

Options to decrease N losses from our global food system

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Content of this presentation

- Goals
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- Conclusions

Goals

- Analysis of the food system for current and future scenarios in the context of planetary boundaries^{1,2}
- Exploration of effective interventions in the food system for guidance towards a safe operating space^{1,2}
- Comprehensive understanding of the trade-offs and synergies when combining multiple measures to multiple targets

1) Rockström et al., 2009. Planetary Boundaries: Exploring the Safe Operating Space for Humanity. *Ecol Soc* 14.

2) Steffen et al., 2015. Planetary boundaries: Guiding human development on a changing planet. *Science* 347.

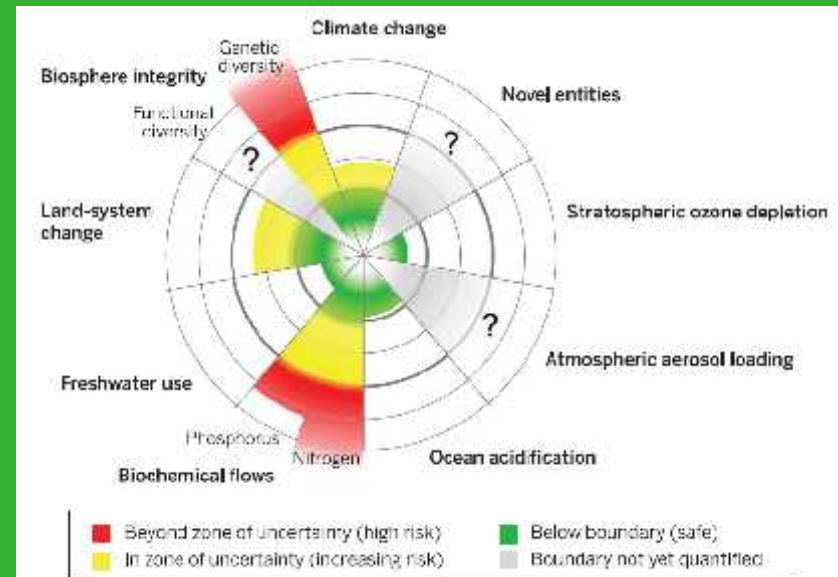
Planetary boundaries?

- PB framework defines a safe operating space for humanity
 - Earth system processes (nine) and
 - Control variables (1 or 2 for each Esp) and
 - Limits = PB

Steffen et al., 2015. Science 347

- In our food system study:
 - Climate change
 - Land-system change
 - Biochemical flows of N and P

- This presentation: N loss



- We developed a quantitative model to calculate
input requirements (land, N and P fertilizer) and
associated emissions (GHG, N and P losses/wastes)
as a function of food demand (~ # people, intake/cap & diet_%)
- **BIOSPACS**: **B**alancing **I**nputs and **O**utputs for the **S**ustainable
Production of **A**gricultural **C**ommoditie**S**.

