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Reconciling food security and sustainability organically

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Is organic a moral choice?

Before we go back to an organic agriculture in this country (USA), somebody must decide which fifty million Americans we are going to let starve or go hungry.

Earl Butz, US Secretary of State for Agriculture 1971

Going organic will mean that we have to plough up the cricket fields of England

ICI advert (early 1980s)

How low are organic yields?

Ponti et al. analysed 362 studies

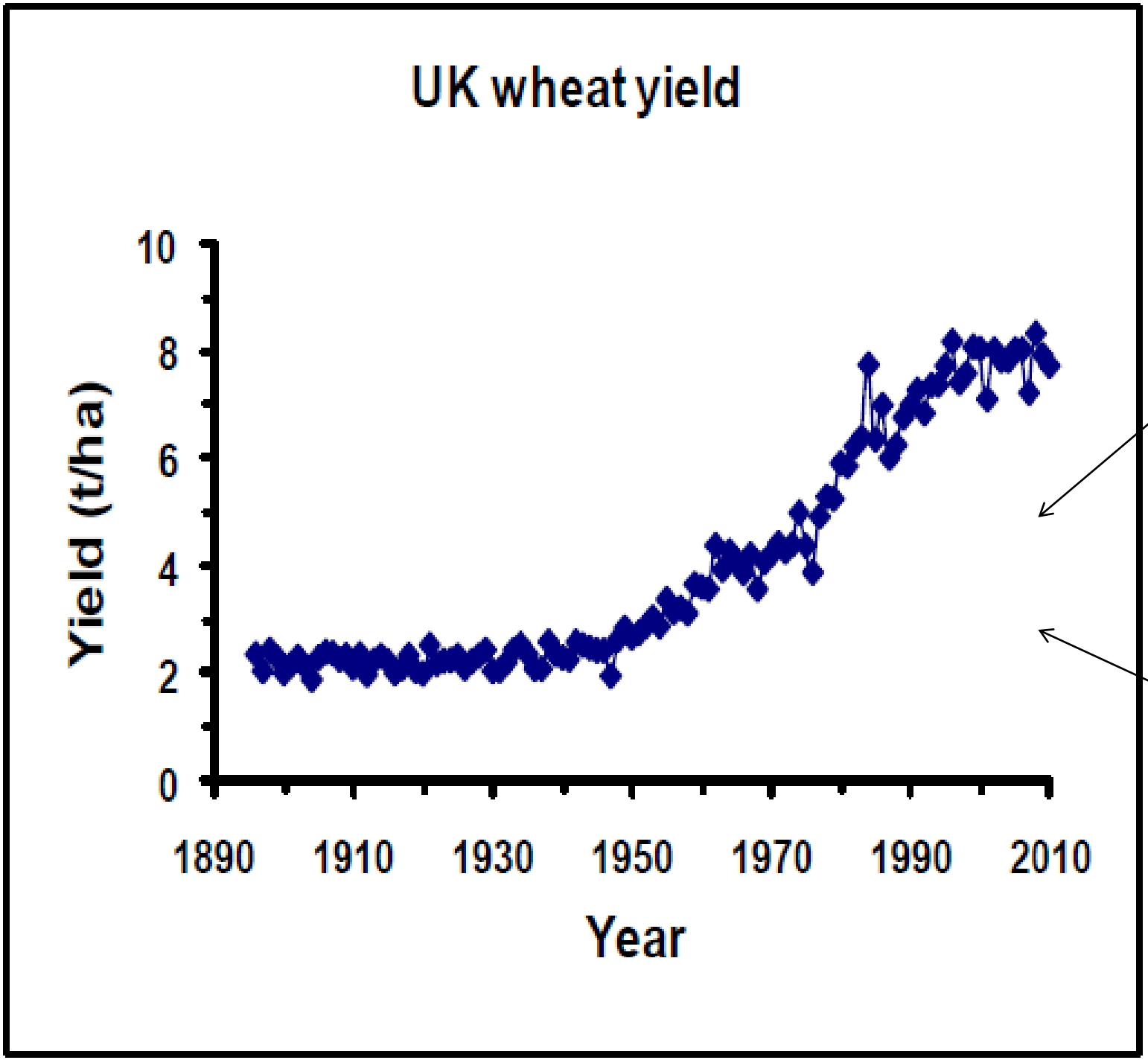
- on average 80% of conventional yields
- significant regional and crop type variations, range 20-177%

Seufert et al.

