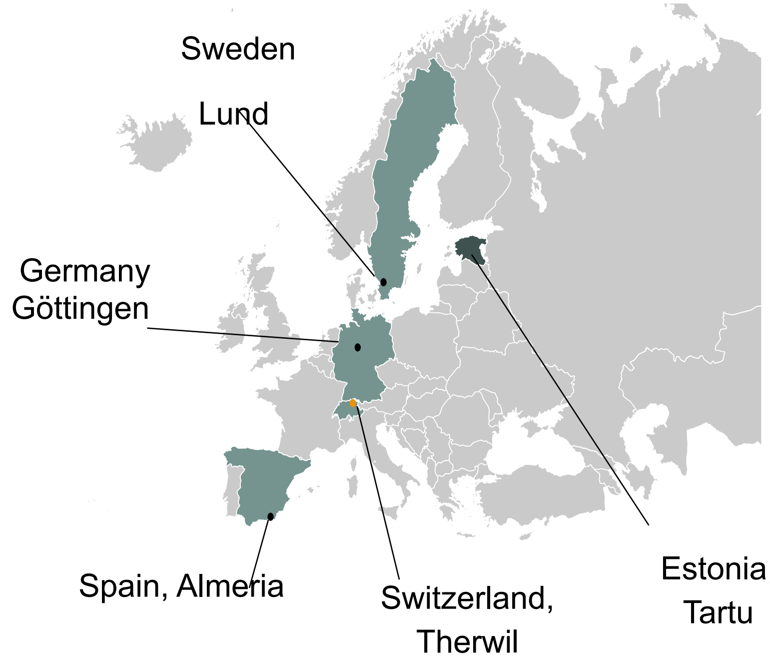
Biodiversity:

- Birkhofer, K. et al. 2008. Long-term organic farming fosters below and aboveground biota: Implications for soil quality, biological control and productivity. *Soil Biology & Biochemistry* 40, 2297-2308.
- Esperschütz, J. et al. 2007. Response of soil microbial biomass and community structures to conventional and organic farming systems under identical crop rotations. *FEMS Microbiology Ecology* 61, 26-37.
- Hartmann, M. et al. 2014. Distinct soil microbial diversity under long-term organic and conventional farming. *The ISME Journal* 9, 1177.

Climate:

- Skinner, C. et al. 2014. Greenhouse gas fluxes from agricultural soils under organic and non-organic management — A global meta-analysis. *Sci. Total Environ.* 468–469, 553-563.
- Gattinger, A. et al. 2012. Enhanced top soil carbon stocks under organic farming. *Proc. Nat. Acad. Sci. USA* 109, 18226-18231.

Current project: Managing soil biodiversity and ecosystem services in agroecosystems across Europe under climate change



