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## "Ecological precision farming" - reintegrating spatial crop diversity and ecological principles in agricultural cropping systems?

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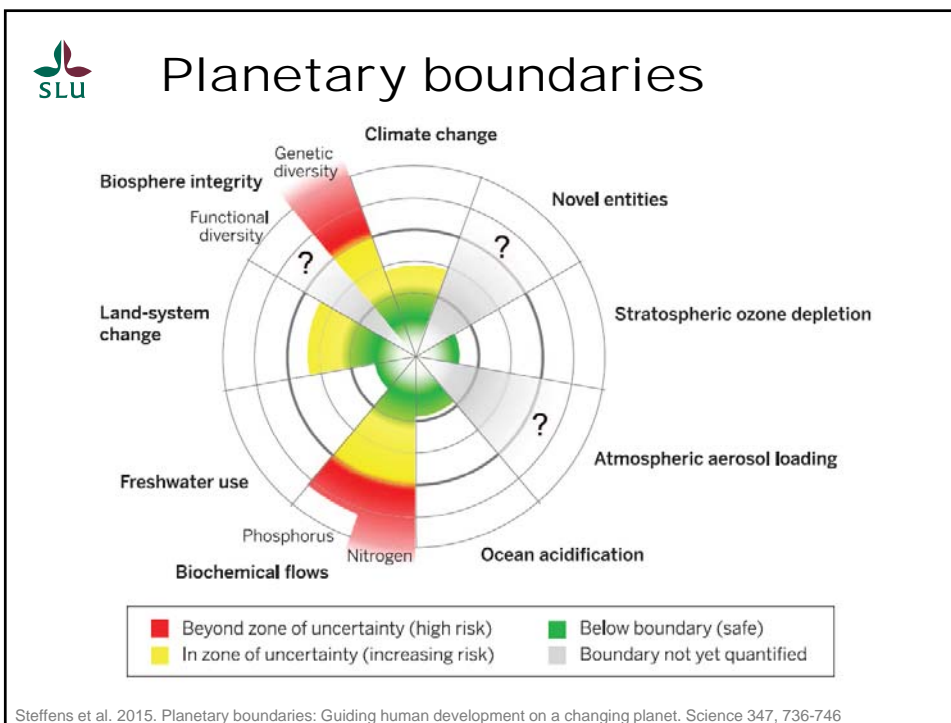
E. Justes, INRA, France



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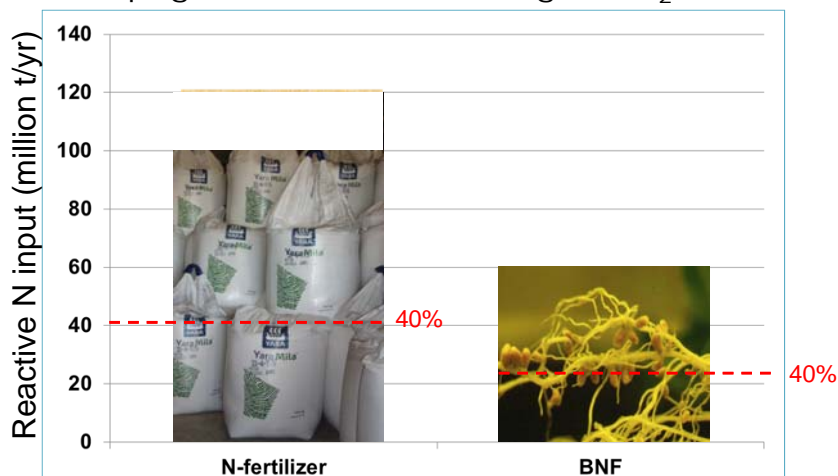


5th International ECOSUMMIT, Ecological sustainability. Montpellier, 29 Aug. – 1 Sept 2016. Session 40: Increasing species richness and genetic diversity in agriculture





## Global reactive N input from fertilizers and anthropogenic mediated biological N<sub>2</sub> fixation



Galloway, J. N. et al. 2008. Transformation of the N cycle. Recent trends, questions and potential solutions. *Science* 320, 889; Herridge, D.F, Peoples, M.B, and Boddey, R.M. 2008. Global inputs of biological N<sub>2</sub> fixation in agricultural systems. *Plant and Soil*, 311, 1-18

