Research Institute of Organic Agriculture FiBL
info.suisse@fibl.org, www.fibl.org

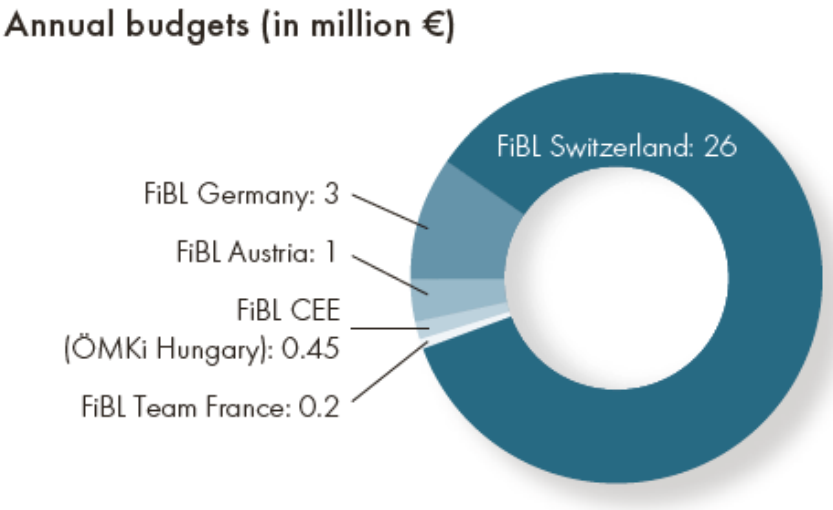
Euroopa Maaelu Arengu Põllumajandusfond: Euroopa investeeringud maapiirkondadesse

Organic agriculture and sustainable food systems

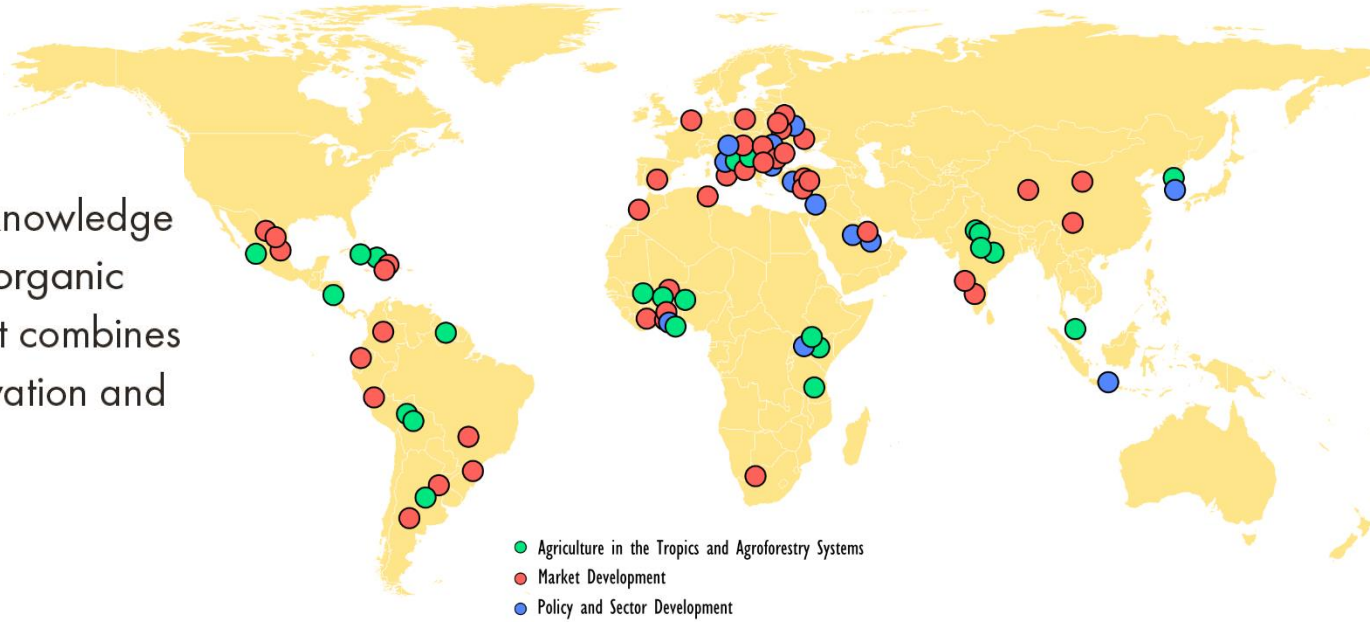
Urs Niggli

November 28, 2017

FiBL – organic research and consultancy since 1973



FiBL is the world's leading knowledge center for best practice in organic food and farming systems. It combines excellence in science, innovation and sustainable practice.