Rain-out shelters in the DOK trial to simulate the expected drought scenarios

Partners
Lund, **Sweden**
PI: Klaus Birkhofer, coordinator

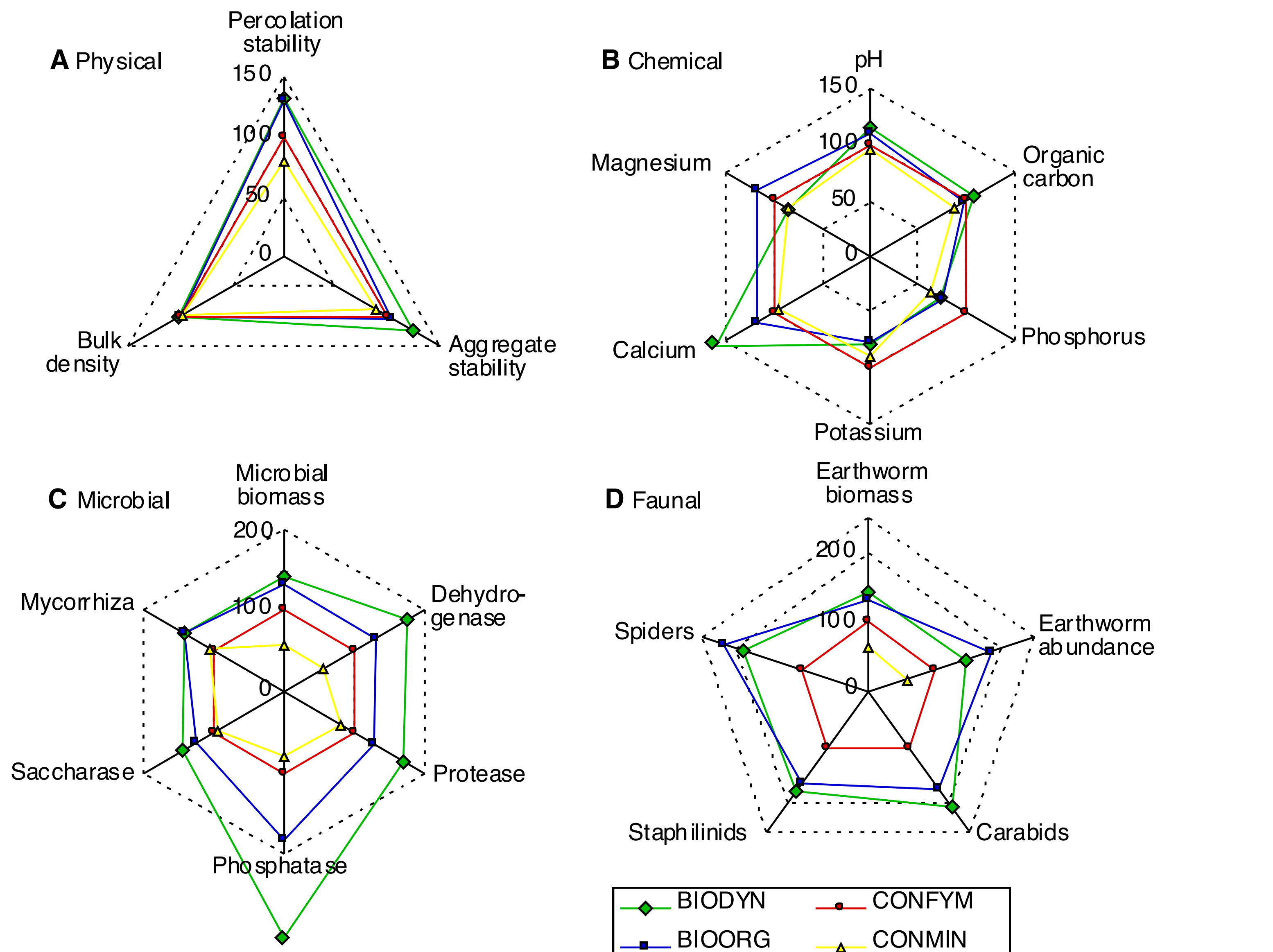
Tartu, **Estonia**
PI: Jaak Truu

Göttingen, **Germany**
PI: Stefan Scheu

Almeria, **Spain**
PI: Jordi Moya-Laraño

Frick, **Switzerland**
PI: Paul Mäder

Overview on soil properties Overblik over jordegenskaber



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Mäder, P., Fließbach, A., Dubois, D., Gunst, L., Fried, P., Niggli, U., 2002. Soil fertility and biodiversity in organic farming. Science 296, 1694-1697.

Synthesis

Crop yields in the organic systems of the DOK trial are lower by 15-25 % as compared to conventional.

Soil quality has improved in farming systems with organic fertilizers.

Among the farming systems with organic fertilizers the biodynamic systems shows the highest soil quality.

The microbial communities in soils of organic farming systems are different from the ones of conventional.

Nitrous oxide emissions are lower in the biodynamic system as compared to conventional.

Opsamling

I DOK-forsøget er udbytterne i de økologiske dyrkningssystemer 15-25% lavere end de konventionelle.

Jordens kvalitet øges i dyrkningssystemer med økologisk gødning.

Af de landbrugssystemer, der får økologisk gødning, opnår den biodynamiske jord den højeste kvalitet.

Økologiske dyrkningsmetoder medfører andre mikroorganisme-samfund end konventionelle dyrkningsmetoder.

Der er mindre tab af lattergas til atmosfæren fra biodynamisk jordbrug end fra konventionelt jordbrug.

Thank you for your attention!

Tak for opmærksomheden!

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