Organic agriculture – a option for mitigation and adaptation

› Urs Niggli

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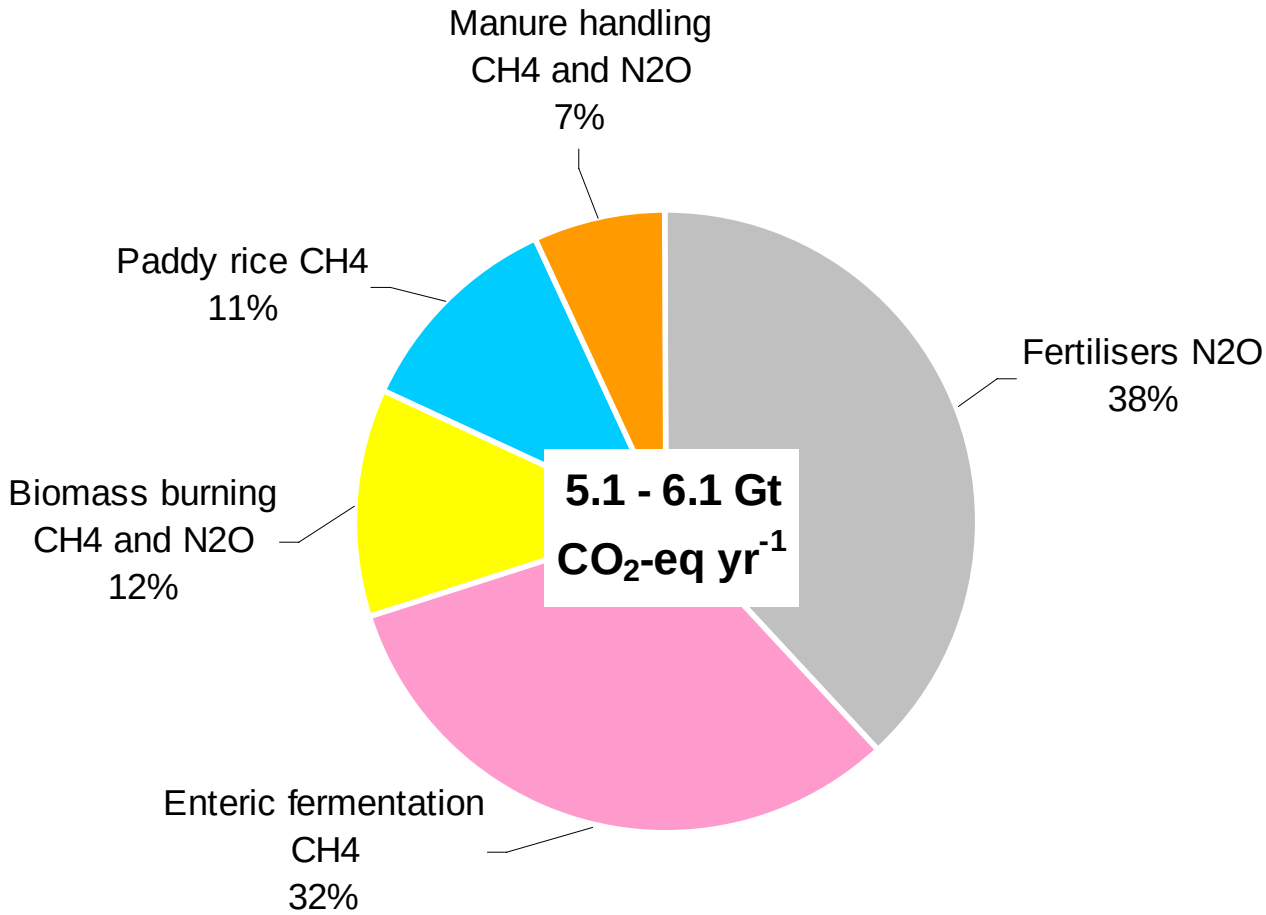
Global GHG emissions of agriculture



