Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

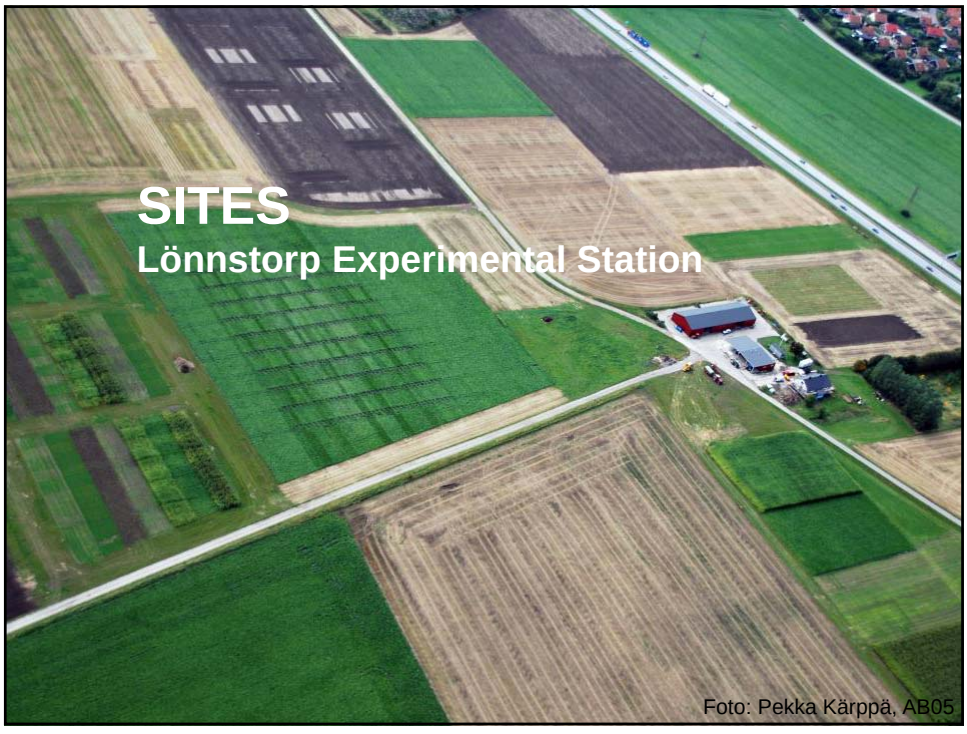
CLIMMAR – Stockholm Oct 2015

Organic farming and agroecology as momenta for sustainable development of food systems

Erik Steen Jensen

Swedish University of Agricultural Sciences

Faculty for Landscape Architecture, Horticulture and Crop Production Science, SLU Alnarp



Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

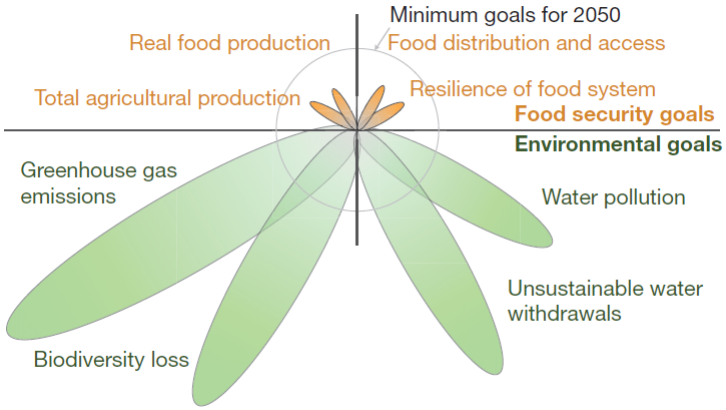
Future challenges of agriculture
What is agroecology?
Agroecological methods and systems
Performance of agroecological systems
Conclusions- recommendations

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Some challenges for global agriculture

