Water related trade-offs of different crop production schemes for biogas production in a German case study

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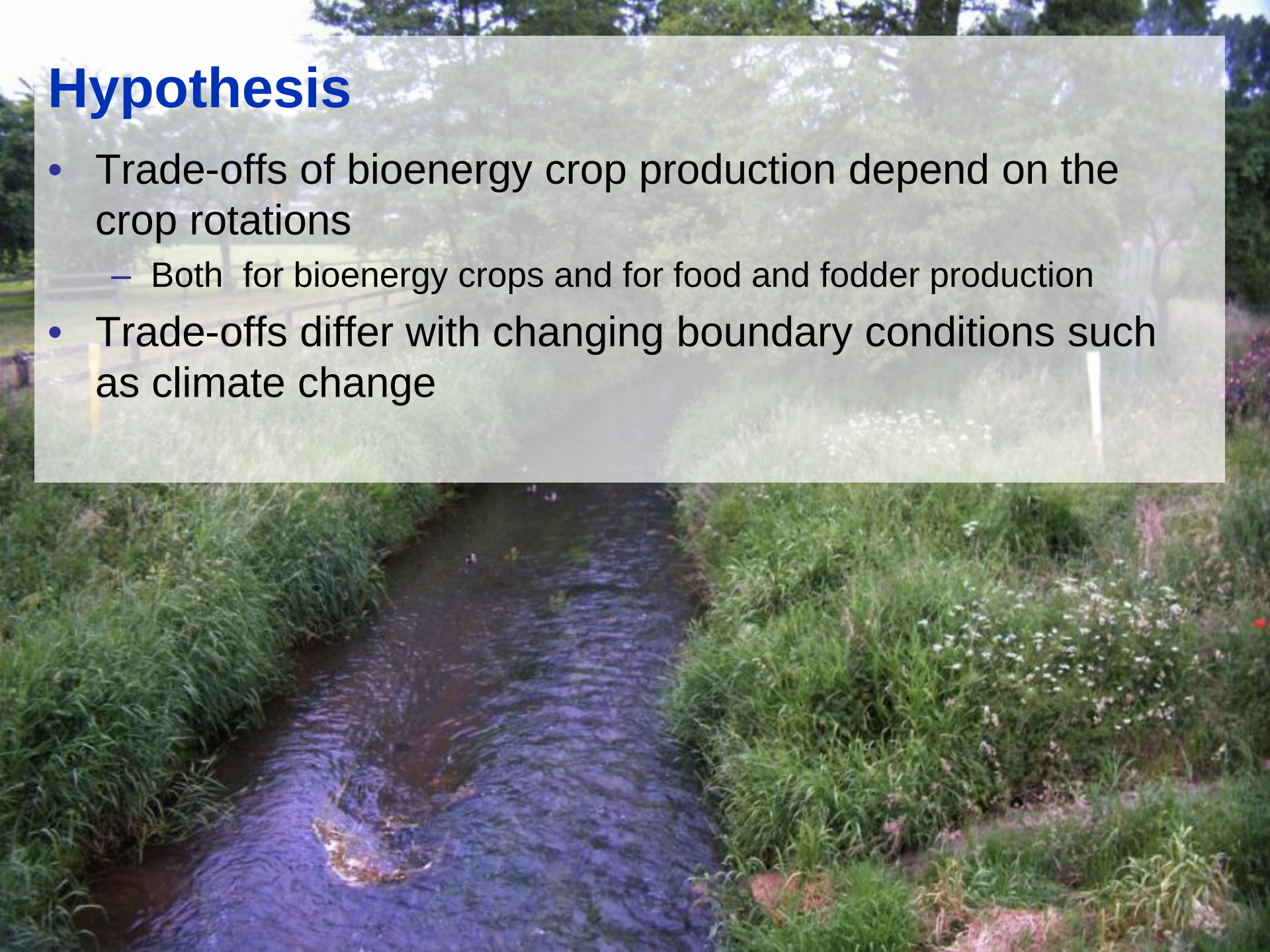
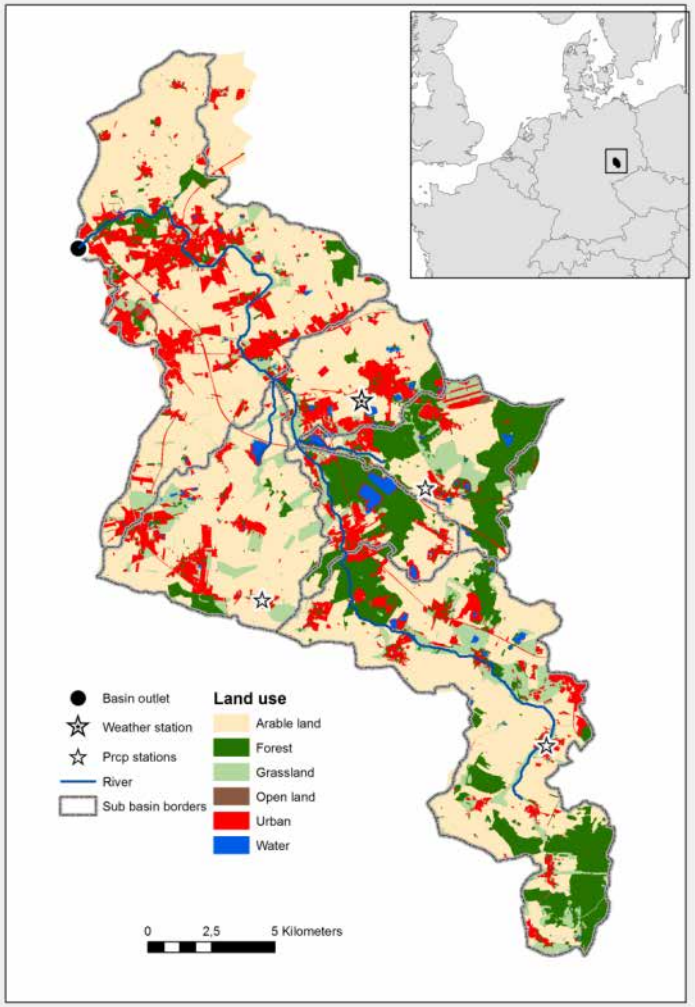
Hypothesis