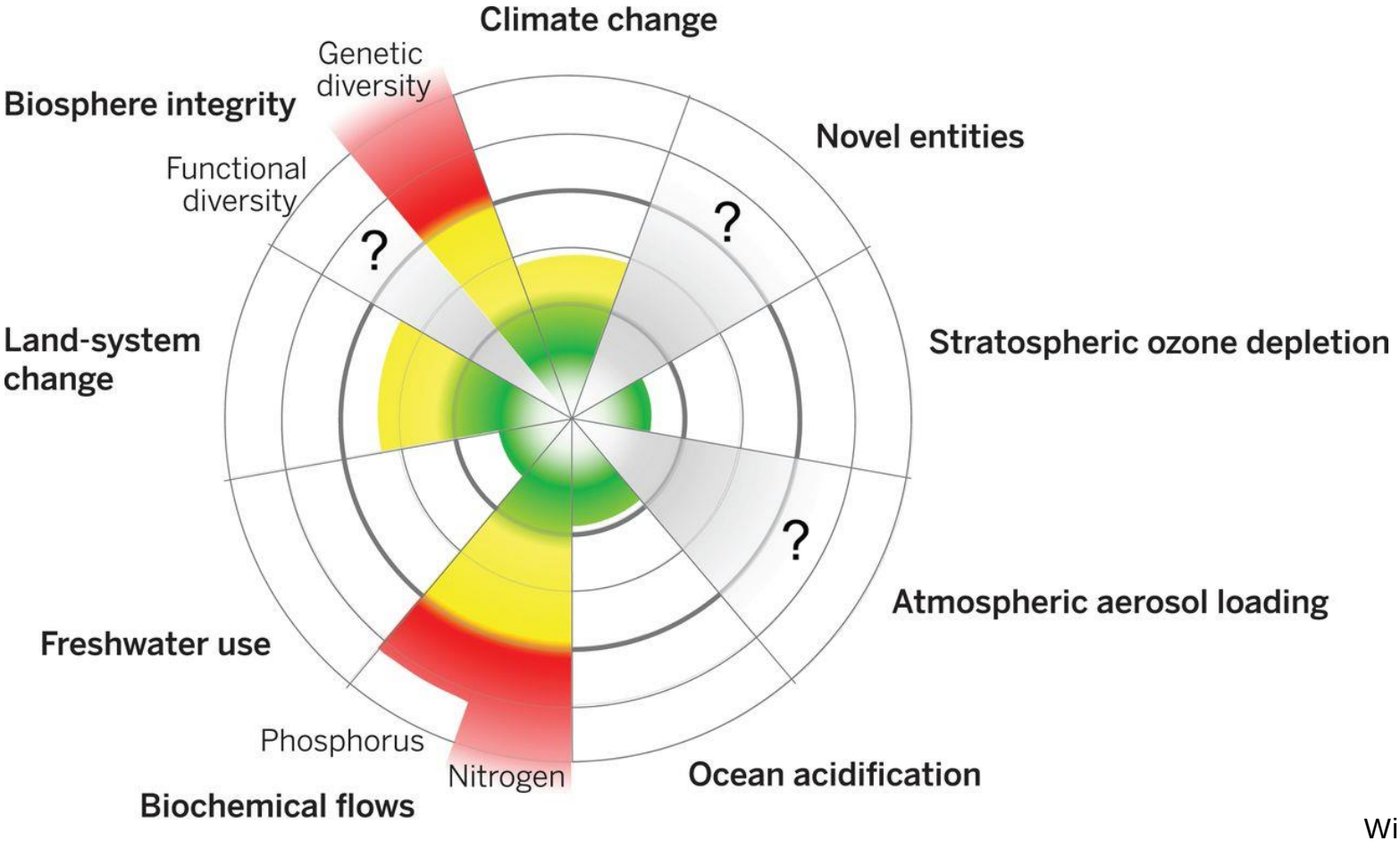


FiBL www.fibl.

Table of contents

- Global challenges.
- Potential contribution of organic agriculture.
- Recommendation for research & innovation.
- Conclusions.

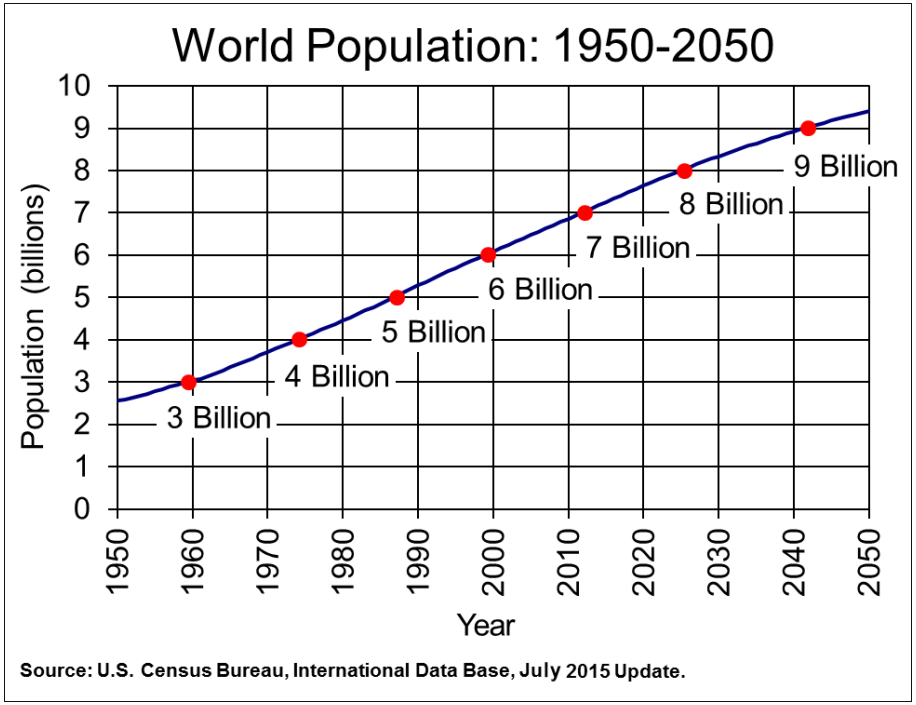
Planetary boundaries

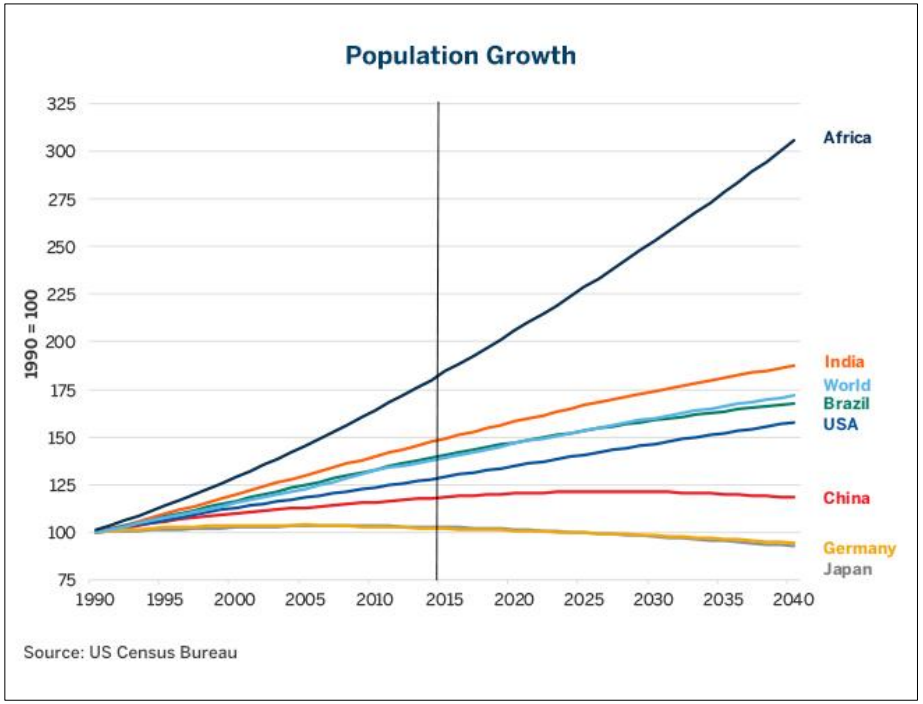


FiBL www.fibl.org

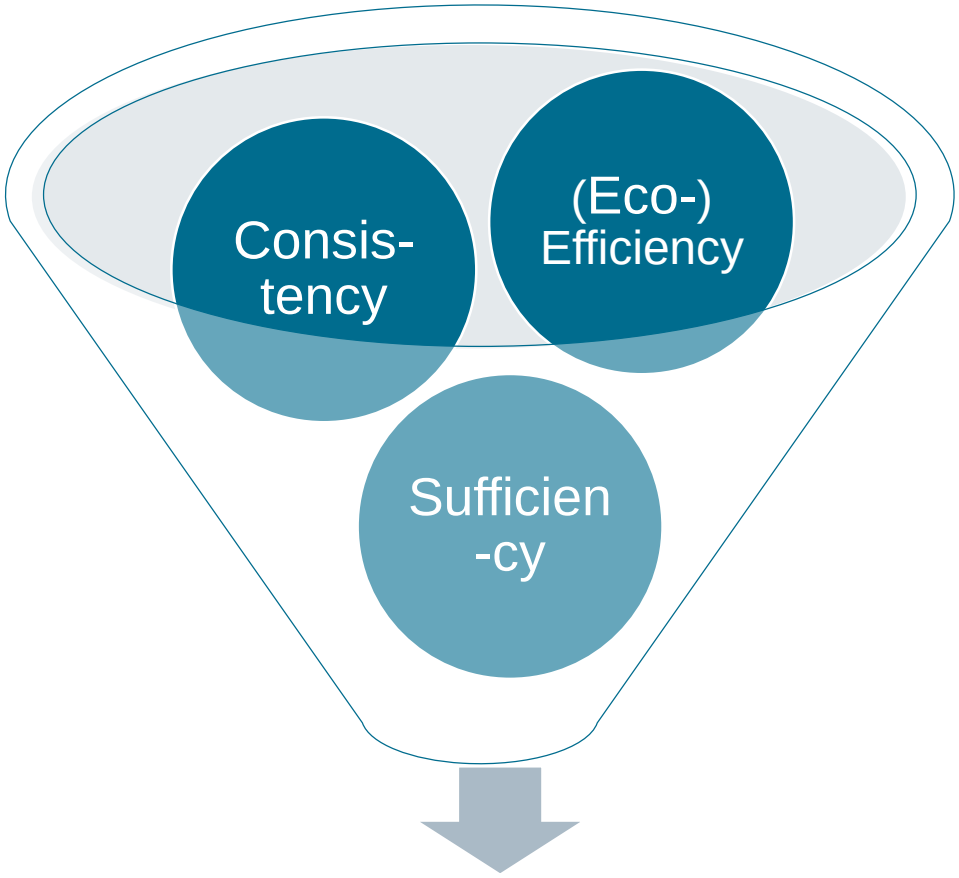
Will Steffen et al: *Planetary boundaries: Guiding human development on a changing planet.* In: *Science*. (2015), doi:10.1126/science.1259855.