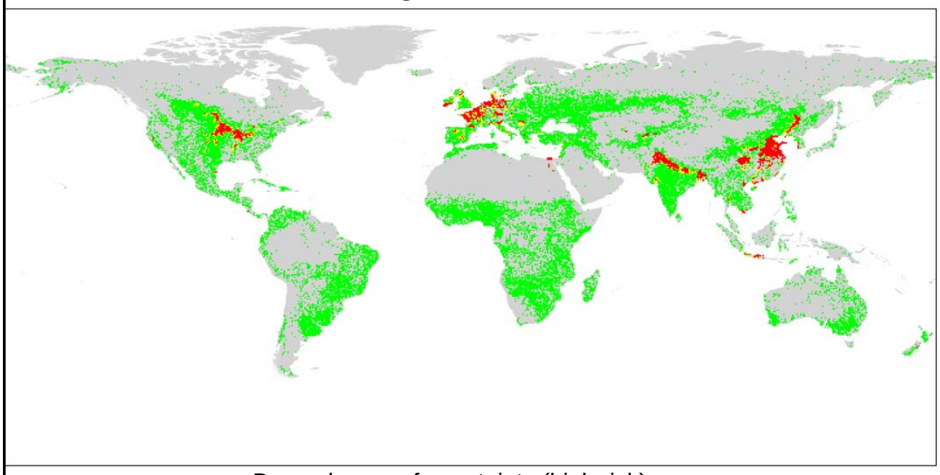
Food security and sovereignty
Climate change – adaption and mitigation
Clean water
Reduced use of pesticides
Healthy and safe quality food
Energy supply
Non-renewable resource supply
Biodiversity
Changing markets – free trade
Rural development

Global goals for 2050



Foley, J. et al . 2011. Solutions for a cultivated planet. Nature, 478.

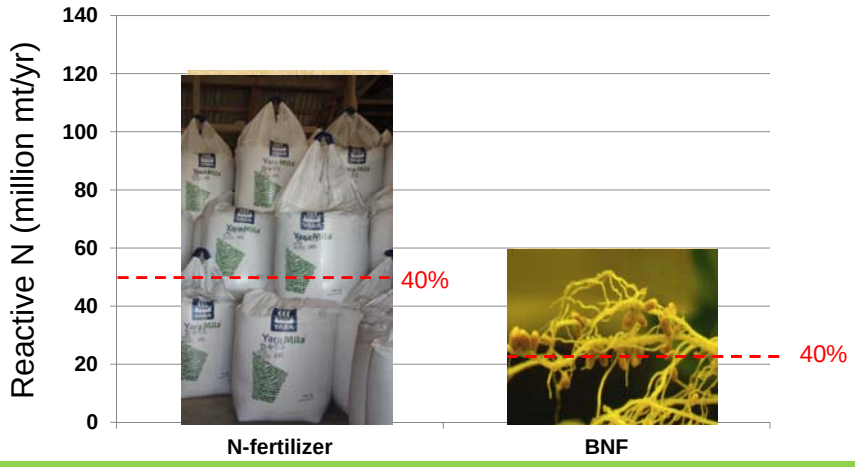
Planetary boundary for biogeochemical flows of nitrogen



Beyond zone of uncetainty (high risk)
In zone of uncertainty (increasing risk)
Below boundary (safe)

Will Steffen et al. 2015 **Planetary boundaries: Guiding human development on a changing planet**. *Science Vol. 347 no. 6223 DOI: 10.1126/science.1259855*

Global reactive N input from fertilizer and BNF (2008)



Galloway, J. N et al 2008. Transformation of the N cycle- Recent trends, qustions and potential solutions. *Science* **320**, 889; Herridge, D.F, Peoples, M.B, and Boddey, R.M. 2008.Global inputs of biological N2 fixation in agricultural systems. Plant and Soil, 311, 1-18.