- Trade-offs of bioenergy crop production depend on the crop rotations
  - Both for bioenergy crops and for food and fodder production
- Trade-offs differ with changing boundary conditions such as climate change



The study area: Parthe watershed



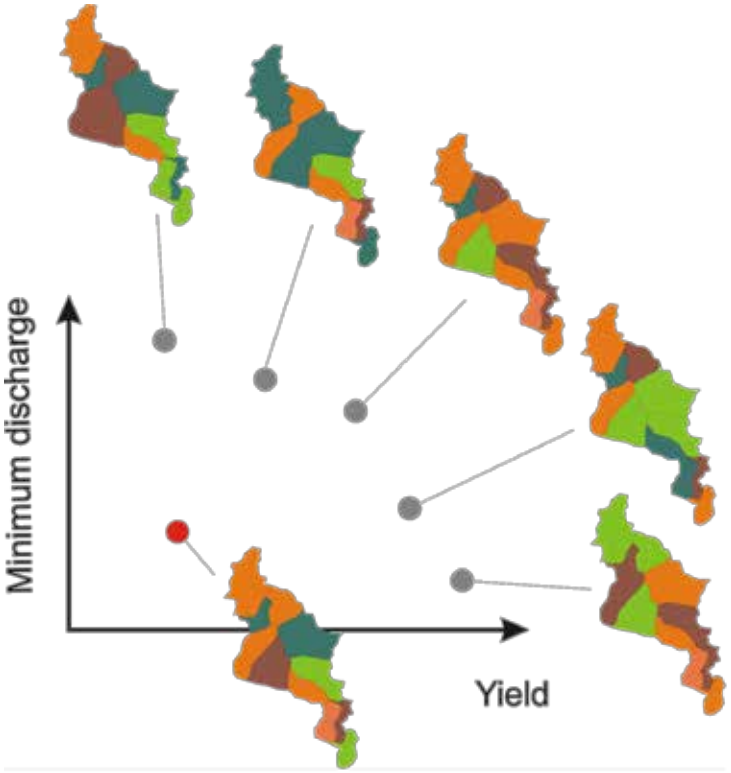
- **Area:** 315 km²
- **Topography:** Flat (106 m and 230 m a.s.l.)
- **Precipitation:** 590 to 640 mm/a (1981-2000).
- Typical lowland river.
- **Runoff dynamics:**
  - High flows in spring (snow melt and rainfa
  - Low flows in summer with occasional stor

  flow events.
- **Water use:** Drinking water provisioning

Trade-offs

- What are the searching for? -

- How much do we gain in goal A if we decrease goal B?
- Functional relationships between different goals?
  - How does water quality change with increasing bioenergy crop production?
  - Does it depend on the crop rotations used?
  - How is this effected by climate change?



