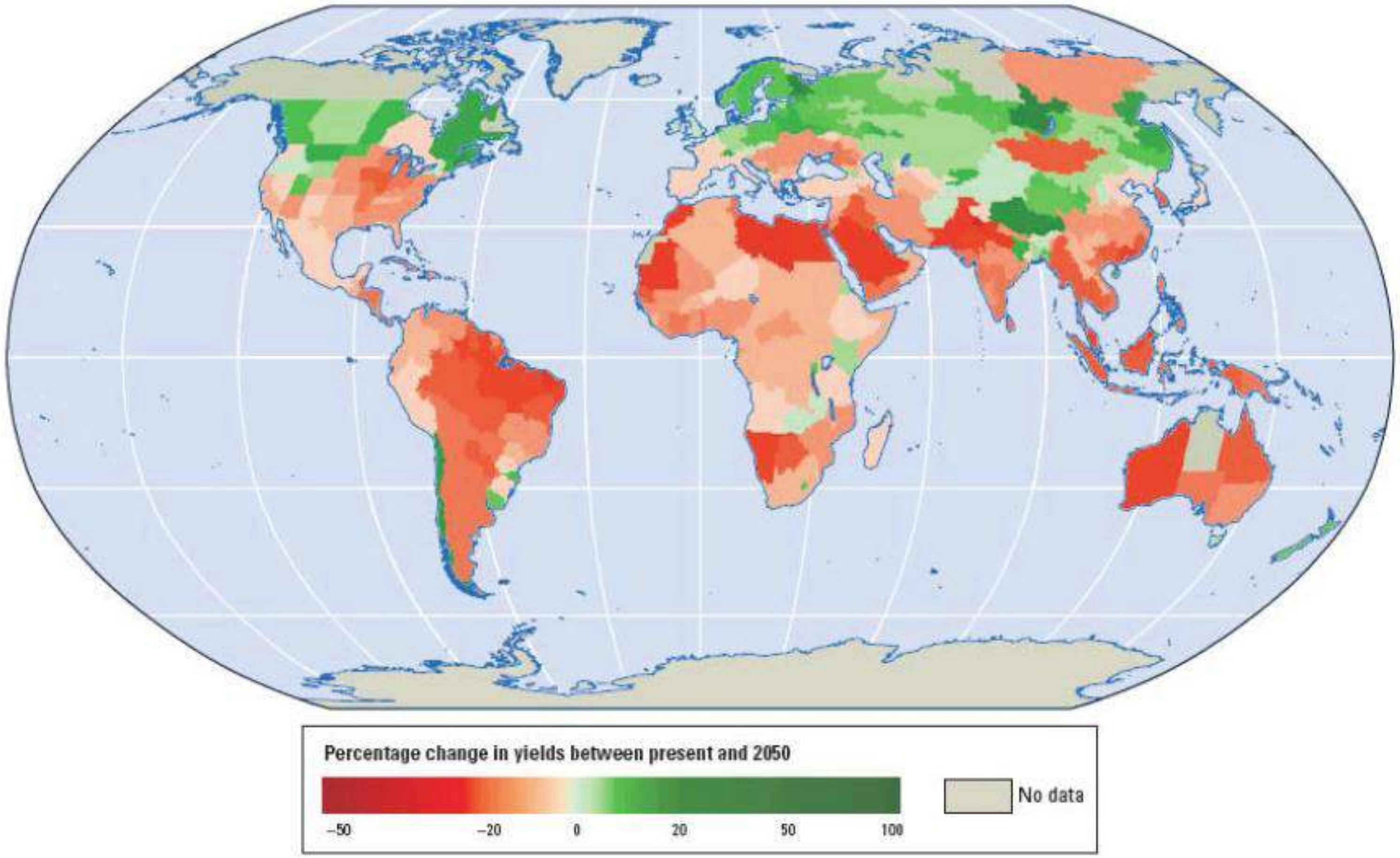
Higher frequency of weather extremes

Climate change impacts on ag. productivity



Change in yield (%) of 11 important plant crops until 2046-2055, in relation to 1996–2005 (Mean for 3 emission scenarios and 5 climate models)