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

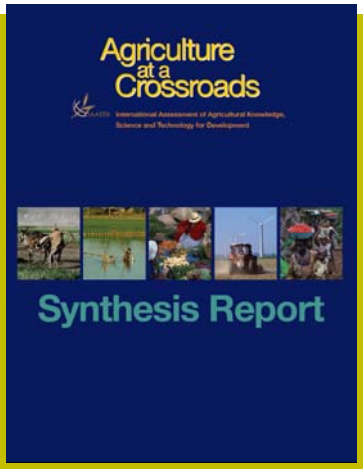
"….increase the agricultural production in a sustainable way"

Increased diversity of farming systems

Multifunctionality of crops and systems

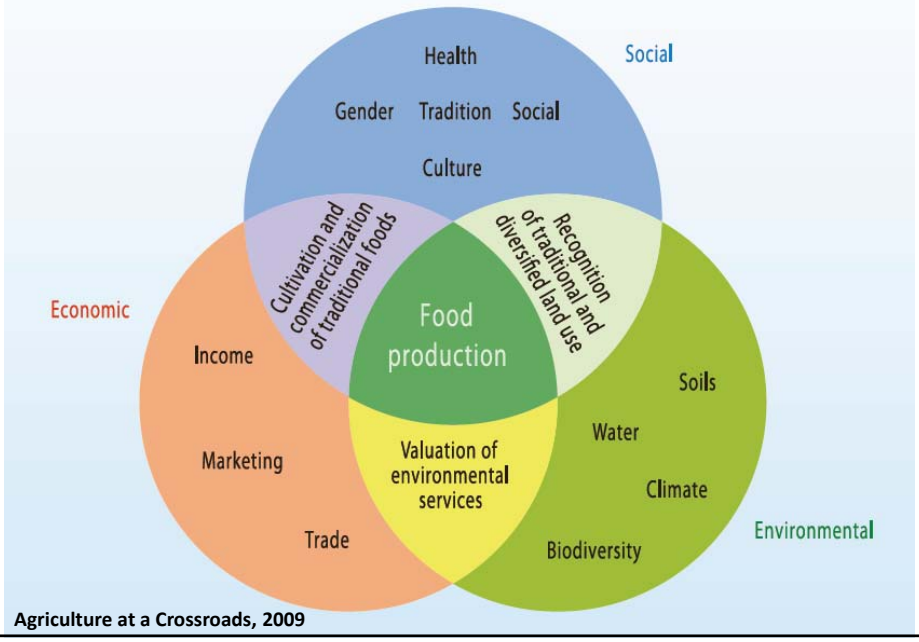
Improved nutrient, energy and water use

Supporting agroecological systems



Agriculture at a Crossroads. Key recommendations from the International Assessment of Agricultural Knowledge, Science and Technology for Development – Johannesburg, April 2009

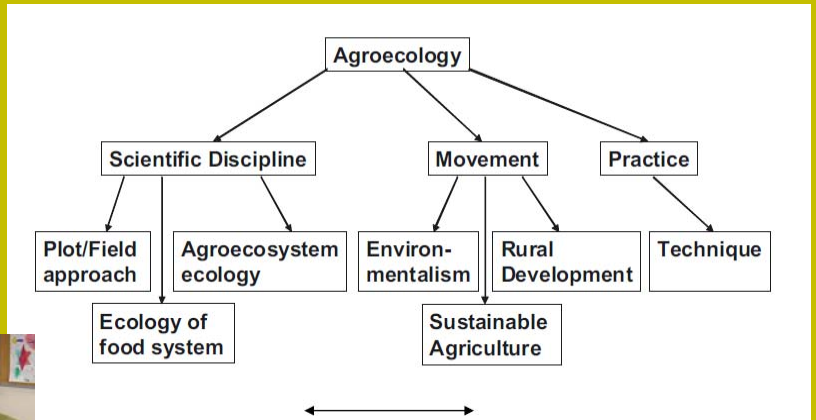
The inescapable interconnectednes of agricultures different roles and functions