Population growth





A sustainable economy is defined by 3 narratives:



Sustainable Food Systems

(Eco-)Efficiency:
More output with less input and less environmental footprint

Consistency:
Adaptation to territorial, cultural and socio-economic context, resilience, anthropo-genic and natural flow of material compatible, cradle-to-cradle.

Sufficiency:
Reduction of consumption and waste, temperance, avoidance of rebound effects

Different approaches to sustainability

- Improved technologies like minimum/ no tillage or GMO crops.
- Integrated Production (IP, IPM).
- Low Input Agriculture (LIA) or Precision Farming.
- Low External Input Sustainable Agriculture (LEISA).
- Organic Farming.
- Organic Farming & reduced tillage.
- Organic (successional) agroforestry systems.

Ecological or eco-functional intensification

Comparing SDGs* to what organic agriculture delivers

Economic

Social

Environmental

Increase global food production by ~ 50 % ✗

Stabilize and secure yields of cash crops (and staple foods?). ✗

Foster learning and cooperation of farmers ✓

Increase productivity of subsistence & small holder farms ✓

Foster farmer-owned knowledge instead of external inputs & knowledge ✓

Literature to be found:
Niggli, U (2014) Sustainability of Organic Food Production: Challenges and Innovations. Proceedings of the Nutrition Society. doi:10.1017/S0029665114001438, 6 pages.

Reduce poverty of farm families ✓

Strongly reduce negative environmental externalities ✓

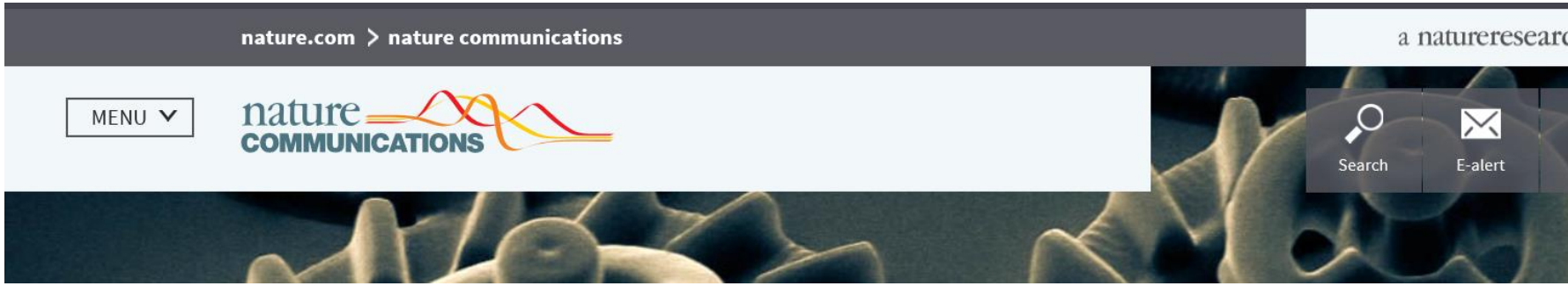
Create value addition in food chains ✓

Increase agronomic and ecological resilience ✓

Use ecosystem functions for productivity increase ✓

SDGs: Sustainable Development Goals of the UN

Organic agriculture is a sufficiency narrative



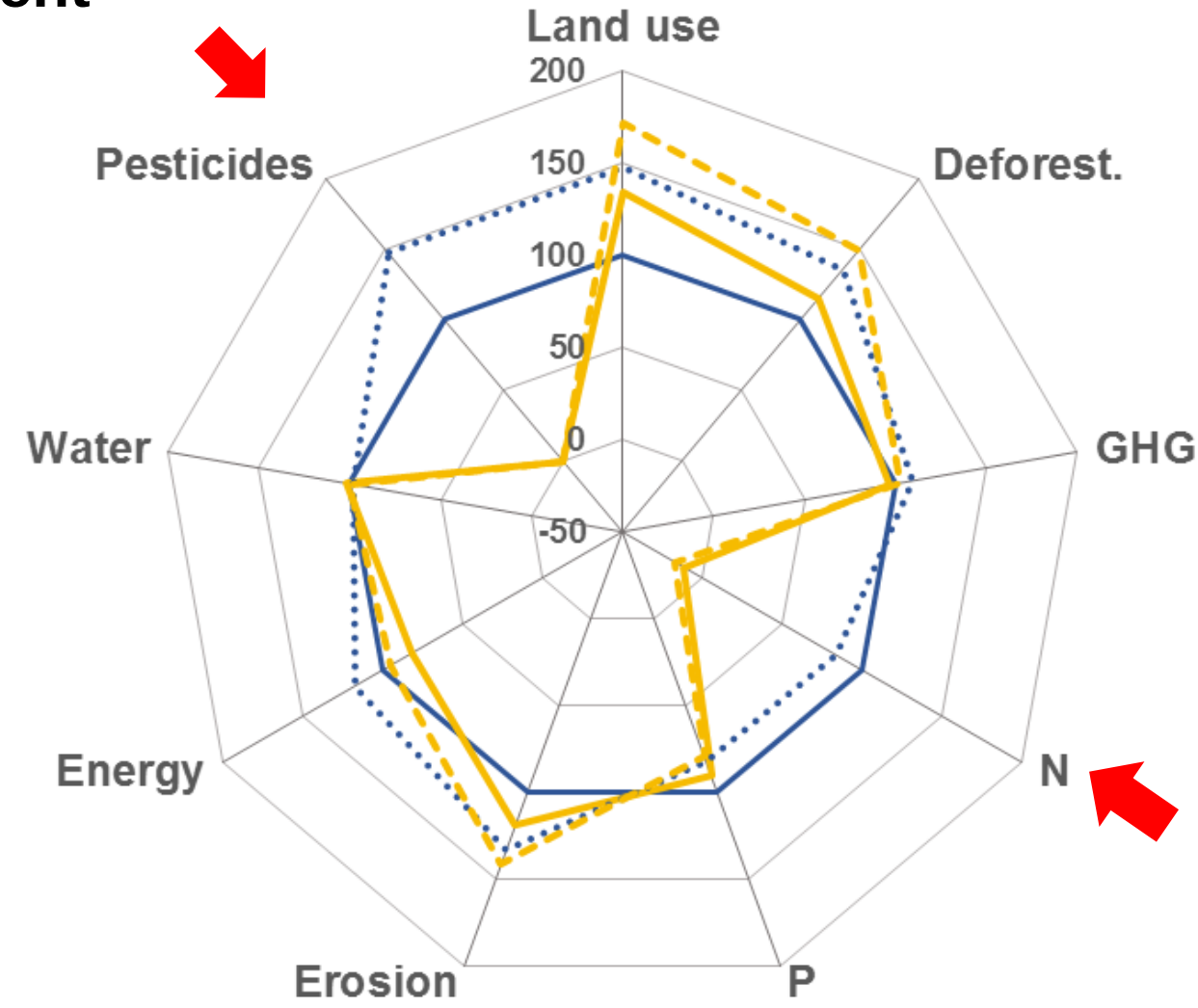
Optimal combination of various strategies

The new study shows how to optimally combine these various strategies to deal with conflicts of goals. Even if 60 % of agriculture would convert to organic farming, concentrated feed were reduced by 50 % and food waste by 50 %, it would result in a food system with significantly decreased environmental impacts, including lower overall greenhouse gas emissions, and only a marginal increase in agricultural land area.