Müller et al., World Dev. Report, 2010

Forecasted yield increase to nourish increasing world population

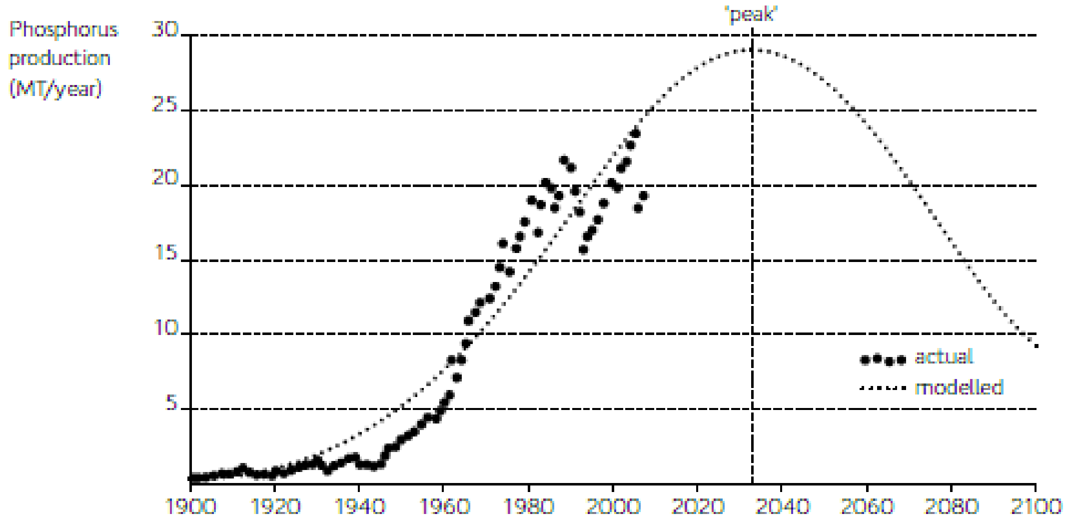
Year	Cereal Yield / Mg ha^{-1}	Total Production / 10^6 Mg
2005	3.27	2240
2025 a.	3.60	2780
b.	4.40	3629
2050 a.	4.30	3255
b.	6.00	4553

a = without dietary change
b = with change to preference for meat-based (animal-based) diet

- 45% more yield until 2050 necessary without dietary change
- 103% more yield until 2050 necessary for an animal based diet

Lal, 2010

What to do? Business as usual?



- N-Nutzungseffizienz ist begrenzt
- Endlichkeit der Düngemittelreserven

Greening in society and agricuulture: Increase in efficiency of our food system is urgently needed