Agriculture at a Crossroads, 2009

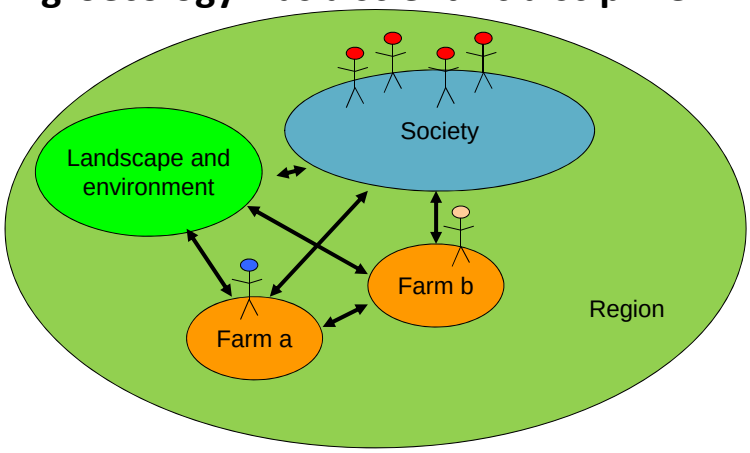
Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Agroecology as a science, a movement and a practice



Wezel, A . et al. 2009. Agroecology as a science, a movement and a practice. Agronomy for Sustainable Development. 29, 503-515.

Agroecology – as a scientific discipline

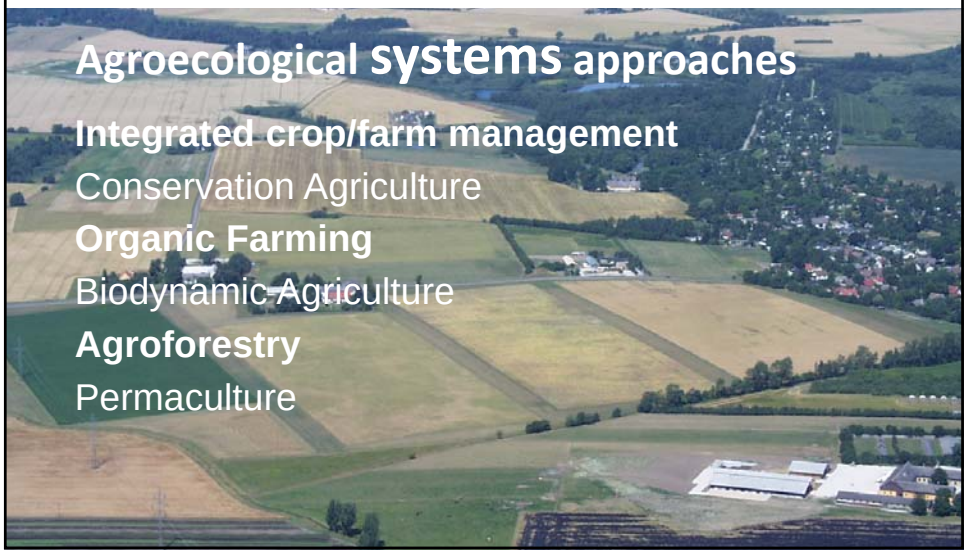


• The integrative study of the ecology of food systems, involving the entire process of converting natural resources to what reaches consumers tables,encompasing ecological, economic and social dimensions.

• Design of individual farms using principles of ecology involving landscape, community and region with emphasis on uniqueness of place and the people and other species that inhabitat that place.

Francis, C et al 2003. J. Sustainable Agriculture 22, 99-118

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences



Organic Farming

- Organic agriculture is a production system that sustains the health of soils, ecosystems and people.
- It relies on **ecological processes, biodiversity and cycles adapted to local conditions**, rather than the use of inputs with adverse effects.
- Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved

IFOAM, 2011

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Key agroecological **methods**

Use of ecosystem services
Sustainable management of soil organic matter
Biological N_2 fixation
Recycling of nutrients and energy on farm
Diversification of crops and genetic resources in time and space (e.g. rotation-intercropping)
Cover crops
Eco-functional intensification