The consumption of animal products would need to decrease by about a third because less feed would be available.

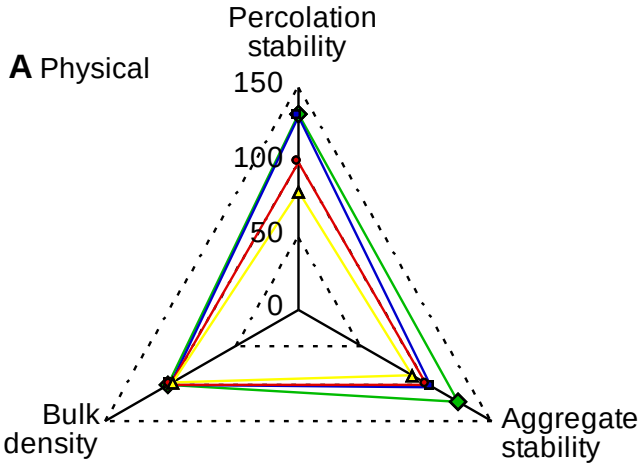
Muller, A., Schader, C., El-Hage Scialabba, N., Hecht, J., Isensee, A., Erb, K.-H., Smith, P., Klocke, K., Leiber, F., Stolze, M. and Niggli, U., 2017, Strategies for feeding the world more sustainably with organic agriculture, Nature Communications 8:1290 | DOI: 10.1038/s41467-017-01410-w

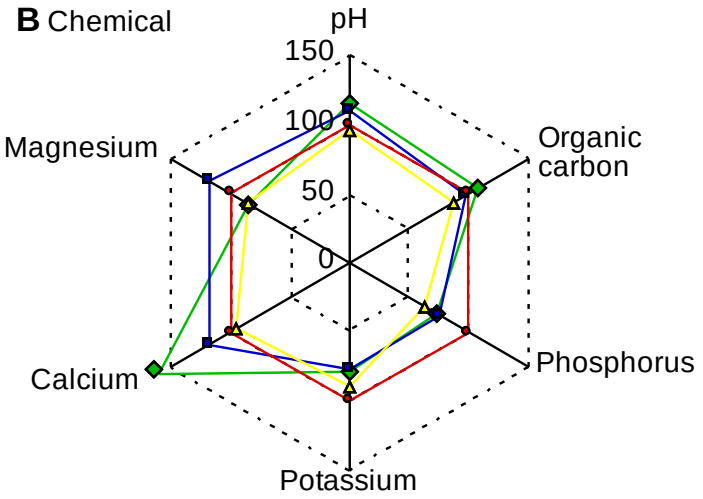
Greatest effect on pesticides and on nitrogen in the environment

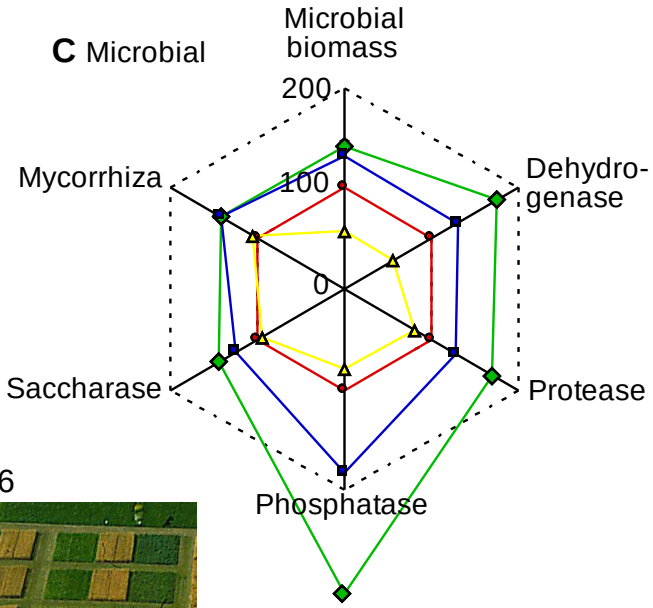


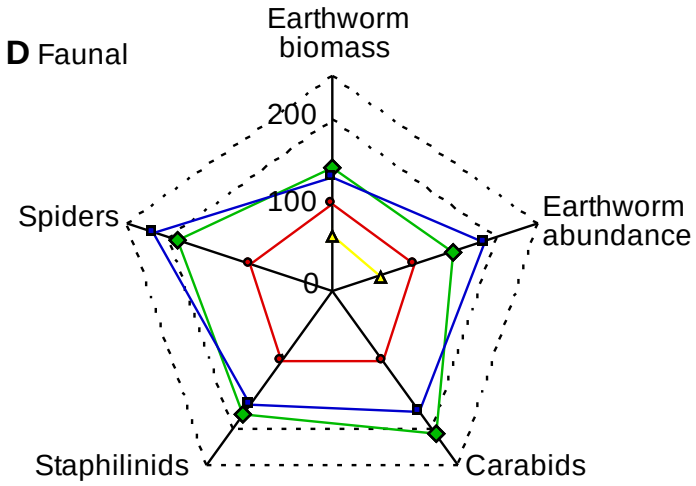
without food waste & concentrate reduction

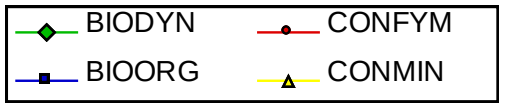
Organic farming (arable crops) improves soil quality parameters











Conventional, integrated, organic & biodynamic farming. DOK field trial in Switzerland since 1977

Mäder er al. (2002), Science 296

Biodiversity on organic farms* (global literature review of comparison studies)

* Scales: Plots, fields, farms, landscape

Taxon	Positive	Negative	No difference
Birds	7		2
Mammals	2		
Butterflies	1		1
Spiders	7		3
Earthworms	7	2	4
Beetles	13	5	3
Other arthropods	7	1	2
Plants	13		2
Soil microbes	9		8
Total	**66**	**8**	**25**

Hole *et al.,* 2005. Biological Conservation 122, 113-130

Tuck SL, Winqvist C, Mota F et al. (2014) Land-use intensity and the effects of organic farming on biodiversity: a hierarchical meta-analysis. J Appl Ecol 51, 746–755.