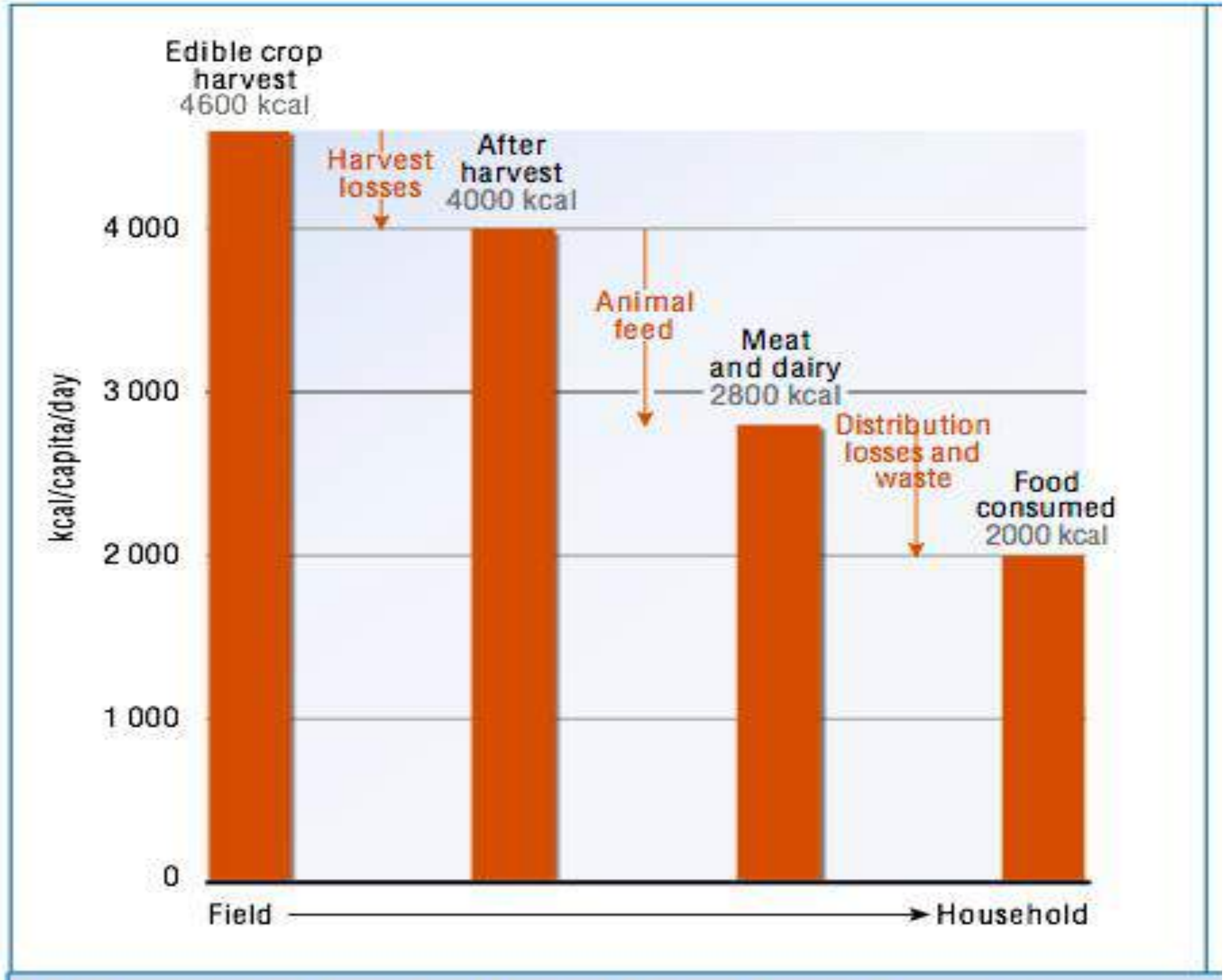
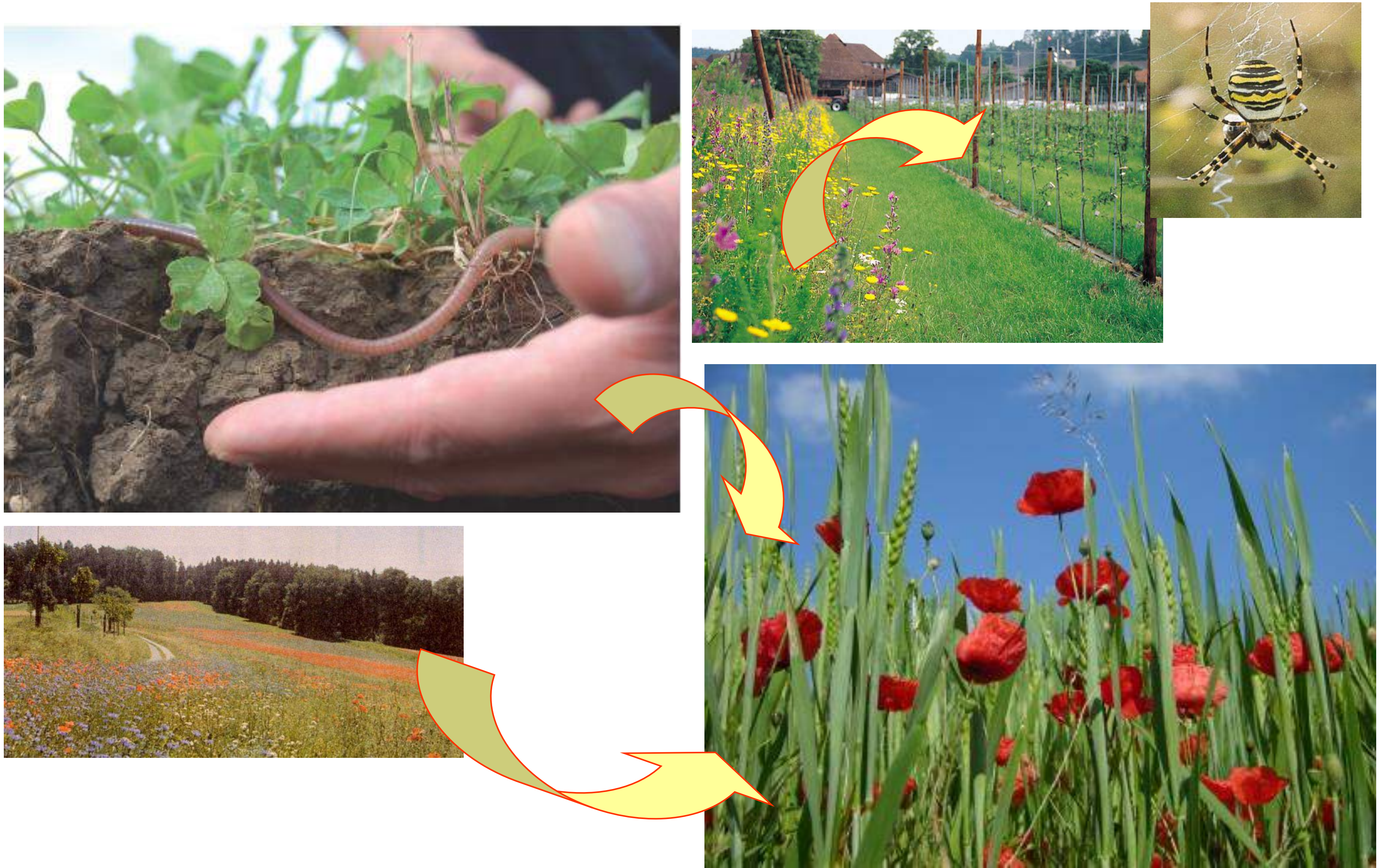


