Long-term experiments can advise us of soil organic matter management, crop yield development and carbon sequestration

Joachim Raupp

raupp@agric-science.org

ISOFAR / MOAN Symposium, Sousse (Tunisia)
23-25 March 2010
Long-term experiments can advise us ...

My background: international co-operation with researchers

- ISOFAR: Working Group for Long-term Experiments (LTE)

http://www.isofar.org/sections/wg-long-term-experiments.html

Long-term field studies on organic farming (25):

Austria (1)
Canada (3)
Denmark (2)
Finland (1)
Germany (6)
Italy (2)
Sweden (1)
Switzerland (1)
United Kingdom (2)
Unites States of America (6)

- Probably, there is a number of other trials that are not shown.

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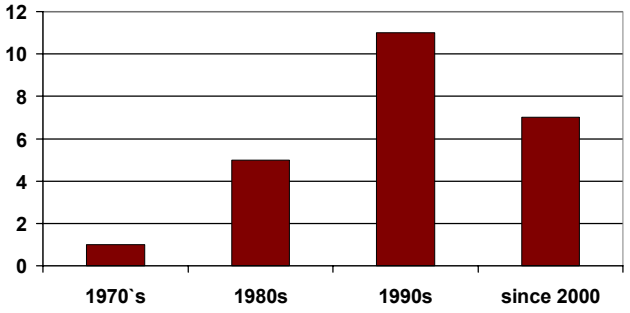
When did these field studies start ?



- 11 experiments (46%) are carried out for more than 15 years

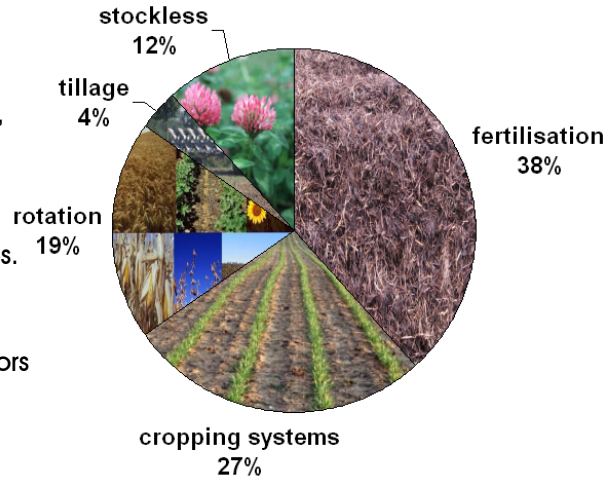
→ 231 experimental years

The main research subjects

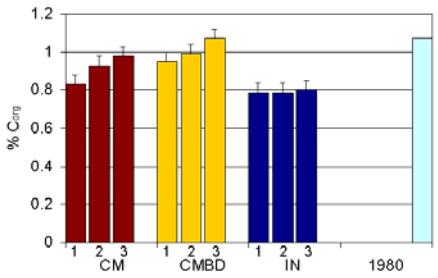
- Nutrient management,
- crop performance,
- soil properties,

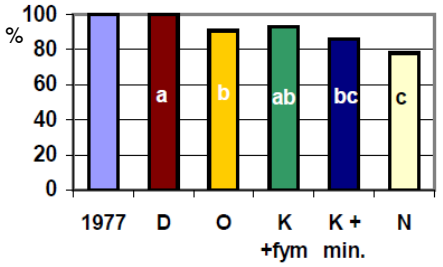
are most important issues.

→ Sustainability indicators



Key results: higher contents of soil organic matter (SOM) in organic vs. conventional systems (right) or with organic vs. mineral fertilisation (left)





Fertilisation: CM, CMBD = cattle manure
IN = inorganic fertiliser
(Raupp, 2001)

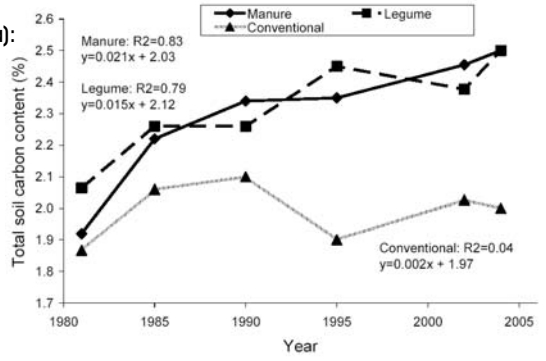
Farming systems: D / O = biodyn / organic
K = conventional
N = no fertilisation
(Fließbach et al., 2007)

Key results: higher contents of soil organic matter (SOM) sometimes because of additional C storage

This is the only organic trial that shows **increasing** C values!