- on average 75% of conventional
- best practice in both 87% of conv.
- 95% of conv. if rainfed & using legumes and perennials

Organic v. non-organic yields
FBS data, E&W, 2011/12

Product	Organic t/ha (farms)	Non-organic t/ha (farms)	Relative (O % non-O)
Winter wheat	4.4 (37)	8.3 (272)	53
Spring barley	3.8 (44)	5.3 (136)	72
Winter oats	4.1 (17)	6.4 (37)	64
Field beans	2.8 (26)	3.9 (59)	72
Potatoes	29 (6)	44 (23)	66
Milk (l/cow)	6315 (45)	7397 (145)	85
Stocking (LU/ha)	1.4	1.7	82
Milk (l/ha)	8841	12575	70
Concs. (est. t/ha used)	2.3 (@ 350/t)	4.8 (@ £200/t)	48

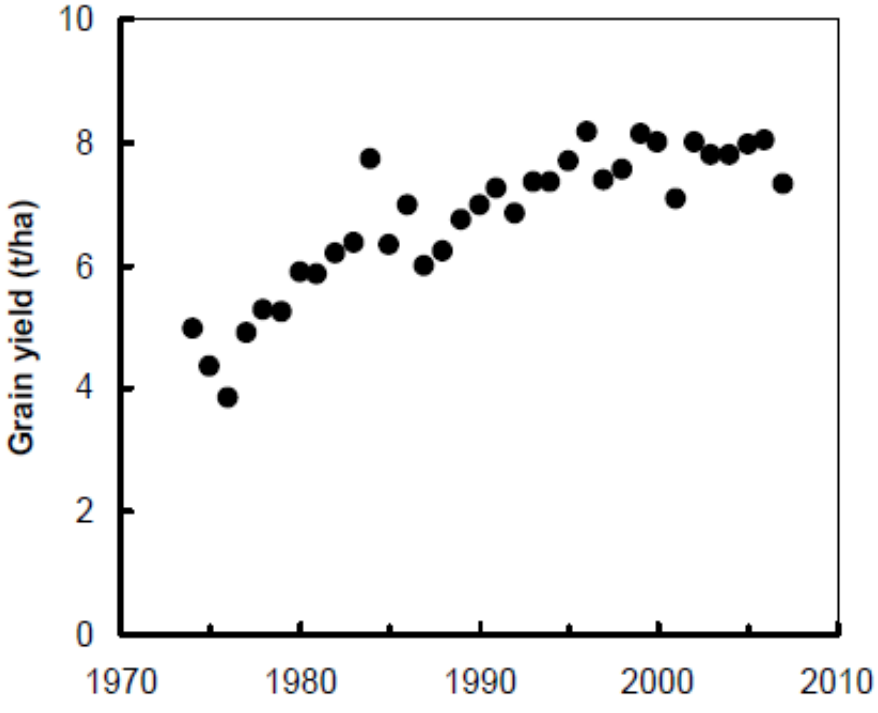


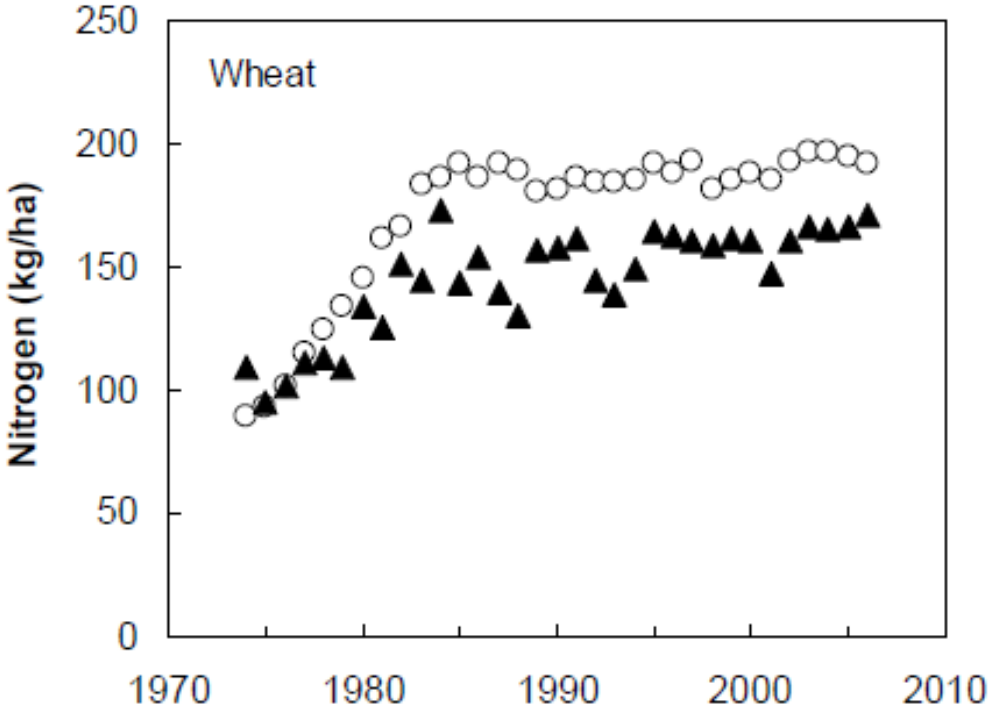
FAO, Defra, in Moloney 2013

UK organic yield 2010

Global average yield 2010

UK average wheat yields (●), N fertiliser use (○) and N removal (▲)





Breeding has improved genetic potential, but yields have not improved, because N use has not increased – solution: use more N!
(Source: Sylvester-Bradley *et al.*, 2008)

Nitrogen intensity is key

- Yield differences greatest where nitrogen use is highest
- Contrast UK and US relative wheat yields