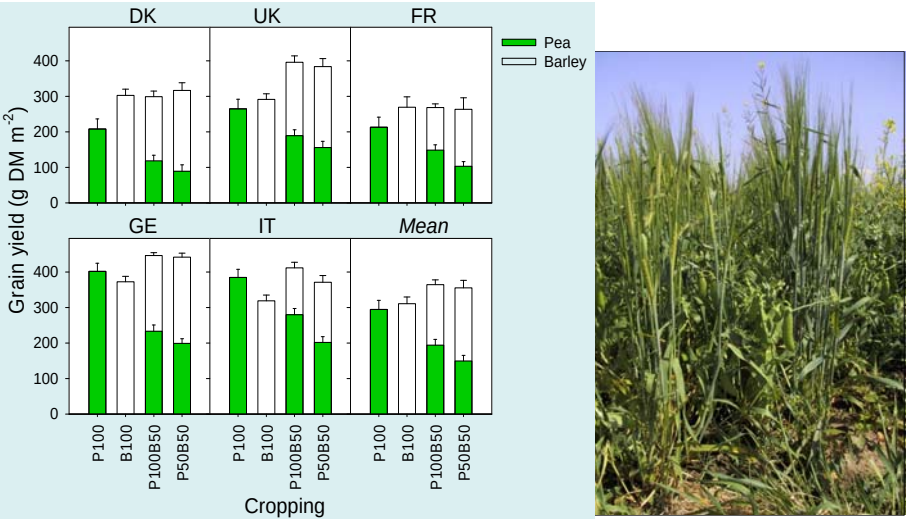
Crop diversification in time and space

- Time: rotation
- Space:
  - Variety mixtures
  - Intercropping
  - Strip cropping
  - Agroforestry
  - Cover crops and living mulches
  - Windbreaks field margins
  - Field design

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Example of agroecological method: Intercropping

Intercropping of pea and barley in European OF systems



Jensen et al, 2006 INTERCROP Final Report, The EU Commission

Land Equivalent Ratio (LER)

$$LER_{AB} = \frac{Y_{AB}}{Y_{AA}} + \frac{Y_{BA}}{Y_{BB}}$$

LER > 1: Advantage from intercropping
LER < 1: Advantage from sole cropping

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Intercropping evaluation
Land Equivalent Ratio LER

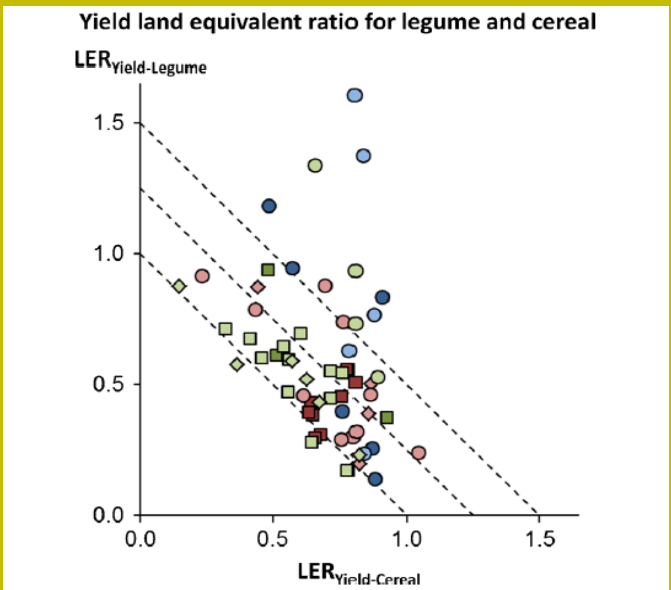
0.5 ha bean

0.5 ha wheat

1 ha 50%:50% wheat-bean intercrop

The yield is 27% greater than sole crops on 1 ha 50%/50% of area
LER= 1.27

Intercropping grain legumes and cereals in EU organic farming



Bedoussac, L. et al. 2015. Ecological principles underlying the increase of productivity achieved by cereal-grain legume intercrops in organic farming. A review. Agronomy for Sustainable Development 35(3), 911-935