Farming Systems Trial (Pennsylvania):
3 cultivation systems (since 1981)
- organic / manure-based
- organic / legume-based
- conventional

Hepperly et al. (2006)



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We can learn from these results:

- SOM maintenance (conservation over decades) is more likely than additional C storage
- role of subsoil ???
- (data not shown) farmyard manure was more effective in SOM maintenance than green manure or other plant based fertiliser
  Migliorini et al. (2008), Raupp & Oltmanns (2006)

Introduction **Soil organic matter** Soil life Crop yield Conclusions, research tasks
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Key results: other effects of organic farming or organic fertilisation on soils

- higher microbial biomass (C_{mic})
  Bachinger (1996); Fließbach et al. (2007)
- lower metabolic quotient ($qCO_2 = CO_2 : C_{mic}$)
  Bachinger (1996); Fließbach et al. (2007)
- lower bulk density
  Mueller et al. (2006)
- higher root colonization with arbuscular mycorrhyza fungi (AMF) and higher AMF spore density in the soil
  Hepperly et al. (2006); Jarosch et al. (2008); Mäder et al. (2006)
- however, other trials showed unclear results / no difference with AMF
  Bedini et al. (2008), Surböck et al. (2006)

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We can learn from these results:

- under organic cultivation (and favourable weather conditions) soils have a high potential for short-term nutrient delivery
- organic farming is the better technology for poor site conditions (i.e. limitation of water and nutrients)

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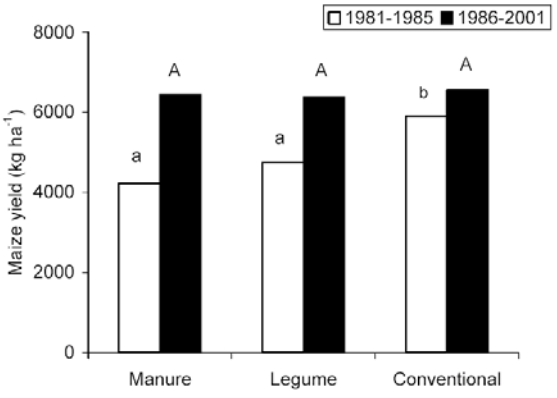
Key results: equivalent maize yields after the conversion period



Maize yield (kg ha^{-1}) in the conversion period (1981-85) and later (1986-2001) in 3 cropping systems:

- organic / manure-based
- organic / legume-based
- conventional

Hepperly et al. (2006)

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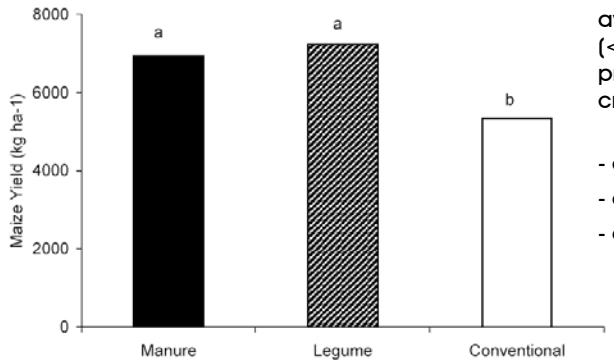
Key results: higher maize yield under drought condition with organic cultivation



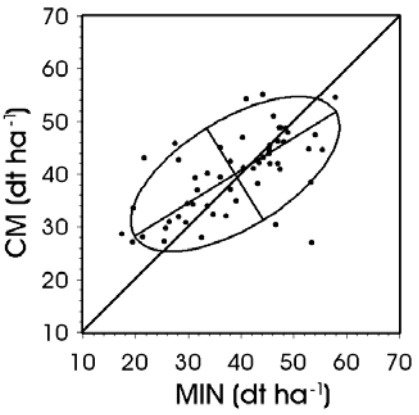
Maize yield (kg ha^{-1}) on average of 5 drought years (<350 mm vs. 500 mm precipitation) with 3 cropping systems:

- organic / manure-based
- organic / legume-based
- conventional

Hepperly et al. (2006)

Key results: higher wheat yield under drought conditions with manure fertilisation

Correlation between spring wheat yields with composted manure (CM) and mineral fertilizer (MIN); results of 4 replicates and 14 years (n=55)



Raupp (2001)

Confidence ellipse ($p<0.05$):

major axis regression:

$Y1 = 15.96 + 0.62\ Y2$

slope (b):

$0.416 < b < 0.868$

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We can learn from these results:

- such yield results (as well as soil properties) show that organic farming gives an advantage under limited growth conditions

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Conclusions:

- All results I presented could only be obtained in long-term trials.
- The information achieved is of relevance for farmers as well as for researchers and politicians.
- After intensive research on topsoil, we should extend our effort on subsoil investigations.
- More research is needed to study the relevance of soil properties for crop development, to elaborate rotation systems for stockless organic farming and to study climate change issues.

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Thanks !

- Many thanks for your attention!

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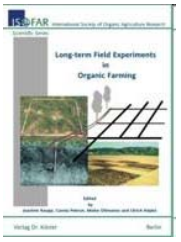

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