- UK yields similar to conventional in 1970s, when N-use in wheat increased significantly
- But still criticism that 3x as much land needed to grow 1 tonne of organic wheat

3 x as much land?

Total output on a given ha for five years:

- Conventional wheat: 8t/ha x 5 = 40t
- Organic wheat: 4.5t/ha for three years plus fertility building for two years = 13.5t

It's obvious which is better, isn't it?

... but what about:

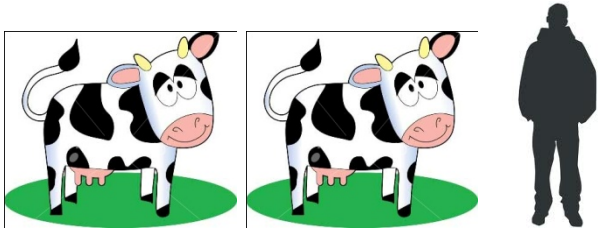
- production on fertility building phase
- how production is used – e.g. feeding grass or cereals to livestock?
- land use choices and ecosystem services

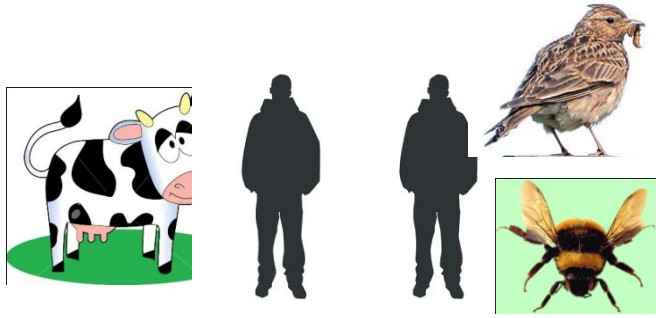
Is this what we want?


Biola

Conceptualising system output

Primary output ---------- Secondary -- Final



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It’s not just about yields!

- Meeting human feed, food and fibre needs

And

- Biodiversity, ecosystem services

And

- Conserving resources
  - land is not the only one, or even the most limiting one
  - (and nitrogen is not necessarily the limiting input, as DOK trials show)