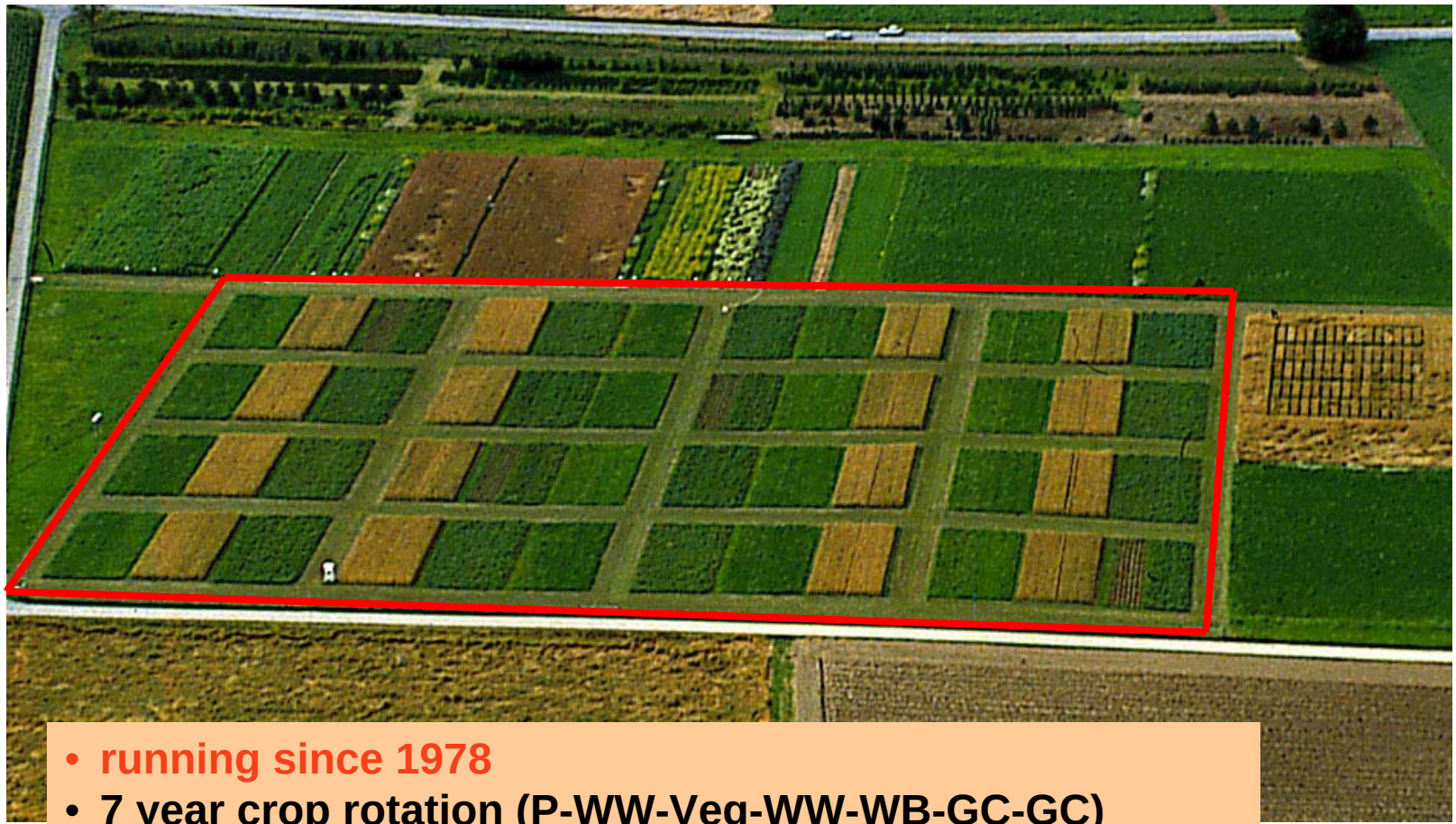
Emissions of the agricultural sector (Smith et al., 2007)

