Research Institute of Organic Agriculture
Forschungsinstitut für biologischen Landbau
Institut de recherche de l’agriculture biologique

Higher accuracy in N modeling makes a difference

Matthias S. Meier, Niels Jungbluth, Franziska Stoessel, Christian Schader and Matthias Stolze

LCAfood 2014

This project is supported by the
Coop Sustainability Fund.

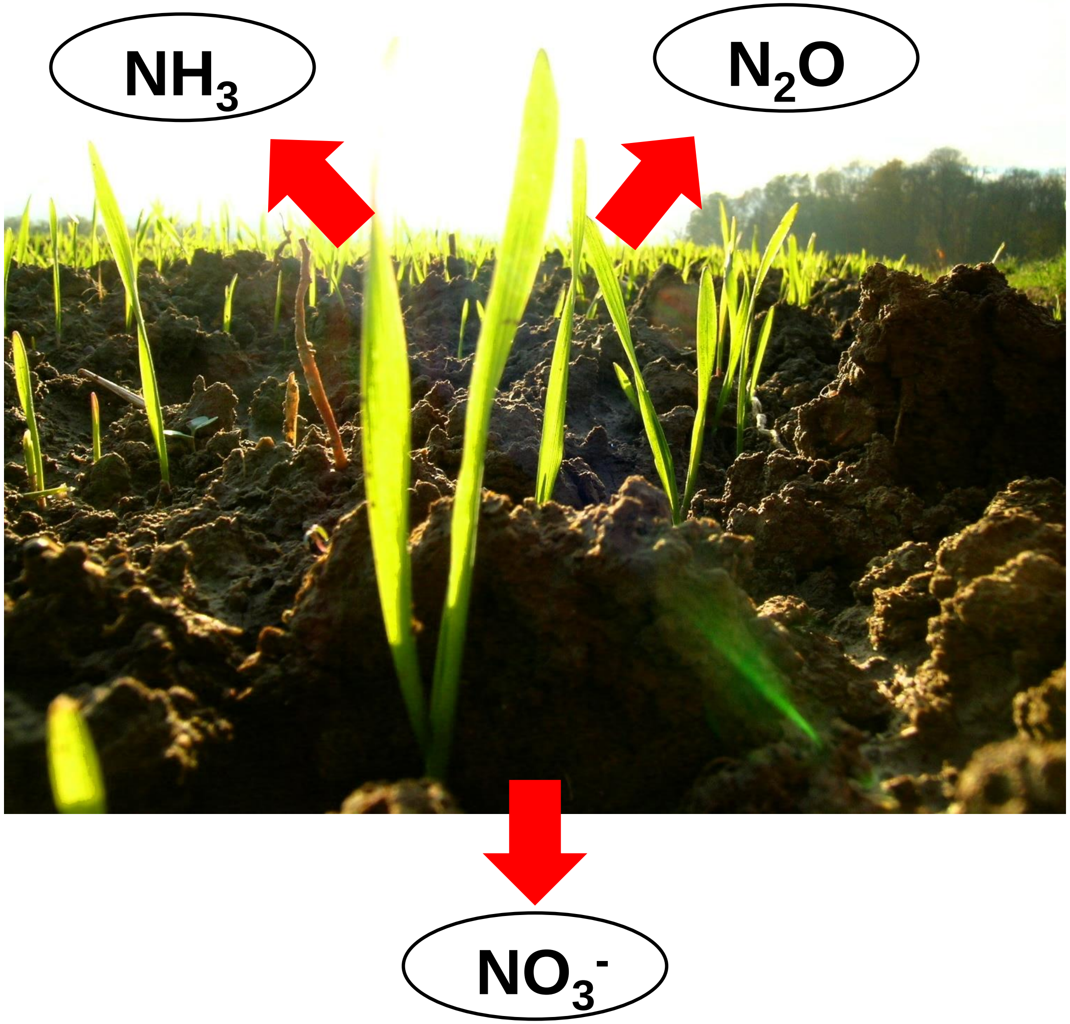
Nitrogen – relevance in agriculture and for the environment

→ Nitrogen is the 5th most abundant element in our solar system!

→ Nitrogen is a limiting factor for primary productivity in agriculture!

→ Nitrogen emissions affect global warming, eutrophication, acidification, and biodiversity!

N-emission modeling of agricultural processes



- NH_3-, N_2O-, and NO_3^--emissions in crop production modeled on the basis of fertilizer N-input.