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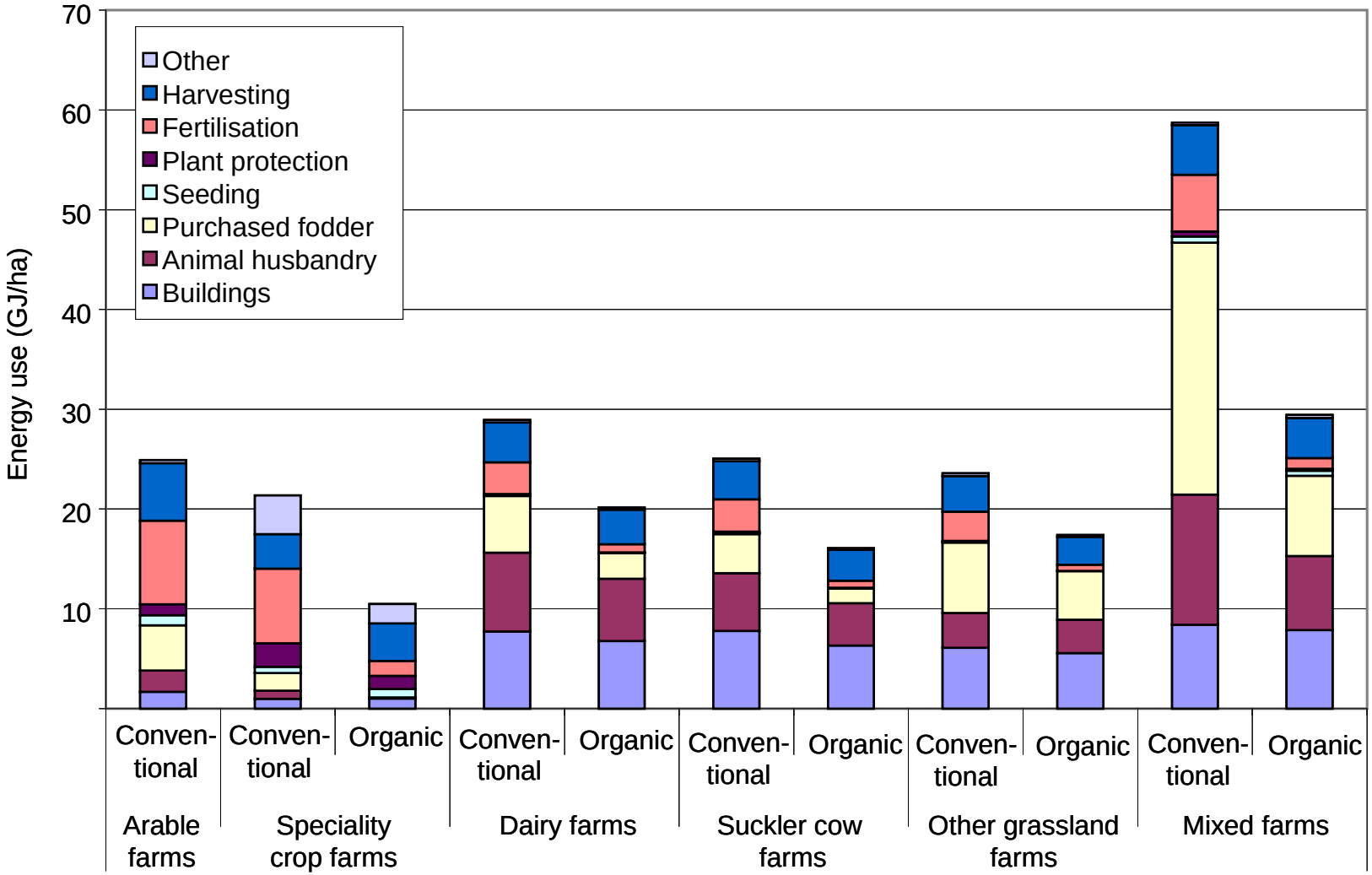
Energy use on organic and non-organic farms in Switzerland (Schader)



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Net System Output - focus on

- Energy (food and fuel)
  - potential links to Carbon cycle, photosynthesis and GHG
- Nitrogen (protein)
  - potential link to Nitrogen cycle
- Calculate net output
  - account for output used as intermediate input
- Express in easy terms to comprehend

(+ residual N)

- Can be linked to ‘people nourished per ha’

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Results for cropping systems

Description	Cereals (C)	Cereals (O)	Cropping (C)	Cropping (O)	Mixed (C)	Mixed (O)
Farms (n)	356	20	199	18	127	16
Size (ha)	248	168	225	198	158	225
FBI (£/ha)	225	242	314	386	245	298
Input (£/ha)	341	66	420	170	202	76
NSO (tWe/ha)	6.9	3.0	11.1	5.0	7.6	3.7
FBI (£/tWe)	33	81	21	78	32	80
Efficiency (kgWe/£In)	20.2	45.5	26.5	29.3	37.8	48.8
GHG (kgWe/ kgCO_2e)	3.4	3.4	3.3	3.5	1.4	1.5