Figure 9a-b: The makeup of total food waste[11]
Source: Lundqvist et al., Godfray

Eco-functional intensification as an approach to reduce vulnerability and improve resilience

Ecofunctional intensification: Synergies between ecosystem services



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 plus innovative elements of low till, precision farming and LEISA.
- Organic (successional) agroforestry systems

The consequences of higher soil organic matter are …

- Increased aggregate stability (Gerhardt, 1997; Siegrist et al., 1998; Brown et al., 2000; Maeder *et al.*, 2002; Pulleman et al., 2003; Williams & Petticrew, 2009).
- Increased water holding capacity, higher water content in soil (Brown et al., 2000; Lotter et al., 2003; Pimentel et al., 2005)
- Improved infiltration rate of water (Lotter et al., 2003; Pimentel et al., 2005; Zeiger & Fohrer, 2009).
- But mineralisation rates of plant nutrients from organic matter can be low under water scarcity; solubilisation of synthetic N to become plant available might be at advantage under such conditions. The combined application of synthetic N and organic fertiliser resulted in the strongest response in maize yields in SSA (Chivenge et al., 2010).

DOK trial: Soil aggregate stability

Conventional/ IPM

Bio dynamic

Mäder et al. 2002, Science

Soil aggregate stability, infiltration rate

Fotos: Fliessbach Nov. 2002

IP with mineral fertilizers

Biodynamic with composted manure

Peak Oil: The alternative is mixed farm und forage legumes (the 2 characteristics of organic)

Global livestock: 21.7 bill. heads (1.5 Milliarden Rinder und Büffel) (Steinfeld et al., 2006).

160 Millionen Tonnen Stickstoff ausgeschieden:

- 34 Millionen (Steinfeld et al., 2006) als Dünger wieder ausgebracht (ungleichgewichtig auf Grünland).
- Rest: Rückstände auf Weiden, Heizmaterial oder als Abfall deponiert.