NH_3-N + N_2O-N + NO_3^--N

=

N-surplus (???)

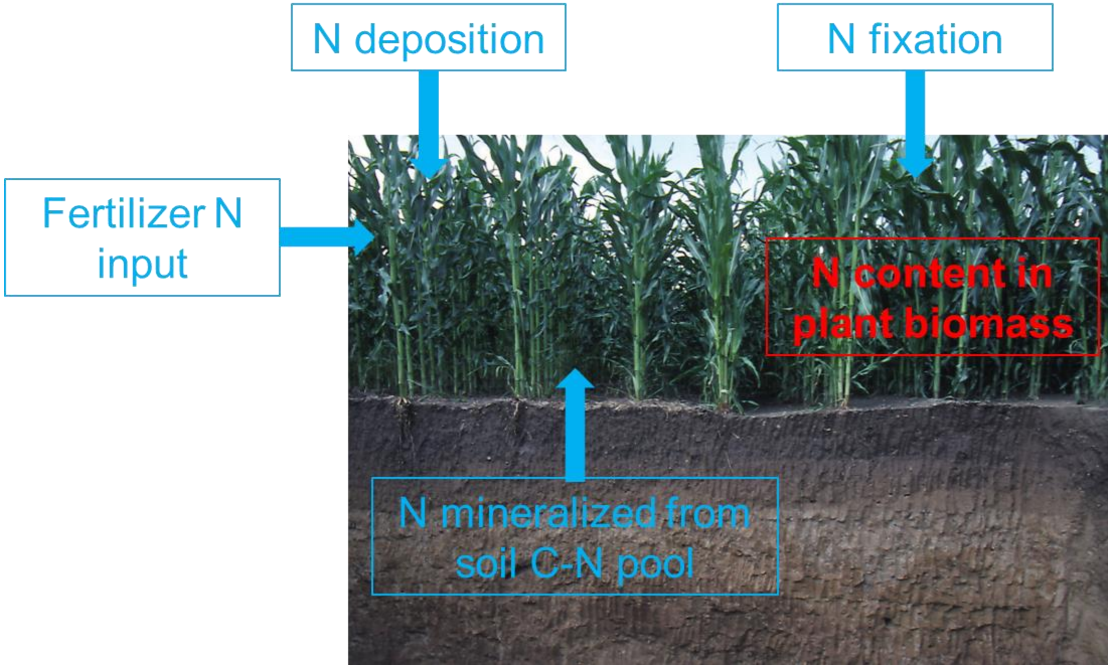
↓

Law of conservation of mass is often violated!

How to solve this problem?

Match N-emissions with N surplus:

∑ (N inputs) - (N content in plant biomass) = **N surplus**



N deposition

N fixation

Fertilizer N input

N content in plant biomass

N mineralized from soil C-N pool

- → Relates N emissions to total N turn over in crop production and not just to fertilizer N input.
- → Especially relevant where crop production in different farming systems is assessed!

Procedure

1. Analyses of ecoinvent v2.2 inventories of 4 different crops available for organic and integrated production (IP):
   - Wheat grains
   - Barley grains
   - Soy beans
   - Potatoes
2. Remodeling of N emissions from crop cultivation (N_2O, NH_3, NO_3^-)
3. Comparing impact assessment (global warming, eutrophication, acidification) before and after remodeling N emissions (using EDIP2003).

Procedure – N emission modeling

1. NH_3 emissions → emission factor model based on total applied ammoniacal nitrogen (organic fertilizers) and total applied nitrogen respectively (mineral fertilizers).