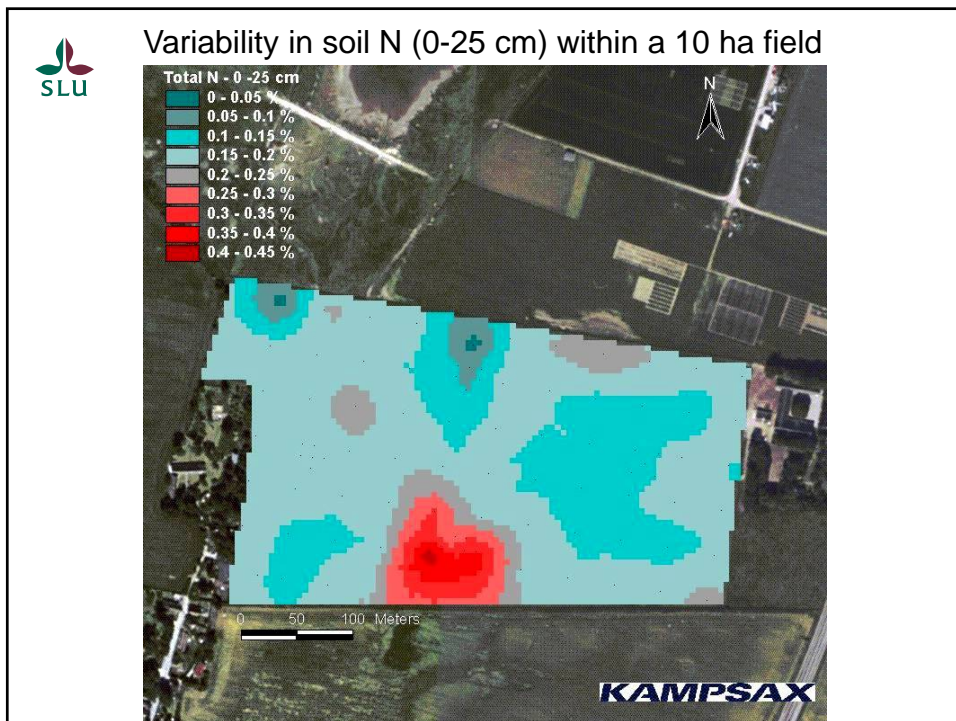


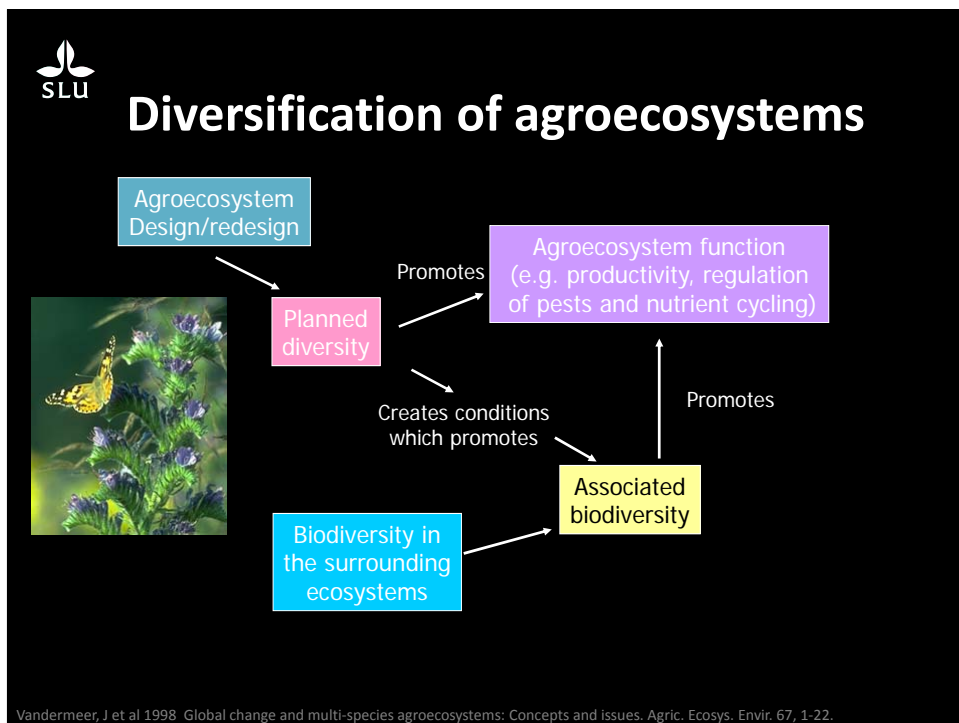
## Intensification Eco-functional Ecological Sustainable



- Farmer involvement in developing sustainable systems
- Increased yields with reduced use of external inputs
- Use of ecological principles and ecosystem services
- Agroecological practices
- Intentionally use functional agrobiodiversity at multiple and spatial scales

Pretty, J. N. 1998. The sustainable intensification of agriculture. *Nat. Res. Forum*, 21, 247-256. Cassman KG 1999 Ecological intensification of cereal production systems: Yield potential, soil quality and precision agriculture. *PNAS* 96, 5952-5959  
Niggli, U. 2008 Vision for an Organic Food and Farming Research Agenda to 2025, TPOrganics.