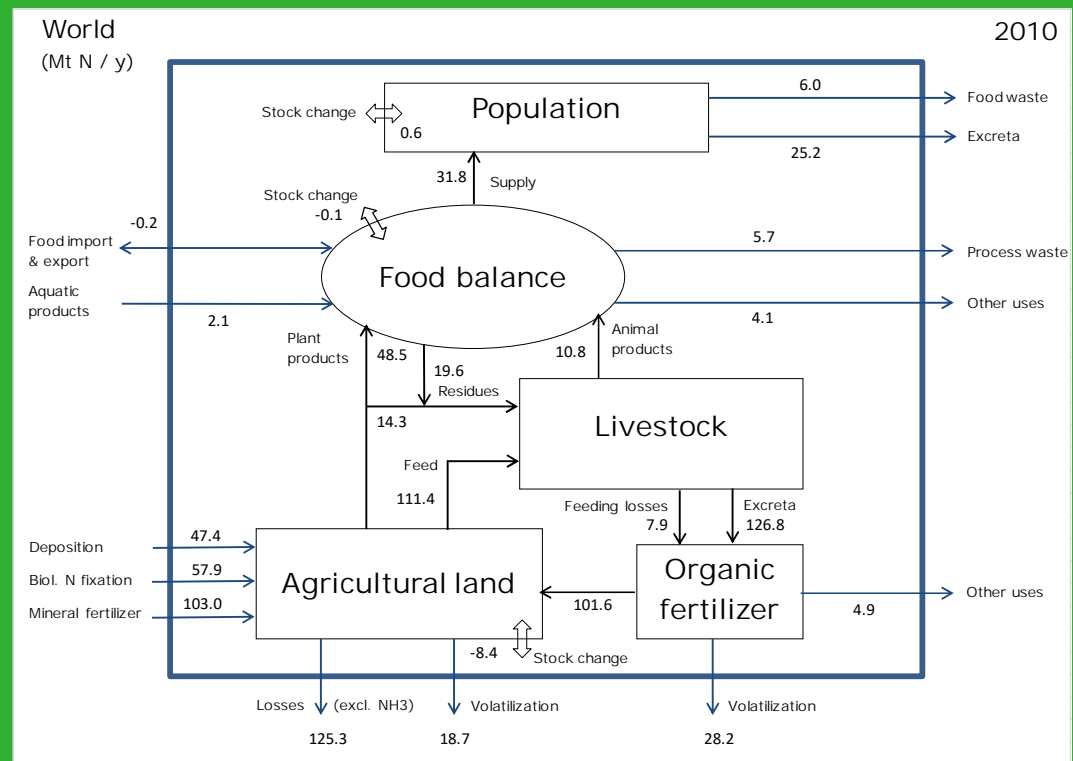
- We distinguish 5 major domains in BIOSPACS,
 1. Agricultural land > Grassland and cropland
 2. Organic fertilizer > Animal manure and feeding loss
 3. Livestock > Bovine, sheep/goats, pig and chickens
 4. Food balance > 20 food groups (plant, animal, aquatic)
 5. Population > Intake and waste in households

- and parameterised their main input – output relations, including their interactions

- Parameterisation is based extensively on data from FAOSTAT (global; 2010) and on additional parameters from literature
 - Land resources and crop production
 - Manure distribution and fertilizers consumption
 - Food Balance Sheets (per capita supply)
 - GHG emissions, etc.
- After parameterisation we applied the model for 2010 and verified that the results were consistent with the FAOSTAT data used for the parameterisation

Results for 2010

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Results for 2010

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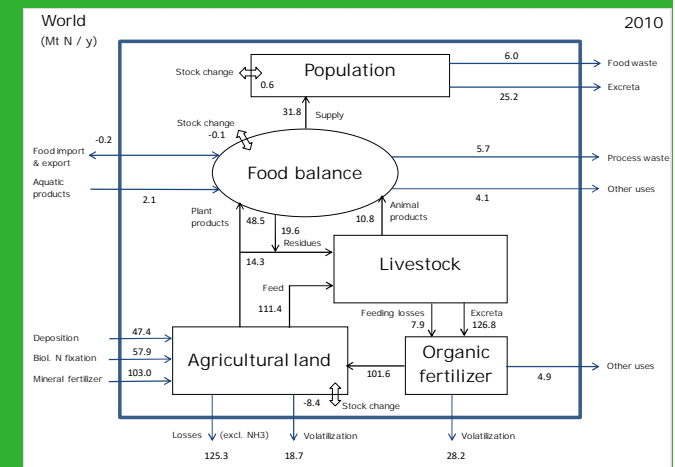
■ Some highlights

>80% of total harvested N from soils
→ production of animal-based food items

1/3 mineral fertilizer, 1/3 organic fertiliser & 1/3 (AD + BNF)
→ total N input into soils (ca. 300 Mt N / y)

~40% of total N input into soils
→ non-NH₃ loss from soils

~12% of total system N input
→ actually consumed
(210 Mt / y → 26 Mt / y)



Results for 2050 (ref. scenario)

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- Results for +60% food demand, due to 43% more people and 12% higher per capita consump. in 2050 (ref. scen.)
 - +45% for plant products and +75% for animal products
→ due to changed diet in 2050 (projected)
 - +78% N excretion by livestock
→ more available
 - +76% mineral N fertilizer
→ more required
 - +70% of total N loss from
→ agri. soils and NH_3 volat.