Documented effects of intercropping of grain legumes and cereals in European OA

- Increased yield compared sole cropping of the two species on a similar area of land
- Enhanced use of ecosystem services, e.g. mineralized nutrients and biological N_2 fixation
- Improved use efficiency of light, water and nutrients
- Improved weed control compared to legume sole crop (SC)
- Reduced disease and pest development in crop
- Enhanced yield stability, resilience to stress and less risk in protein production
- Reduced potential for N leaching compared to legume SC
- Enhanced protein concentration and baking quality of cereals

e.g. Hauggaard-Nielsen, H., Jørnsgaard, B., Kinane, J., and Jensen, E.S. 2008. Grain Legume – cereal intercropping: The practical application of diversity, competition and facilitation in arable and organic cropping systems. Renewable Agriculture and Food Systems: 23, 3-12.

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

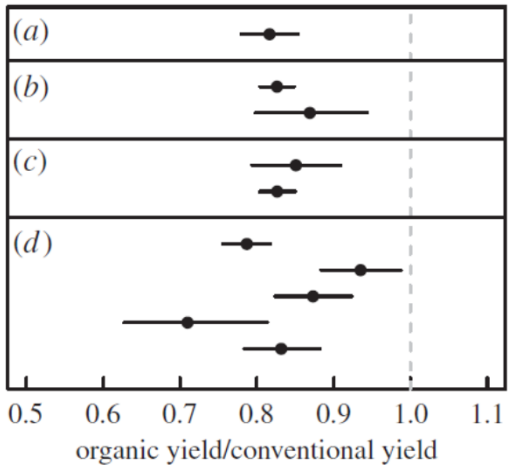
Table 4-5: Factors affecting the productivity of agroecological compared with intensive conventional systems

Output parameter	*Integrated*	*Organic*	*Agroforestry*
Yields per ha	0	-	+
Net system output (NSO)	0	-	+
Land equivalent ratio (LER)	0	-	+
Labour use efficiency	+	-/+	-/+
Input use efficiency	+	++	++

- = less than conventional, 0 = similar to conventional, + = higher than conventional

Lampkin, N.H. et al. 2015. The role of agroecology in sustainable intensification. Report of the Land Use Policy Group, Elm Farm, UK

Organic-to-conventional crop yields



overall (115, 1071)

annual (95, 995)
perennial (21, 58)

legume (19, 83)
non-legume (113, 970)

cereals (56, 559)
fruits and nuts (35, 158)
oilseed crops (24, 126)
roots and tubers (10, 28)
vegetables (19, 166)

Diversification practices reduce organic to conventional yield gap

Lauren C. Ponisio[1], Leithen K. M'Gonigle[1,2], Kevi C. Mace[1], Jenny Palomino[1], Perry de Valpine[1] and Claire Kremen[1]

Proceedings Royal Society, Dec. 2014

SLU
Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Table 4-7: Factors affecting the energy use and greenhouse gas emissions of agroecological compared with intensive conventional systems

Output parameter	*Integrated*	*Organic*	*Agroforestry*
Energy use for cultivations	-	+/-	-
Energy use for other inputs	0/-	--	-
Soil organic carbon	0/+	+	++
Above ground carbon sequestration	0	+	++
GHG emissions per ha	-	--	--
per unit product	-	0/+	--

- = less than conventional, 0 = similar to conventional, + = higher than conventional
Source: Own assessment based on literature presented in this section.

Lampkin, N.H. et al. 2015. The role of agroecology in sustainable intensification. Report of the Land Use Policy Group, Elm Farm, UK

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Table 4-9: Factors affecting the soil and water resource impacts of agroecological approaches compared with intensive conventional systems

Output parameter	*Integrated*	*Organic*	*Agroforestry*
Reduction of soil erosion	+	++	+++
Reduction of soil compaction	++	+	+++
Soil fertility improvement	+	++/-	++
Improved water quality	0/+	++	++/-
Flood mitigation	0	++	++
Improved drought tolerance	0	+	++

- = less than conventional, 0 = similar to conventional, + = higher than conventional
Source: Own assessment based on literature presented in this section.