C: conventional, O: organic
FBI: farm business income
Input: fossil-fuel based crop inputs (ferts, sprays, diesel) and water
NSO: Net system output
We: Wheat equivalent (excluding residual N)
CO_2e: Carbon dioxide equivalent including methane, nitrous oxides

Results for dairy systems

Intensity	High (C)	Medium (C)	Medium (O)	Low (C)	Low (O)
Farms (n)	134	135	22	134	22
Size (ha)	118	111	134	107	148
FBI (£/ha)	600	568	703	397	441
Input (£/ha)	353	302	163	280	131
NSO (tWe/ha)	16.9	12.7	12.8	9.8	6.5
FBI (£/tWe)	36	45	55	40	68
Efficiency (kgWe/£In)	47.8	41.9	78.5	35.1	49.4
GHG (kgWe/ $kgCO_2e$)	1.5	1.2	2.1	1.0	1.1

C: conventional, O: organic
FBI: farm business income
Input: fossil-fuel based crop inputs (ferts, sprays, diesel) and water
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Key research questions

- Can we improve nitrogen utilisation in cropping systems without adopting a neo-conventional supplementation approach?
- Can we close cycles to retain and recycle more of the limiting resources, incl. K & P?
- Can we improve the utilisation of the fertility building phase of the rotation to improve overall system output?
- Can we improve productivity by integrating other species, e.g. trees?

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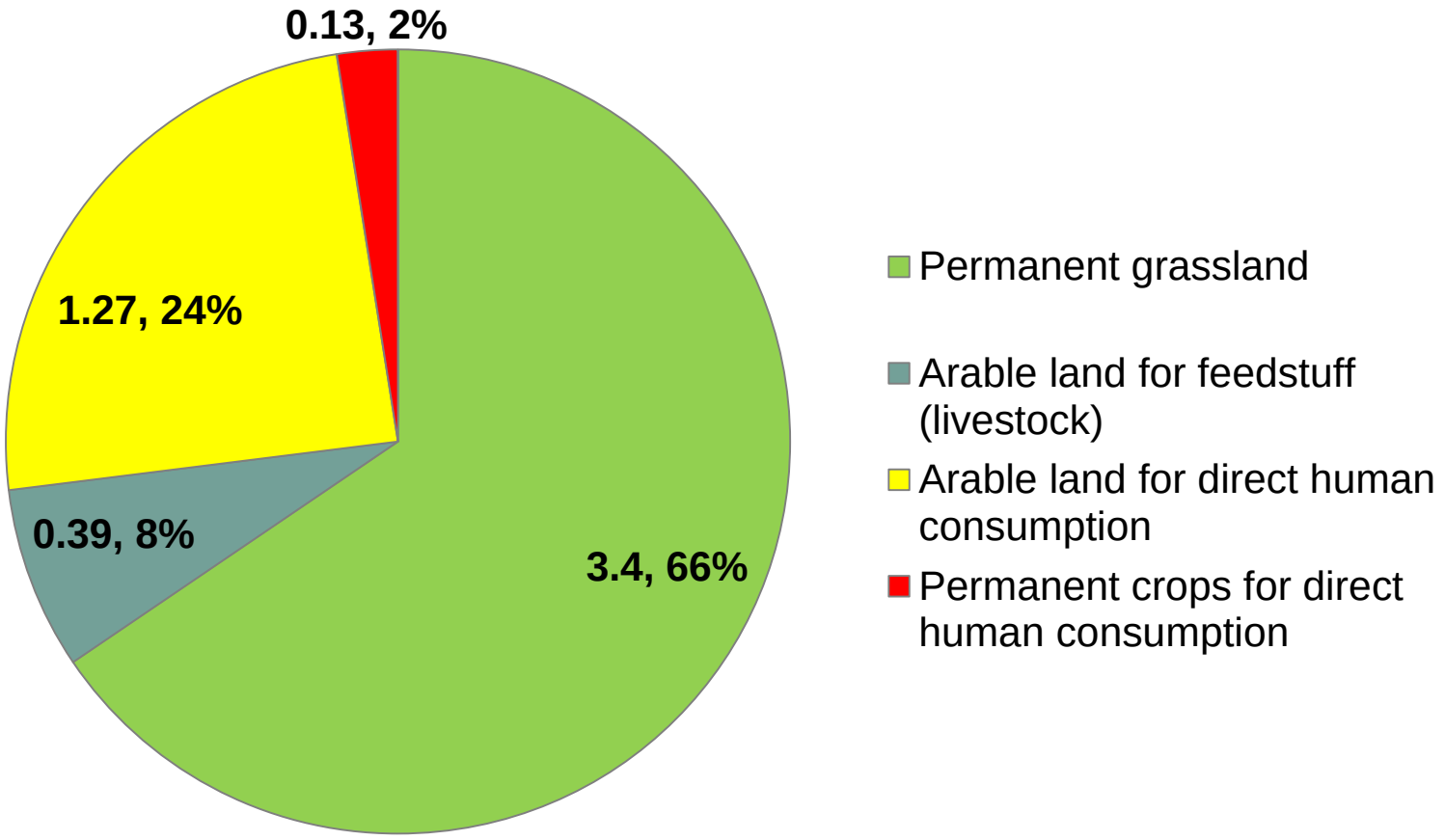
What about the global context?