Carbon sequestration in long term experiments

Field trial	Components compared	Carbon gains (+) or losses (–) kg ha^{-1} yr^{-1}	Relative yields of the respective crop rotations
DOK Experiment, CH (Mäder, et al., 2002; Fließbach, et al. 2007) Running since 1977	Organic, FYM composted	42	83 %
	Organic, FYM fresh	–123	84 %
	IP, FYM fresh, mineral fertilizer	–84	100 %
	IP, mineral fertilizer	–207	99 %
SADP, USA (Teasdale, et al., 2007) Running 1994 to 2002	Organic, reduced till	+ 819 to + 1738	83 %
	Conventional, no till	0	100 %
Rodale FST, USA, (Hepperly, et al., 2006; Pimentel, et al., 2005) Running since 1981	Organic, FYM	1 218	97 %
	Organic, legume based	857	92 %
	Conventional	217	100 %
Frick Reduced Tillage Experiment, CH (Berner, et al., 2008) Running since 2002	Organic, ploughing	0	100 %
	Organic, reduced tillage	879	112 %
Scheyern Experimental Farm, D (Rühling, et al. 2005), Running since 1990	Organic	180	57 %
	Conventional	–120	100 %

Niggli et al., 2009, FAO brochure

DOK long term comparision experiment, Therwil/Switzerland



- **running since 1978**
- **7 year crop rotation (P-WW-Veg-WW-WB-GC-GC)**
- **0 – bio dynamic - organic - IP - conventional**
- **Loess soil, 833 mm precipitation, 9.4 ºC temperature**