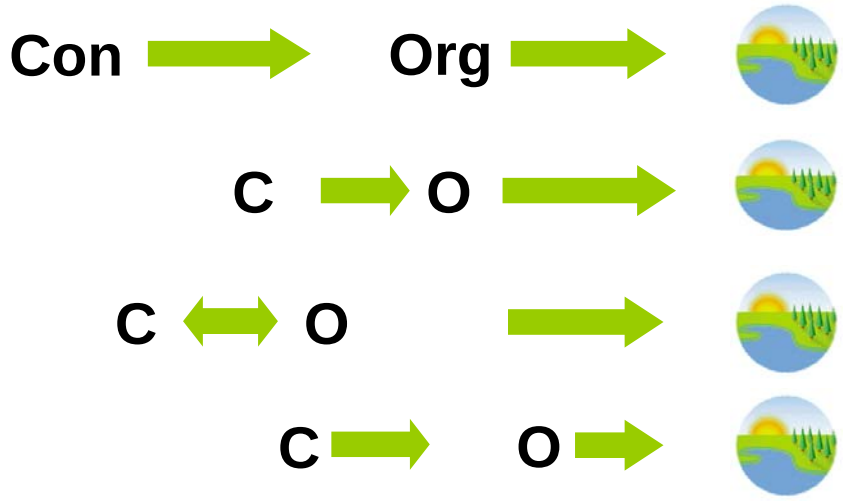
Lampkin, N.H. et al. 2015. The role of agroecology in sustainable intensification. Report of the Land Use Policy Group, Elm Farm, UK

Potentials of organic agriculture in the European context in sustainabe development of food systems

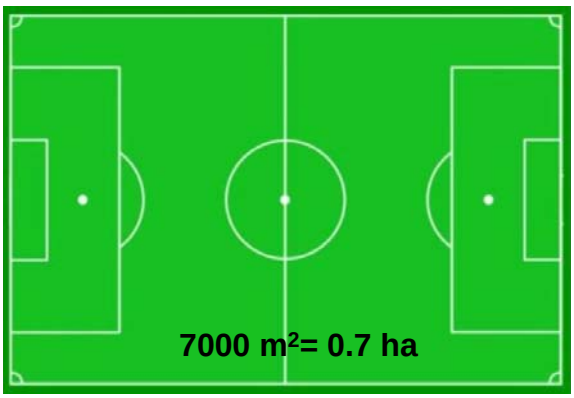
- Climate change - adaption and mitigation
- Reduced eutrophication of aquatic environments
- Reduced pesticide use
- Water availability and quality
- Fossil energy use and energy self-reliance
- Healthy and safe food
- Maintain biodiversity and improve soil health
- Food safety and sovereignty
- Animal welfare
- Recycling of nutrients from society to agriculture
- Rural development

Great potential Must be developed ?

Organic farming & agroecology as momenta for sustainable development of food systems