- Feeding 9 billion people by 2050, who are
- Eating more livestock products
- Looking for other services from land (e.g. energy)
- Increasingly urbanised
- Various estimates 50-100% more production needed

- Do we have no choice but to intensify production?

World-wide agricultural land use (in billion ha and percentage)



FAOSTAT, 2011

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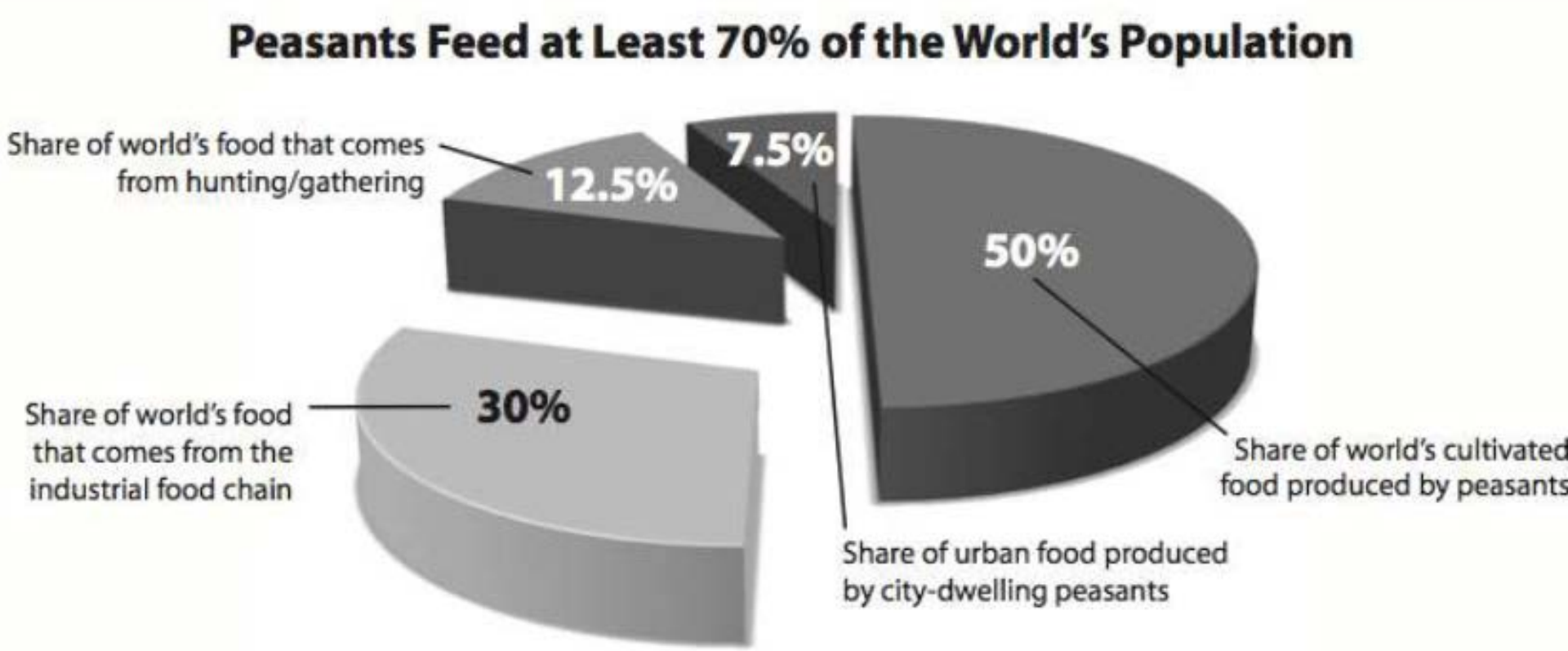
Who feeds us today???