- Future scenarios and measures

Code	Description
2010	The current state in 2010.
2050	Reference scenario for 2050 with +60% food demand
+Waste	50% reduction in the waste fractions
+Diet	50% reduction in supply shares of animal-based products
+Feed	25% improvement in the feed conversion ratios.
+Yield	50% increase in biomass yields of all crops and grassland
+Volat	50% reduction in NH ₃ volatilization (manure and fertilizer)
+Loss	50% reduction in the soil loss fractions of N and P
+All	All above measures simultaneously.

Results for 2050 (measures)

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- Focus on N loss, because

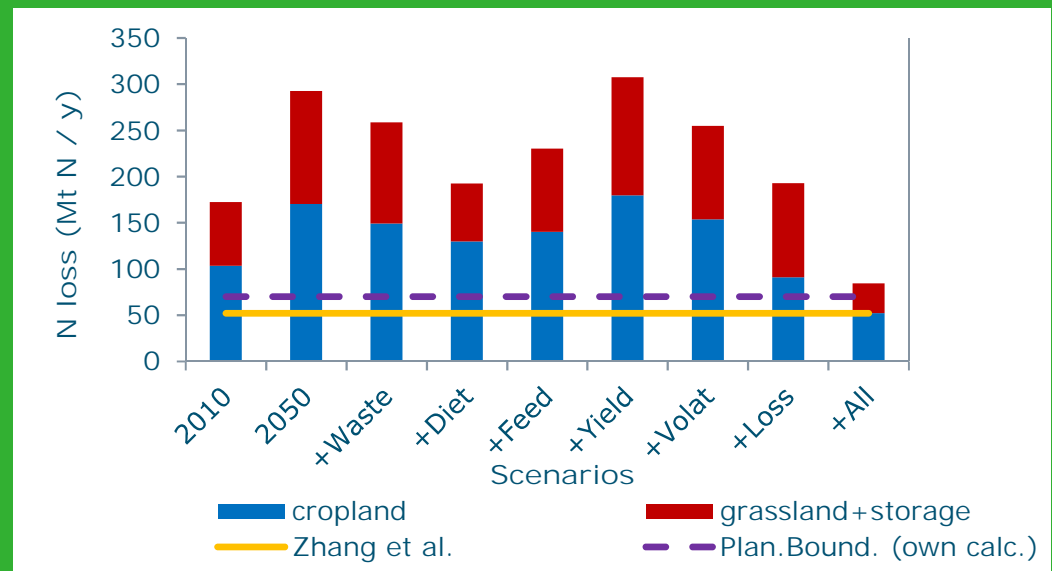
Lost (reactive) N in the environment = problem

Legislation is (often) based on environmental quality targets

Cro-Gra: 60–40%

+All ~ 52 Mt/y

+All > 70 Mt/y



N loss from agri. soils and NH₃ volat. (83 – 307 Mt/y)

Results for 2050 (measures)

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- We computed the N loss ratio (N loss / Food N supply)