+ 30 %

FiBL www.fibl.org

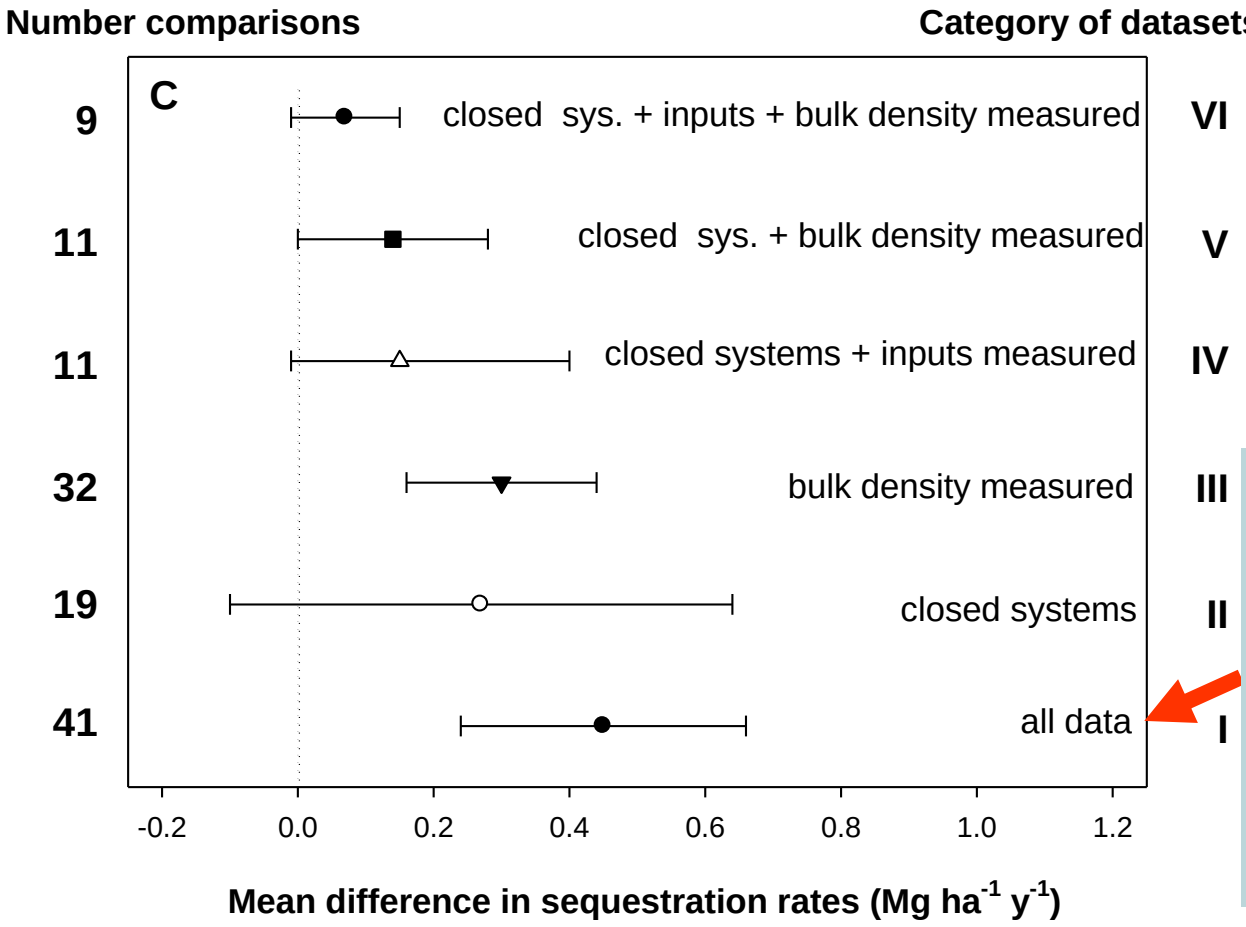
Effect of farming systems on bird populations: lapwing *(Vanellinae)* and skylark *(Alauda arvensis)*

FiBL

www.fibl.org

Source: Christensen et al. 1996, Chamberlain et al. 1999, Kragten et al 2008

Meta-analyses of 74 field trials world-wide: sequestration rate (Mg ha^{-1} year^{-1}) and C stocks



Organic fields sequester 450 kg more atmos-pheric carbon per year than conventional ones.

Mean difference in carbon stocks: 3.5 tons C per hectare

FiBL

www.fibl.org

Gattinger et al., 2012 (FiBL)
www.pnas.org/cgi/doi/10.1073/pnas.1209429109

N_2O emissions organic compared to conventional

	N_2O emissions per acreage (kg N_2O-N ha^{-1} a^{-1})					GWP [d] N_2O emissions per acreage (kg CO_2-eq. ha^{-1} a^{-1})				
land-use	MD [a]	CI [b]	p	studies	comp. [c]	MD [a]	CI [b]	p	studies	comp. [c]
all (annual)[f]	-1.04	0.41	0.00	12	70	-486	191	0.00	12	70
arable	-1.01	0.42	0.00	11	67	-472	195	0.00	11	67
grassland	-2.42	5.16	0.36	2	3	-1133	2416	0.36	2	3
rice-paddies	-1.39	2.22	0.22	1	3	-650	1038	0.22	1	3
overall[g]	-1.03	0.32	0.00	18	98	-482	150	0.00	18	98

Mean difference for all studies
0.5 t ha^{-1} yr^{-1} <u>less</u> CO_2 eq.
as nitrous oxide.