Diet and land requirement

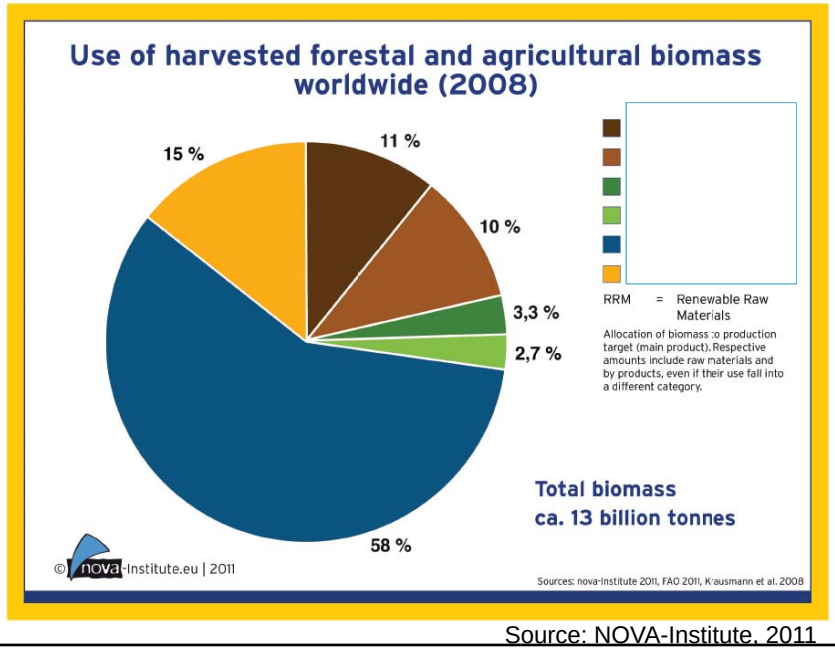


European avg.diet: 0.4-0.5 ha/person- c. 1.5 persons/

Vegetarian diet: 0.07 ha/person – c. 10 persons/

FAO

Making blue orange!



Source: NOVA-Institute, 2011


Intensification:
How to produce more food on a sustainable basis
with reduced inputs and minimal use of additional land?
Ecological, Sustainable or Eco-functional intensification?

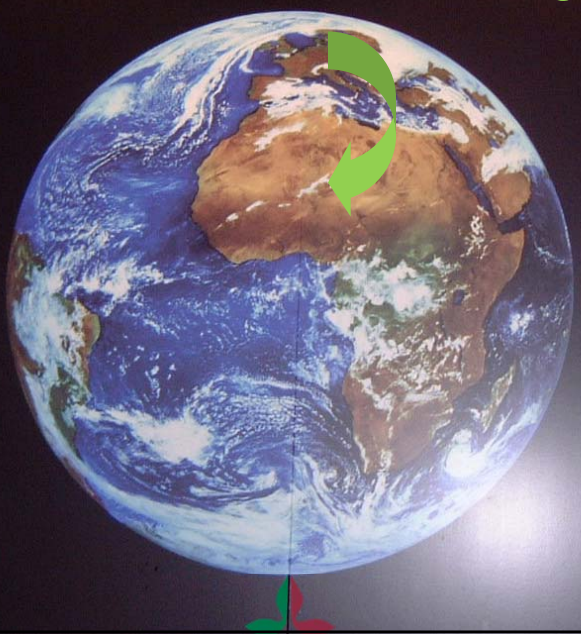

With a context of more than 85% of global farms
being smaller than 2 ha,
where to invest in future agricultural knowledge
science and technology ?

High-tech precision farming?

Photo: Bdk, Wikipedia

Lifting small-scale farmer knowledge?

Education and knowledge



SLU
Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Machinery and agroecology – some wishes

- Non inverting soil tillage
- Lighter machinery to avoid soil structural damage (“swarms”)
- Driven by renewable energy
- Sowing equipment for establishment of multispecies crops in different designs
- Advanced mechanical weeding
- Separation of several components on the combiner:
- cereal - grain legume – weed seed
- Sequential harvest of crops

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Conclusions-recommendations

Agroecological methods and organic agriculture offers framework and principles as momenta for sustainable and multifunctional development of agricultural systems

Educational focus on agroecology, including diets, all levels.

Policies for phasing out agricultural inputs with negative impacts (e.g. pesticides) and substitute with agroecology

Policies for payments for ecosystem services to stimulate agroecological methods and systems - consumers pay the real costs of present food systems (CC, eutrophication…..)

Stronger policies for ”healthy” eating

Improved information and knowledge exchange involving active participation of stakeholders from food systems and society in R&D for transformation of food systems

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Thank you for your attention
erik.steen.jensens@slu.se