140 Millionen Tonnen von Stickstoff aus Leguminosen in nachhaltigen, den Boden verbessernden Fruchtfolgen (Badgley et al., 2008).

90 Million Tonnen Stickstoff aus Erdöl hergestellt (Steinfeld et al., 2006).



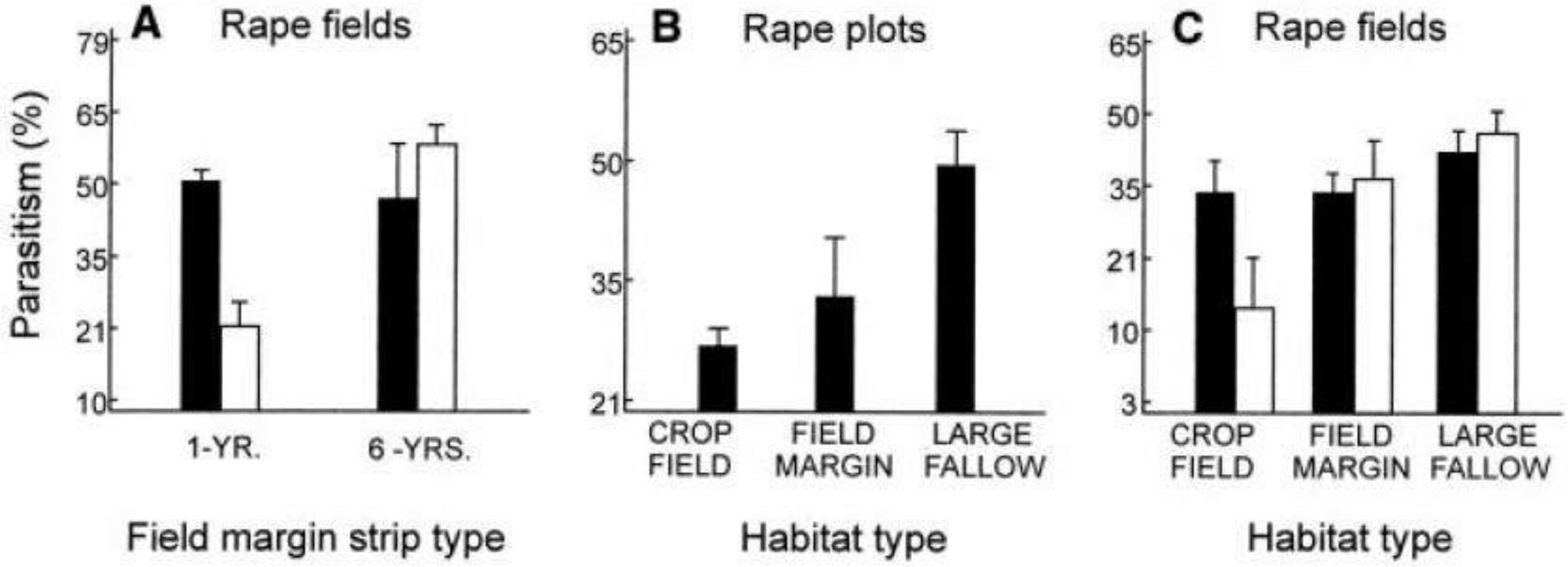
Organic farming is about …

… using high diversity nature for promoting beneficial insects and combating pests.

… spraying extracts of plants and other natural compounds against pests and diseases.

… using robust varieties.

Biological control of rape pollen beetle as influenced by landscape structure

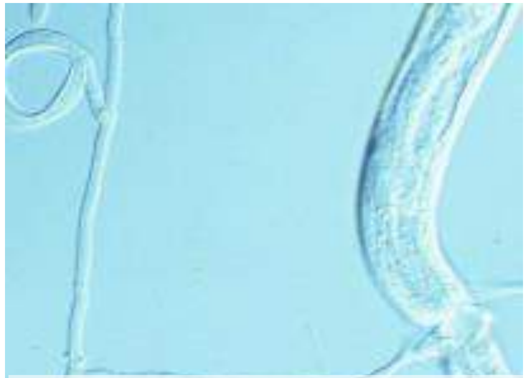


(Thies & Tscharntke, Science, 2006)

Control of endoparasites of livestock

Pasture management

Variation in genetic tolerance?