Cut-off point: - 17% yields

FiBL

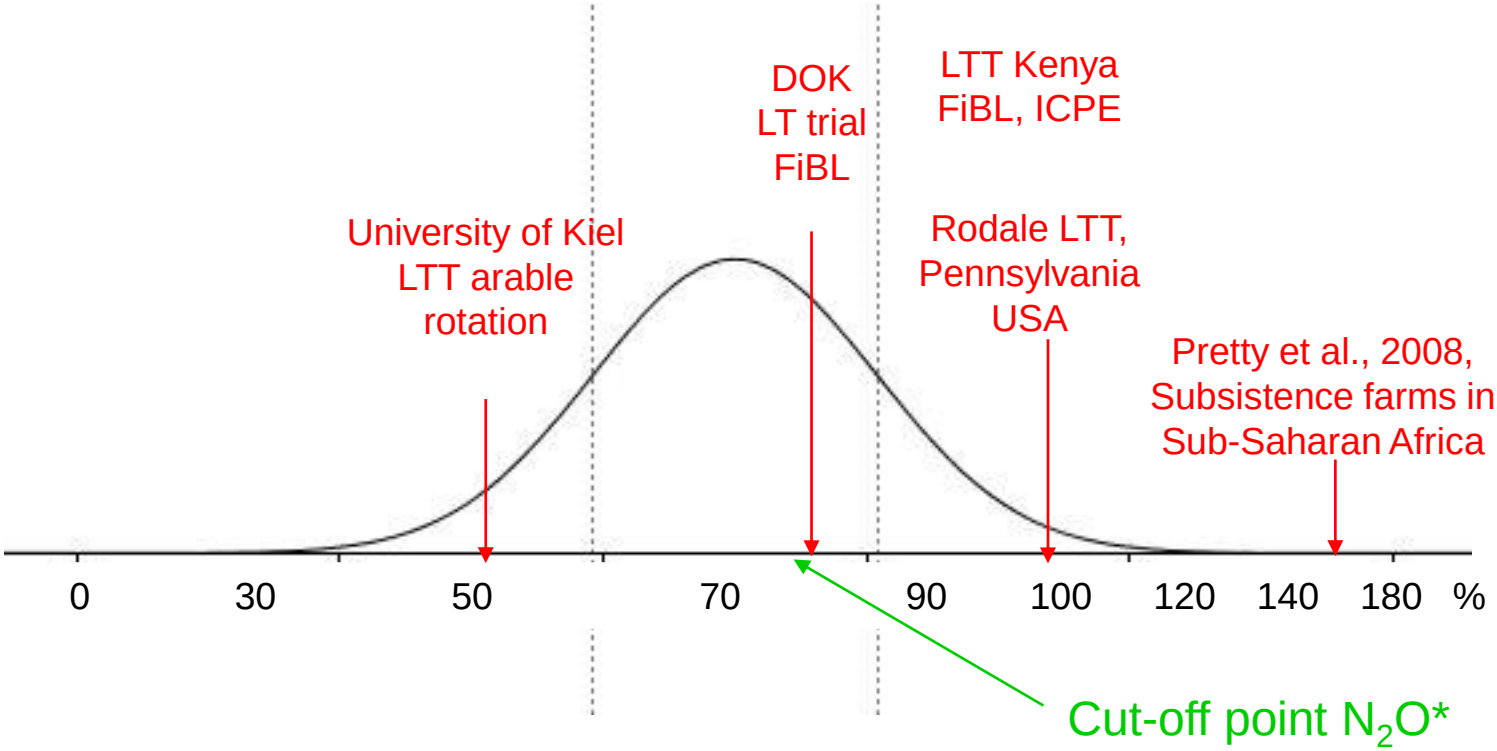
www.fibl.org

Skinner, C., Gattinger, A., Müller, A., Mäder, P., Fliessbach, A., Stolze, M., Ruser, R. and Niggli, U. (2014) Science of the Total Environment, pp. 553-563 DOI information: 10.1016/j.scitotenv.2013.08.098

Meta-analyses on yields of organic and conventional crops

Study	Yield Gap
Lotter 2003	-10 to -15%
Seufert et al. 2012	-25%
Stanhill 1990	-9%
Ponisio et al. 2014 (2015)	-19% (-9%)
de Ponti et al. 2012	-20%
Badgley et al. 2007(developed countries)	-9%

Yield gap of organic farming, results from meta-analyses (Seufert, Ponisio, de Ponti)



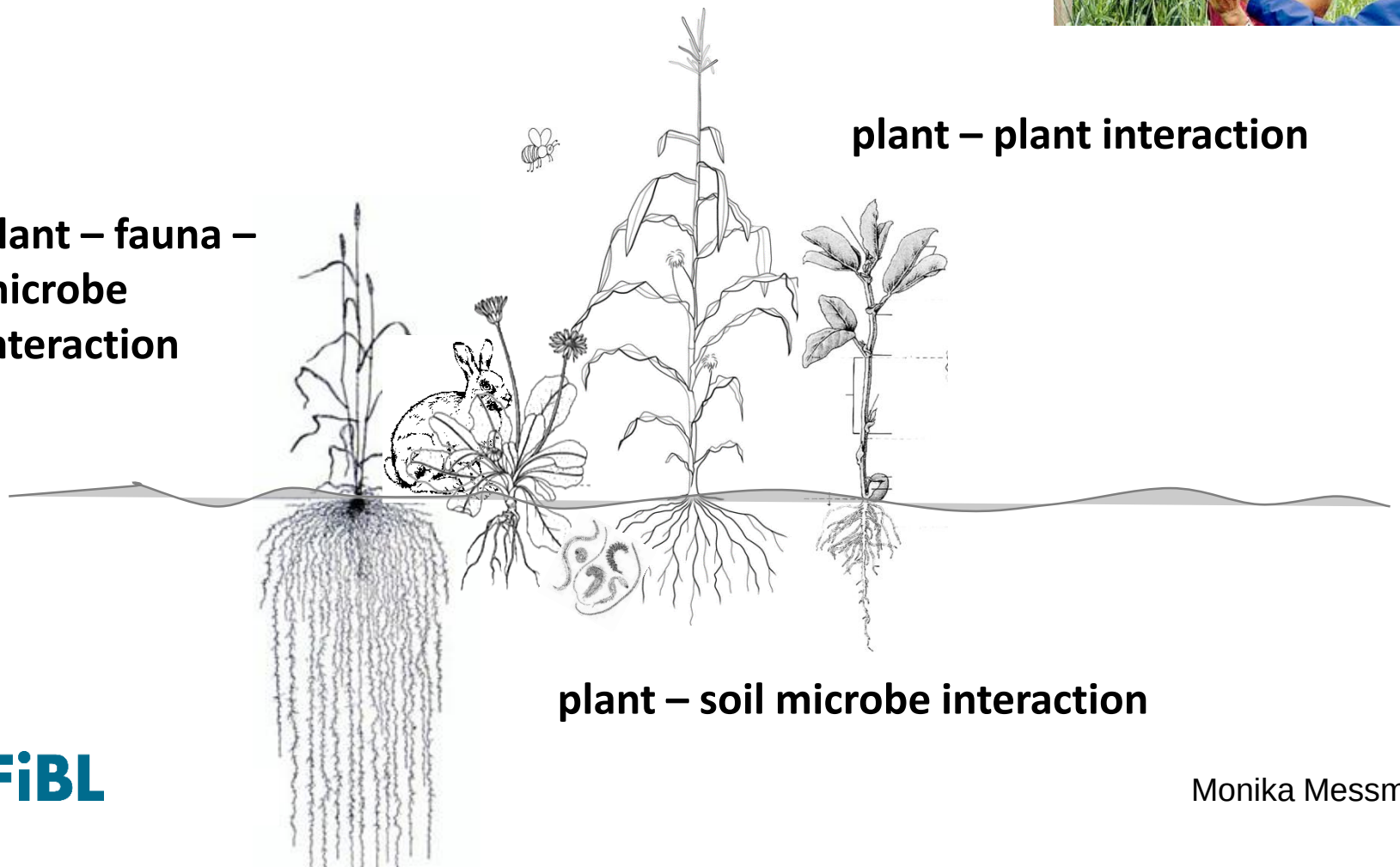
Yields are negligible for a **niche** strategy
Yield gap might be overcome in a consequent **sufficiency** strategy

FiBL

www.fibl.

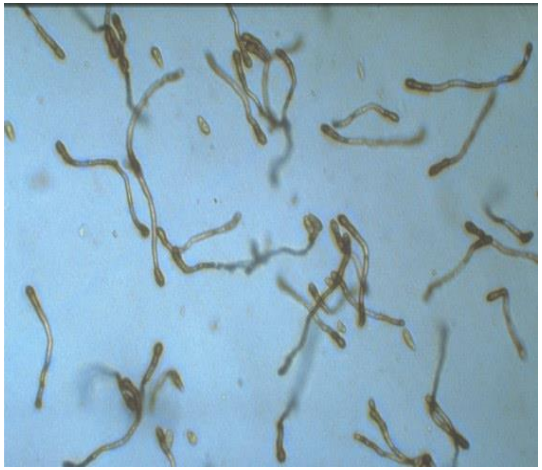
* Skinner, C., Gattinger, A., Müller, A., Mäder, P., Fliessbach, A., Stolze, M., Ruser, R. and Niggli, U. (2014) Science of the Total Environment, pp. 553-563 DOI information: 10.1016/j.scitotenv.2013.08.098

Research priorities: **Plant breeding tailored to the needs of organic agriculture**



FiBL

Research priorities: **biocontrol with novel plant extracts, biocontrol organisms, physical methods and new application technology**



Screening of 3000 plant extracts against *Venturia inaequalis* and *Plasmopara viticola* spores in the lab (FiBL)

Trichogramma wasps) against European corn borer (*Ostrinia nubilalis*).