How many peasants there are in the world? (ETC 2009)

- 1, 5 billion peasants in 380 million small farms
- At least 370 million of these are also indigenous peoples occupying *92 million farms*
- 17 million peasant farms in Latin America grow between a half to two-thirds of staple foods
- Africa's 33 million peasant farms (mostly female-led) account for 80% of farms and most of the domestic food consumption
- Asia's 200 million peasant rice farms produce most of its harvest


Organic/
agro-ecological
principles
supporting food
sovereignty/
security in Kibera,
Nairobi

Food security or food sovereignty?

- In subsistence systems, where ability to purchase inputs is limited, organic yields can be higher than non-organic due to improved (eco)system design.

- Is the answer really a shift from peasant to corporate agriculture to generate more output at the cost of substantial social and environmental change?

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What about livestock?

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How far do livestock compete with humans?

- 36% of global calories produced used for livestock
- Only 12 % of these used ultimately for human consumption
- With current cropping patterns, not feeding the calories to livestock could increase human availability by 70% - enough to feed 4 billion more people

(Cassidy *et al.* 2013)

iopscience.iop.org/1748-9326/8/3/034015/article

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Aims of the FAO project: SOL-m

- Model the impact of upscaling organic/sustainable livestock production globally on food availability, resource use and major environmental impacts
- Study the trade-offs and synergies between the main environmental and socio-economic challenges at global level

Research questions

- Would organic livestock production be able to meet the increasing demand for food (energy and proteins)?
- Would such a scenario lead to higher land occupation? Deforestation of rain forests? GHG emissions?
- How can the trade-offs between the environmental impacts and food security be minimized and positive synergies be utilized?
- Which dietary changes would be necessary to assure that organic production could meet demand and guarantee food security?

Conclusions (1)

Organic farming could feed the world IF:

- Livestock production/consumption reduced
- Livestock systems complementary to human food, fibre and energy needs
- Potential benefits for diet, health and environment

AND

- Systems are locally adapted to suit local conditions and meet local needs
- Economic institutions adapt to address income and food distribution issues

Conclusions (2)

Sustainable intensification not sustainable IF

- More TOTAL non-renewable resources used and soil/water degraded
- Production is wasted
- Diets are unhealthy
- Environmental trade-offs are ignored

Improving systems productivity should not be at expense of genuine sustainability

Initial results SOL (April 2013)

Indicator	Base year	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	2005-2009; current situation	2050; baseline according to official FAO forecast	2050; 50% reduction of concentrate use	2050; 100% reduction of concentrate use	2050; full conversion of livestock to organic management	2050; Scenario 3 and 4 combined
Agricultural land	→	↗	↘	↘	↑	↘
Human population	→	↑	↑	↑	↑	↑
Available food energy for human consumption	→	↑	↑	↑	↑	↑
Available food protein for human consumption	→	↑	↑	↑	↑	↑
Share of livestock products	→	↑	↓	↓	↓	↓
Share of plant products	→	↘	↑	↑	↑	↑
Nitrogen surplus	→	↑	↗	↓	↓	↓
Phosphorus surplus	→	↓	↑	↗	↓	↓
Energy use	→	↑	↘	↓	↗	↓
Global Warming Potential (GWP)	→	↑	↑	↓	↓	↓
Land degradation potential	→	↑	↘	↘	↑	↘
Deforestation pressure	→	↑	↓	↓	↑	↓
Toxicity potential	→	↑	↘	↘	↓	↘
Grassland overexploitation	→	↑	↑	↗	↑	↗
Biodiversity	→	↓	↗	↑	↑	↑

- The direction of the arrows specifies whether the paramer will increase in a scenario.
- Green arrows indicate a development that is considers beneficial from a societal perspective.
- Red arrows indicate a development which is considered detrimental from a societal perspective.
- Yellow arrows indicate constant trends or minor changes (less then 5%) according to the preliminary SOL-m calculations.