Biocontrol with the fungus Duddingtonia flagrans

Fooder crops like Chicory and Sainfoin (Esparsette)

Heckendorn, FiBL, 2010

Sustainable food-production in the tropics:

Long-term farming systems comparisons in the tropics

Maize and vegetables in Kenya

Cotton in India

Cacao in Bolivia

Productivity and profitability in cotton based cropping systems in India

Table 1 Yield development [kg ha^{-1}] in cotton, soybean and wheat 2007 to 2010

Year	Treatment	Crop						
		Seed cotton	SEM	Wheat 2 grains	Soybean	SEM	Wheat 1 grains	SEM
			CV			CV		CV
Average	BIODYN	1970 [b]	0.06	-	1603.2[a]	0.26	3167.3 [b]	0.17
	BIOORG	2004 [b]	0.06	-	1637.7[a]	0.27	3066.9 [b]	0.16
	CON	2156 [b]	0.30	-	1737.4 [a]	0.28	3767.2 [a]	0.21
	CON-GM**	2483** [b)]	0.33	1’573	1734.8[a]	0.35	3605.3[ab]	0.18
ANOVA		*P* value	Df		*P* value	Df	*P* value	Df
	Treatment (T)	< 0.001	3		< 0.05	3	< 0.001	3
	Year (Y)	< 0.001	3		< 0.001	3	< 0.001	3
	Block	n. s.	3		n. s.	3	< 0.01	3
	T × Y	< 0.001	9		n. s.	9	< 0.001	9
	Residuals		43			43		45

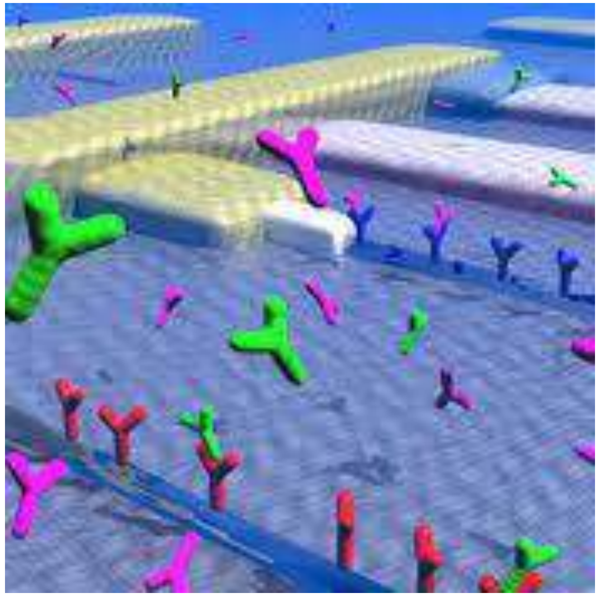
Yields in cotton, soybean and wheat were on average 14%, 7% and 15% lower, respectively. However, also production costs of organic treatments were on average 33% lower than those of conventional treatments.
Similar gross margins among treatments!

Forster, et al., submitted

Contents

Future Innovations?

Nanodraht-Sensoren
mit Mikrochips zur Erkennung
von DNA, RNA, Proteinen:



Contour Farming in Ohio
(Beispiel: Mais, Luzerne):

Tierbeobachtung
mittels
Elektronik.

SMS von der Kuh

Kühe werden heute künstlich besamt. Forscher der Berner Fachhochschule haben nun ein Gerät entwickelt, das den richtigen Zeitpunkt für die Besamung bestimmen kann. Die «Anebox» misst die Temperatur und die Bewegung der Kuh, um den Zeitpunkt der Fruchtbarkeit zu bestimmen, und verschickt anschliessend eine SMS an den Bauern. *(cho.)*

Thank you very much for your attention!

Further infos: http://www.fibl.org/de/themen/klima.html
http://www.fibl.org/de/themen/nachhaltigkeit.html
http://www.organicandclimate.org