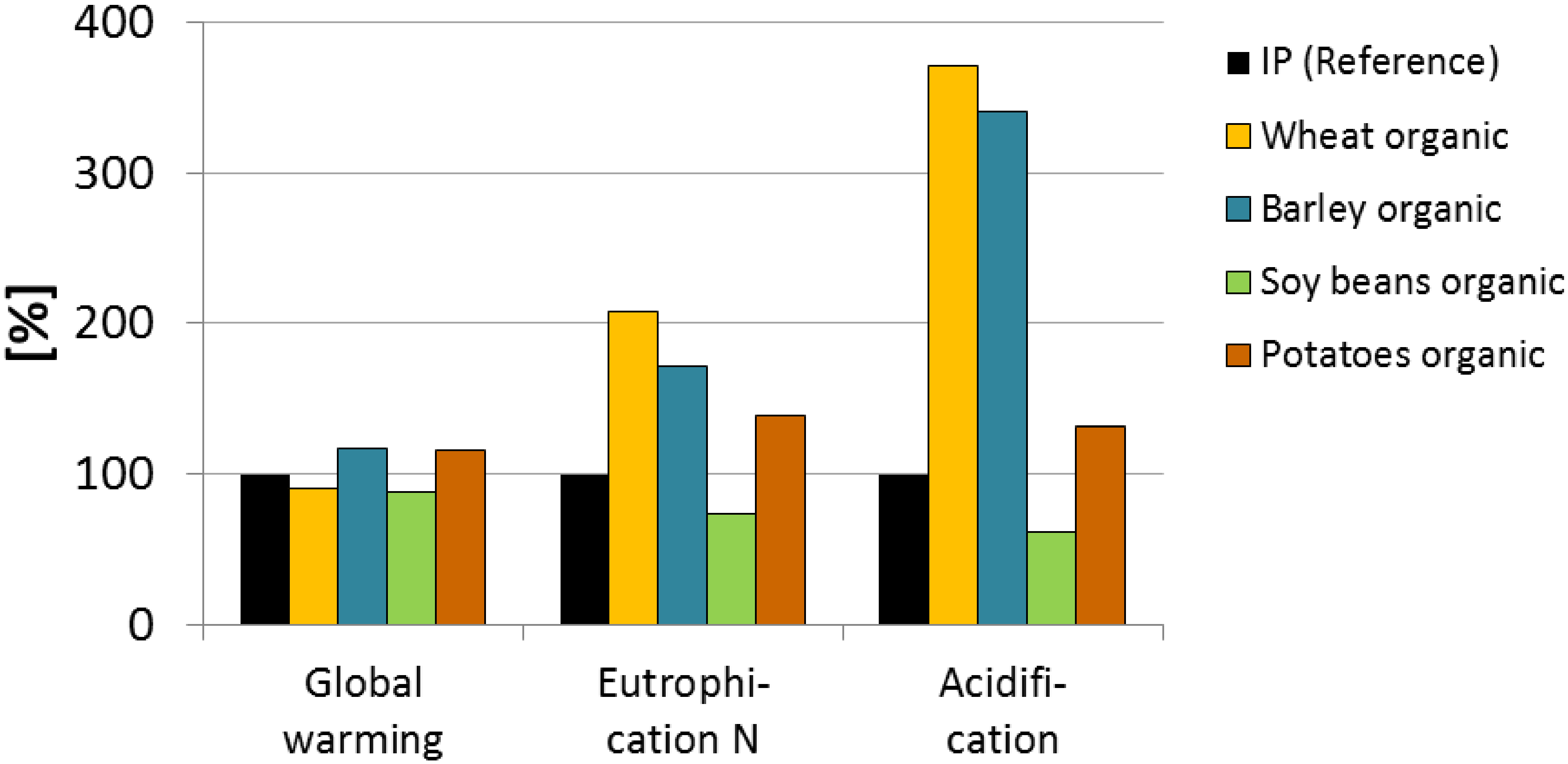
2. N_2O emissions → IPCC emission factor model considering management induced changes to the soil N pool (Meier et al. (2012) and Brock et al. (2012))