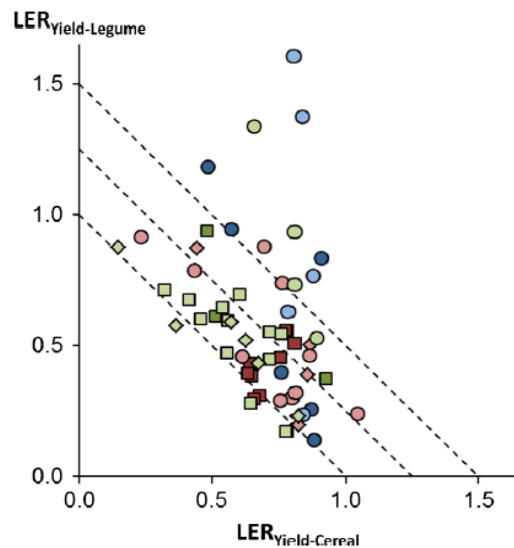
# Intercropping

We know from small plot experiments that:  
 differential canopy architectures, rooting depths,  
 growth patterns in time and space of species  
 mixtures/intercrops better match the availability of  
 light, water and nutrient sources and enhance their  
 use efficiencies as compared to sole crops

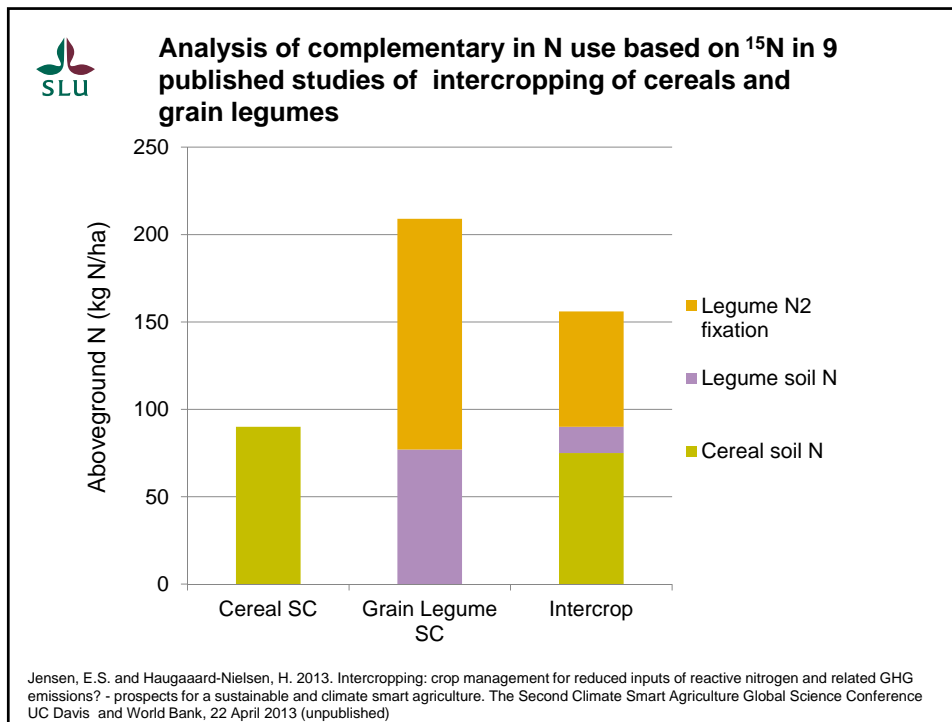



## Intercropping of grain legumes and cereals in European organic farming

Yield land equivalent ratio for legume and cereal



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

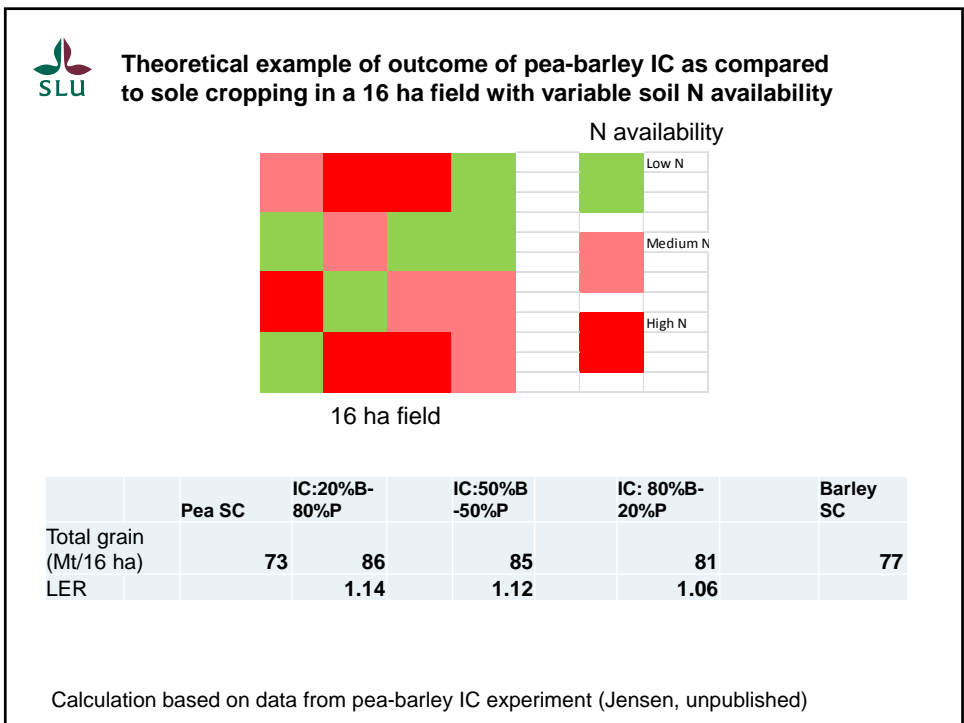
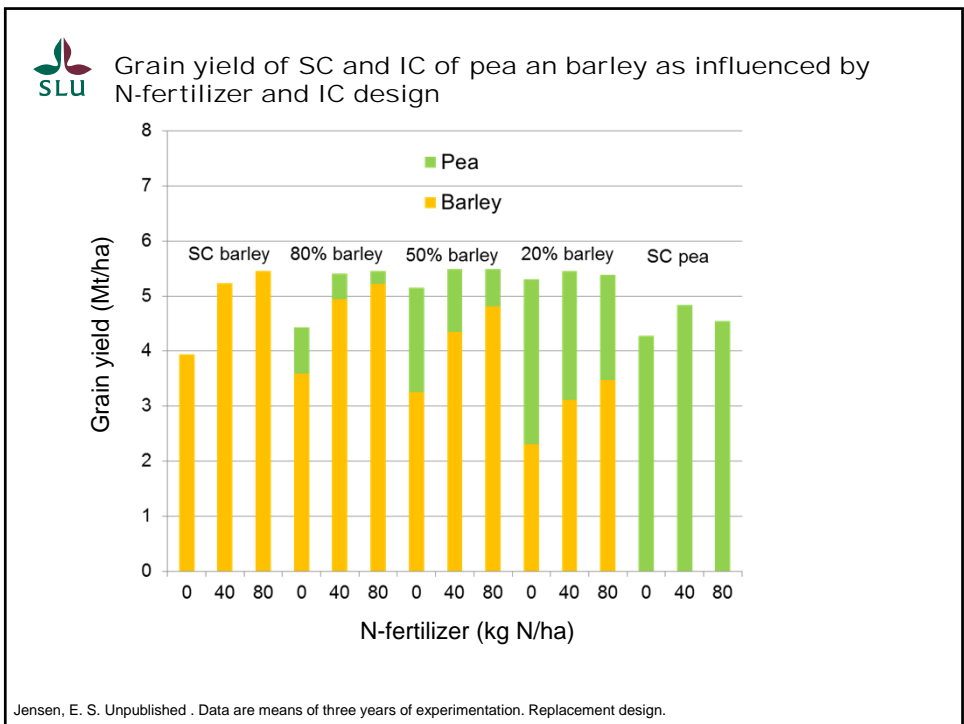


 **We propose the concept:**  
Ecological precision farming

**The variability of abiotic and biotic factors in a field determines the composition of a mixed crop/intercrop, due to competition, complementarity, facilitation and compensation between species, resulting in improved use of resources and greater/more stable yields as compared to sole crops.**

- **Example: N use by cereal-grain legume intercrops (low input)**
  - In parts of a field with more available soil N the cereal is more competitive and will use efficiently the available soil N
  - In parts with less available soil N, the legume will be more competitive and thrive to fix more N and add more residue N to this specific part of the field

Jensen, E.S., Bedoussac, L., Carlsson, C., Journet, E-P., Justes, E. and Hauggaard-Nielsen, H. 2015. Enhancing Yields in Organic Crop Production by Eco-Functional Intensification. Sustainable Agriculture Research 4, 42-50







## Conclusions

- Inter-/mixed cropping of grain legumes and cereals increase resource use efficiency, and
- delivers other services, e.g. weed and disease regulation, enhanced protein conc. of cereals, .....
- Ecological precision farming (EPF) may be a method for eco-functional intensification on heterogeneous land, to make the most efficient use of resources and enhance and stabilize yields.
- The EPF concept should be validated in empirical experiments and modelling including several growth factors.



Thank you