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Mäder et al. 2002, Science

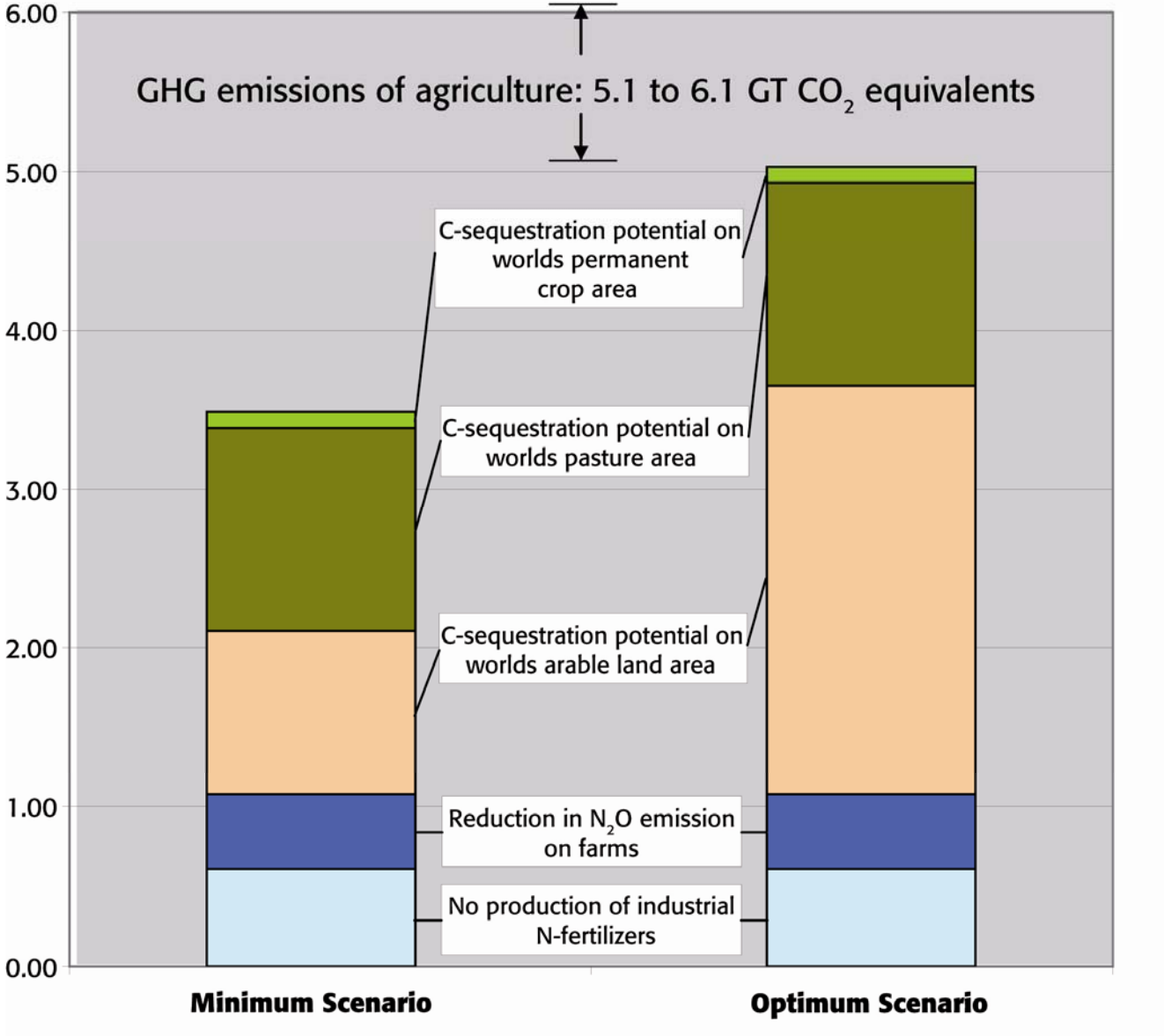
GHG reduction and mitigation potential

Minimum Scenario: todays organic practice

(100/200 kg C ha^{-1} yr^{-1})

Optimum Scenario organic farming and reduced tillage

100/500 kg C ha-1 yr-1



Niggli et al., 2009, FAO brochure

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

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**

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Hole et al., 2005

Organically managed systems more resilient to climate change

- Adaptive management by community knowledge and knowledge-intensive farming methods (Borron, 2006).

- Resilience within agroecosystems:
  - Soils fertility building, physical soil properties (Reganold, 1987, Mäder et al., 2002, Pimentel et al., 2005).
  - Above and below ground macro and micro flora & fauna (Hole et al., 2005; Bengtsson et al, 2005).
  - Crop diversity in time and space
  - Genetic diversity in crops (Kotschi, 2006).

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Results of many case studies*

- Improved food security by adopting OF as good agricultural practice.
- Case studies: yield increases by 112 %.
- Less dependent on expensive fertilizers, pesticides and seeds.
- Lower risks to run into debts.
- Access to high value markets (local and international).
- Knowledge-intensive agriculture.

*UNEP-UNCTAD CBTF (2008).

Resource use efficiency (DOK trial, 28 years)

Parameter	Unit	Organic farming	Integrated farming (IP) with FYM	Organic in % of IP
Nutrient input	kg N_{total} ha^{-1} yr^{-1}	101	157	64 %
	kg N_{min} ha^{-1} yr^{-1}	34	112	30 %
	kg P ha^{-1} yr^{-1}	25	40	62 %
	kg K ha^{-1} yr^{-1}	162	254	64 %
Pesticides applied	kg ha^{-1} yr^{-1}	1.5	42	4 %
Fuel use	L ha^{-1} yr^{-1}	808	924	87 %
Total yield output for 28 years	%	83	100	83 %
Soil microbial biomass „output“	tons ha^{-1}	40	24	167 %

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Mäder, Fliessbach, Niggli (2002), Science 296

Conclusions (1)

- Organic farming intensifies farm-internal processes like biological activities of soils, recycling of livestock and crop waste, enhanced biodiversity as well as nitrogen fixation and improved phosphorous availability by symbiosis.

  - *Thus reliance on high energy external inputs is reduced and less negative externalities occur.*

Conclusions (2)

- Organic farming diversifies farm organization by more complex crop rotations, by more farm activities and by deploying more knowledge.

  - *Thus, productivity gets higher in many cases, yields are more stable and farms become less vulnerable to climate change.*

Conclusions (3)

- Organic farming builds up soil fertility and increases or conserves soil organic matter.

  - *Thus, supply and demand of nutrients get synchronized, water and soils get conserved and CO_2 sequestered into the soil.*

Conclusions (4)

- Organic farming is a relevant mitigation and adaptation option in the context of climate change.
- Organic farming delivers many additional societal benefits.
- Organic farming is a viable solution for small holder farmers in developing countrie

Consequences ….

- Can organic agriculture feed the world?
- Less erosion – a rate of 10 million hectare annually (Pimentel, 1995) – crucial for future food security.
- OF to recultivate poor soils and bring such soils back into productivity.
- Lower livestock densities and can compensate for lower yields (land use 1:7 !).
- Higher productivity by scientific agro-ecological research?