3. NO_3^- emissions →
   (N surplus) – (NH_3-N) – (direct N_2O-N) + (NO_3^- -N plant residues)

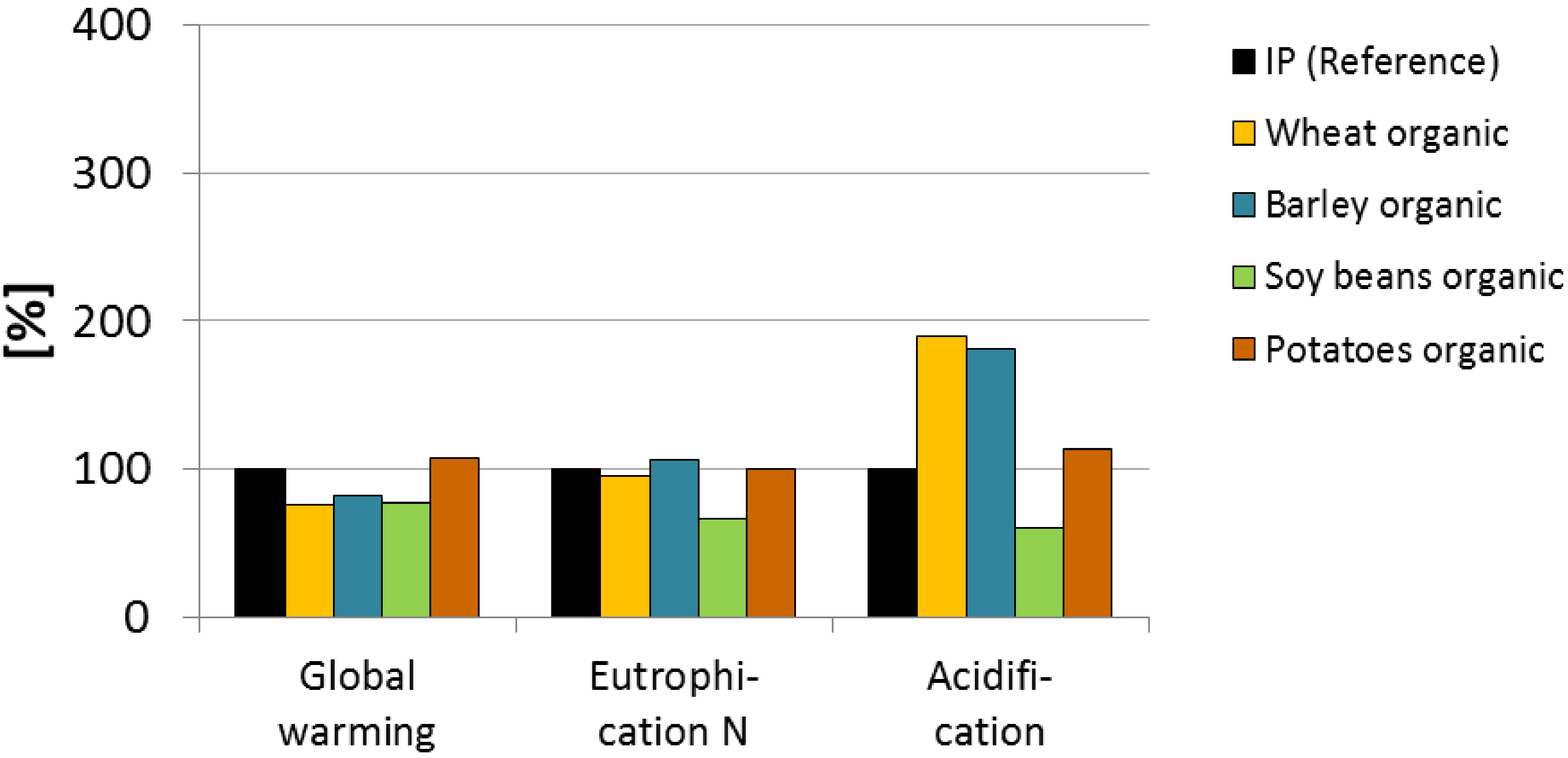
Results – N surplus

	Wheat organic	Wheat IP	Barley organic	Barley IP	Soy beans organic	Soy beans IP	Pota-toes organic	Pota-toes IP
«N surplus» in original ecoinvent inventories [kg N/ha]	**121**	**86**	**119**	**107**	**51**	**54**	**81**	**77**
N input from fertilizers [kg N_{tot}/ha]	122	143	98	121	20	27	84	127
N input from fixation [kg N/ha]	0	0	0	0	144	150	0	0
N input from deposition [kg N/ha]	25	25	25	25	25	25	25	25
N mineralized from soil C-N-pool [kg N/ha]	35	134	13	69	49	48	2	23
Sum N inputs	**182**	**302**	**136**	**215**	**238**	**250**	**111**	**175**
N content in plant biomass [kg N/ha]	136	230	99	159	220	230	89	137
N surplus from N balance [kg N/ha]	**46**	**72**	**37**	**56**	**18**	**20**	**22**	**38**

Results – Impact assessment of original ecoinvent processes



Results – Impacts after remodeling N emissions



Conclusions

- Calculating N emissions based on the actual N flow in crop production leads to a more precise differentiation of impacts for global warming, eutrophication, and acidification.

- Higher accuracy in N modeling from fertilization helps to improve the differentiation of environmental impacts of products from different agricultural systems such as organic and conventional agriculture.

Acknowledgement

- This study is part of the research project „Improving LCA methodology to comprehensively model organic farming".

- Funded by:

This project is supported by the
Coop Sustainability Fund.

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and

the Federal Office for the Environment (FOEN), Switzerland.