Research priorities: **Functional biodiversity**

Companion plants increase life span, fecundity and mobility of parasitoids in fields by factor 10

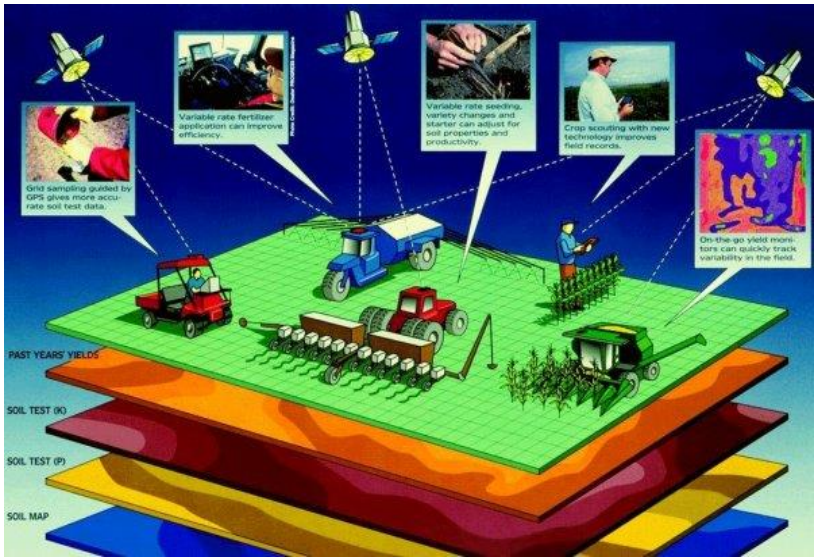
Centaurea cyanus

Diadegma semiclausum

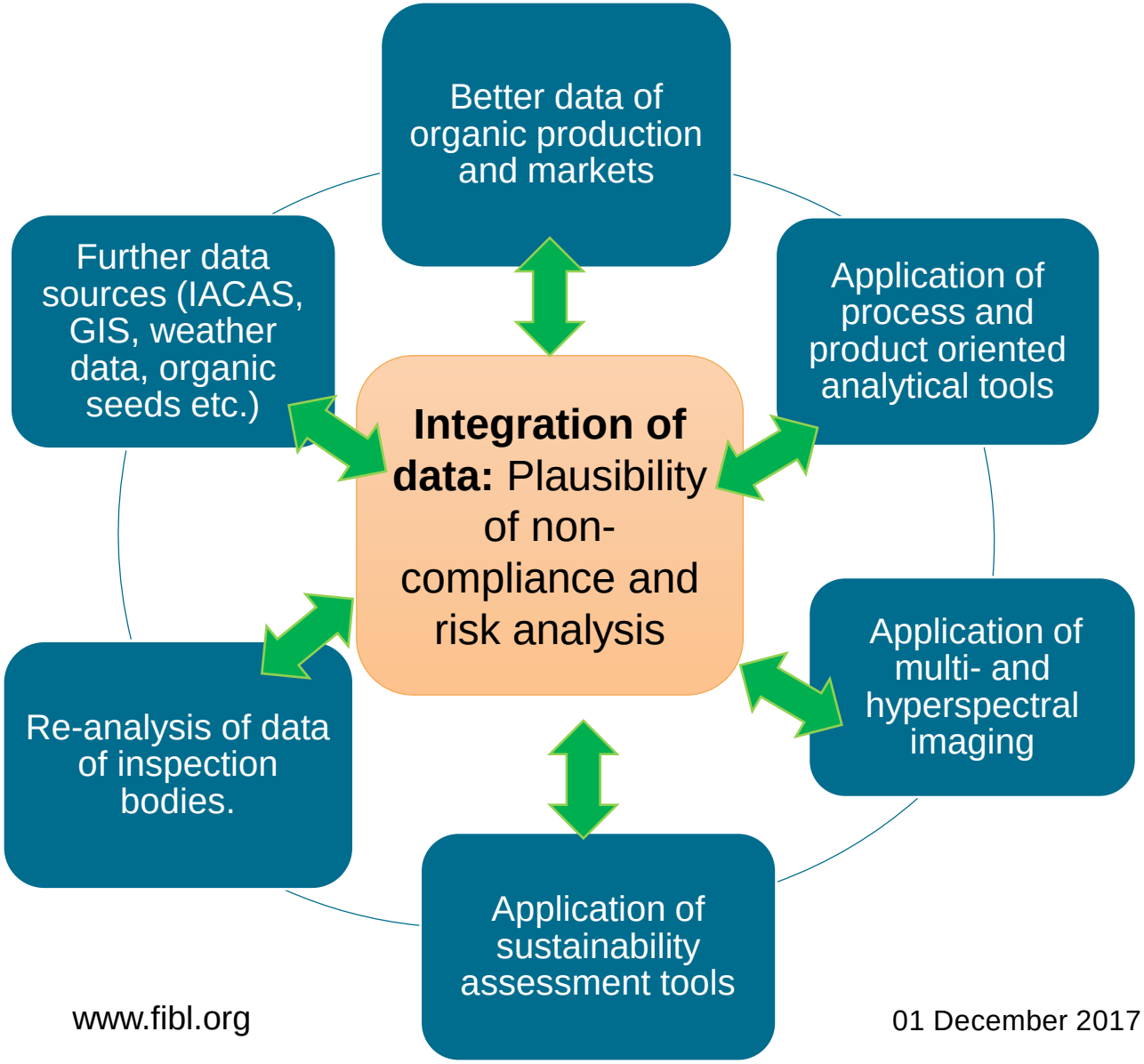
Larvae parasitoid of Plutella, blackamond moth

Research priorities: **organic digital farm ?!?**

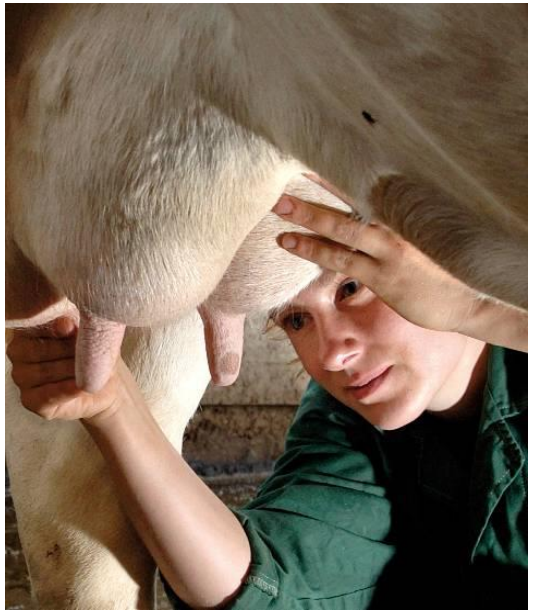
- Autonomous field mini-/micro-robots.
- Precision agriculture which foster diversity.
- Application techniques for organic inputs.
- Open source data.