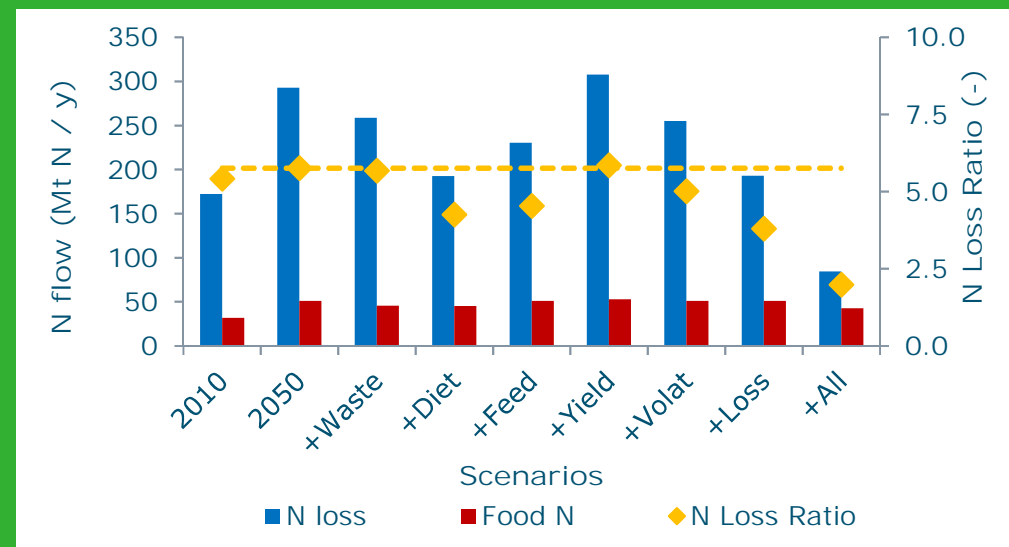
Nr footprint (kg N/kg N)

$$\text{NLR} = [1/\text{NUE}] - 1$$

- Food N supply = available for popul. (intake + waste)

→ 2010: 32 Mt/y

→ 2050: 42 – 53 Mt/y



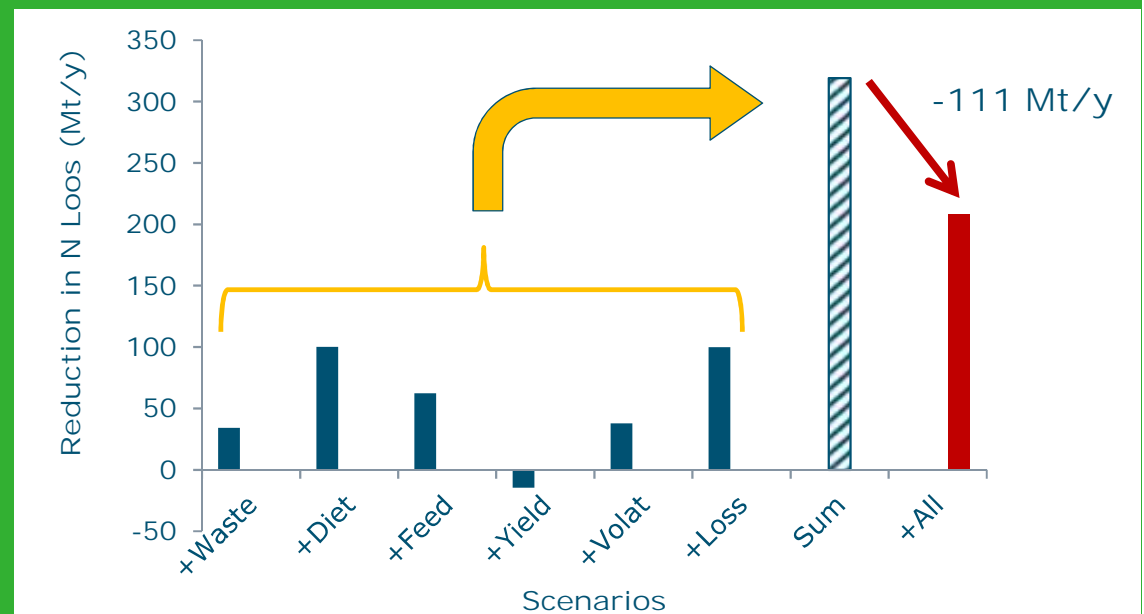
Results for 2050 (measures)

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- The sum of the effects of single measures overestimates the actual potential of combining all measures.

Sum = 319 Mt/y

+All = 208 Mt/y



Conclusions

- Single measures are insufficient and we need a combination of measures to substantially reduce N loss and NLR.
- Only a comprehensive analysis can prevent overestimation when single measures are analysed and summed.
- Improving grassland / manure management has a large potential to reduce N loss.
- NLR is a useful indicator for guidance towards environmental targets, better than NUE (?)

Thank you for
your attention

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Food N in 2050



Food N + N loss (All measures)



Food N + N loss (single measure)



Food N + N loss (no interventions)