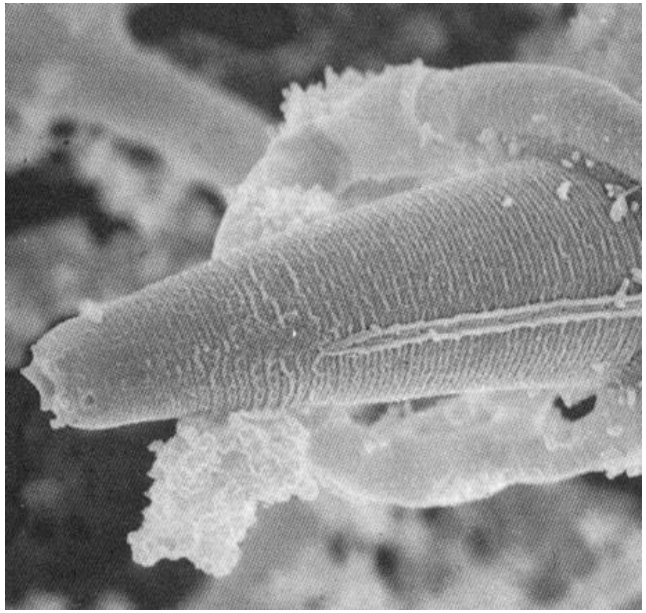


Research priorities: **Corporate Data Quality Management?**



Research priorities: **herd management and holistic health strategies, breeding for robustness, bio-control, bioactive fodder plants**





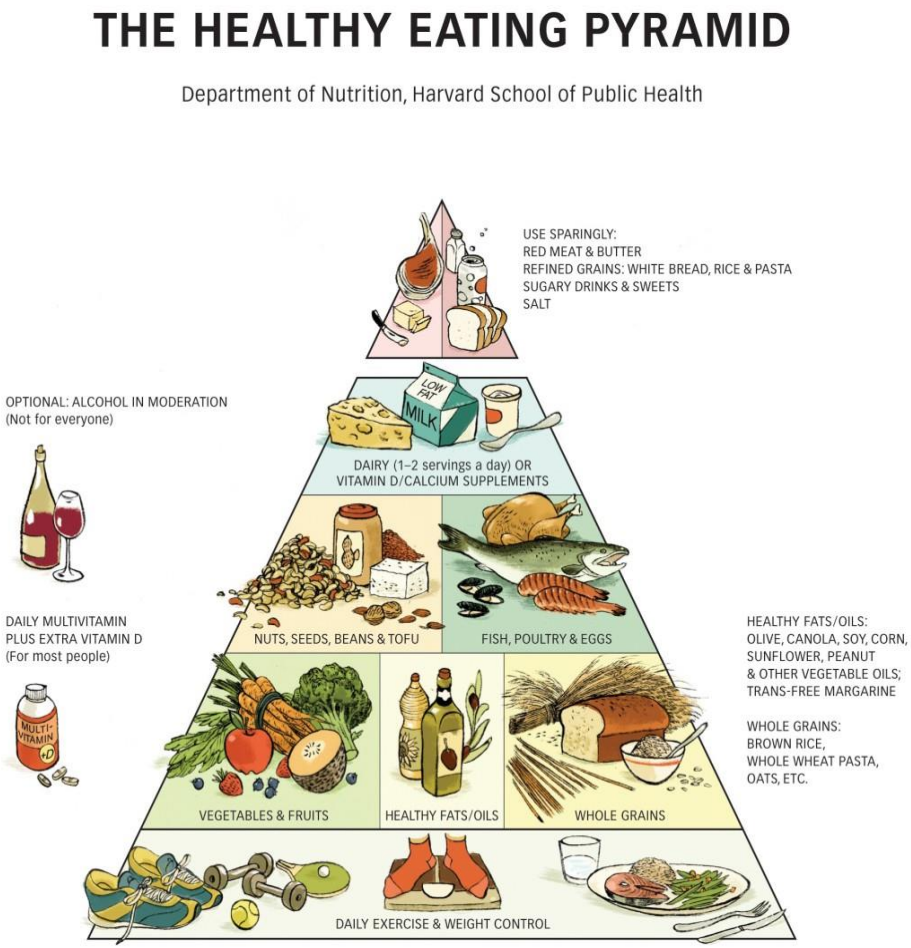
Example right/above: Sheep endo-parasites (worms)
140 fungus species known attacking nematodes:
Duddingtonia flagrans digesting a worm larvae

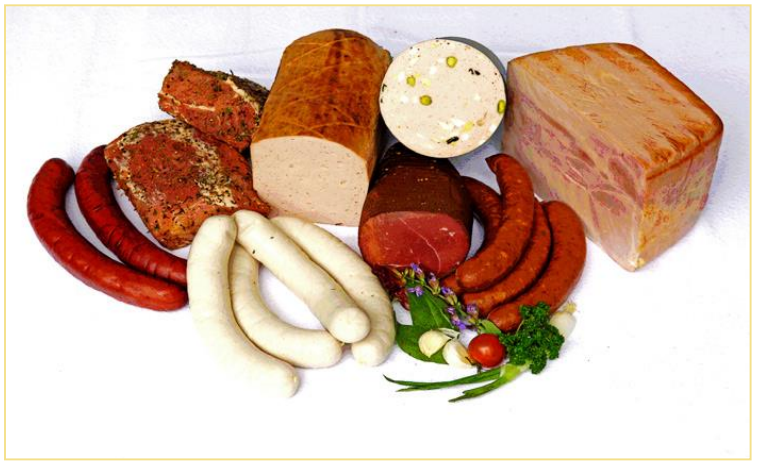
Research priorities: **Food waste management and circular economy**



Consistency narrative (“cradle-to-cradle”): Organic as a leader
Up-grade all waste (including human) to a raw material for the next production circle.

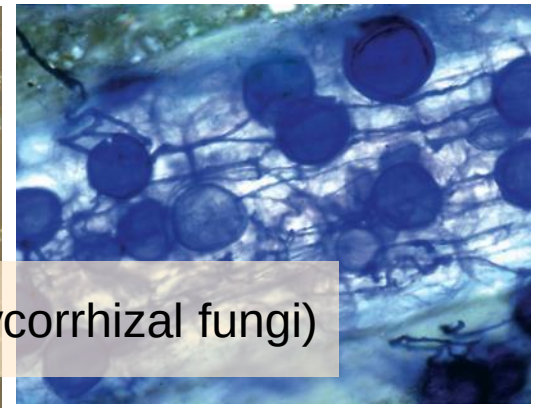
Research priorities: **From organic food to “organic” diets (eating pattern).** Look into what people drives.





FiBL www.fibl.org

Best practice: **Soil fertility and farm productivity**



Factors of influence (by farmers):

soil tillage
crop rotation
(organic & green) manuring
xenobiotics

FiBL

www.fibl.org

Best practice: **Soil fertility & plant health.**

E.g. FP4 projects BlightMOB and FP5 project QLIF lifted the fog (example of a trial with potatoes and an increa-singly complex combination of management option).

Best practice: **Legumes in arable crop rotations.**

Explored in several big EU and in many national projects.

Share knowledge with farmers

Youtube channel FiBL
300 videos, 2,7 million
visitors/accesses

FiBL www.fibl.org

Conclusions

- Organic agriculture with its multifunctional approach offers huge benefits for a sustainable, environmentally safe production.
- Organic agriculture has 2 speeds: a modern, productive farm production and a traditional, preserving strategy for small farmers in urban and peri-urban regions. Both are great!
- Organic has a big potential for innovation. It’s only a question of whether the research community becomes involved or not.
- Innovation in it’s broadest sense must be used to address successfully the global challenges. See the sustainability narratives!