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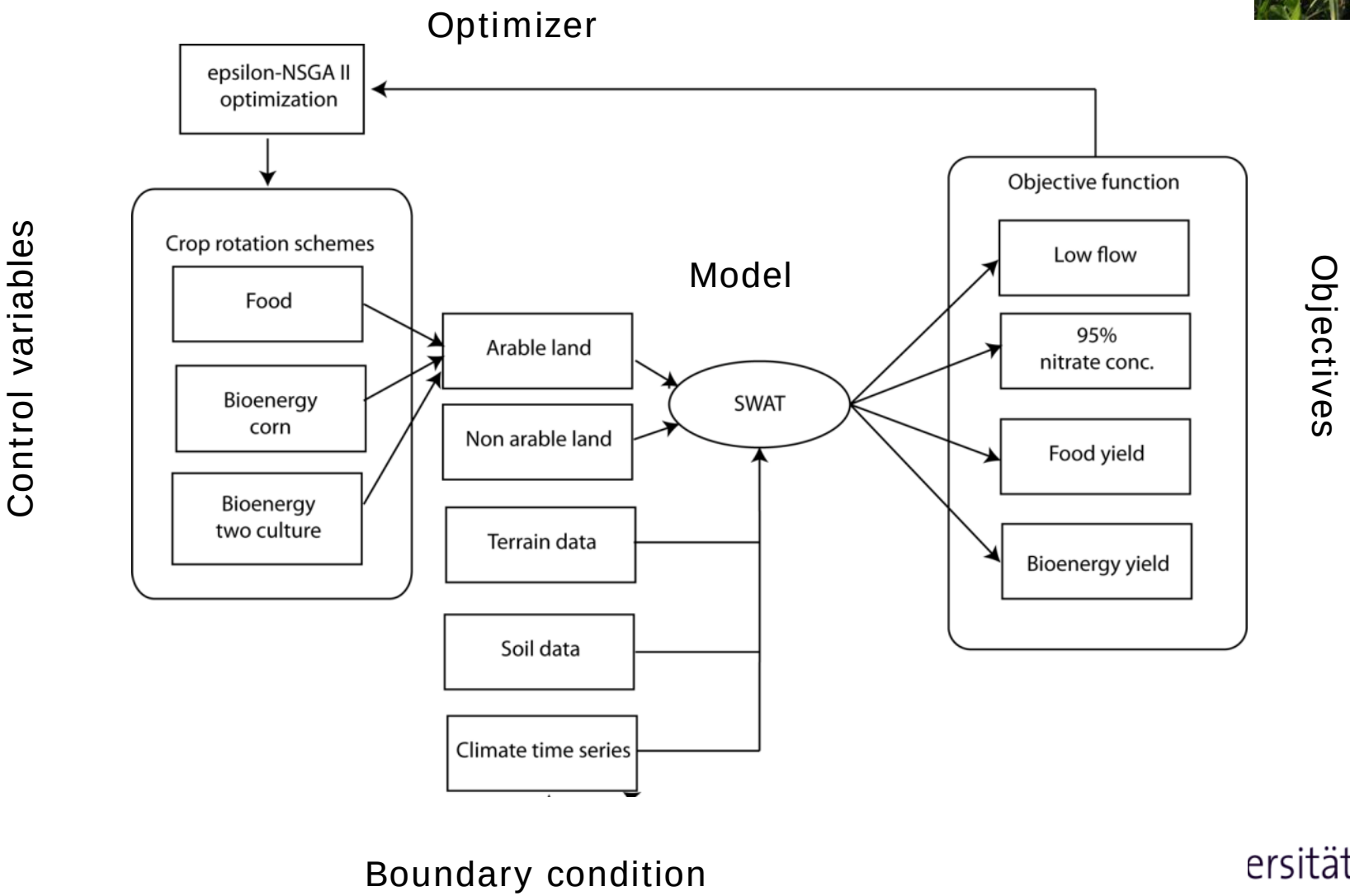
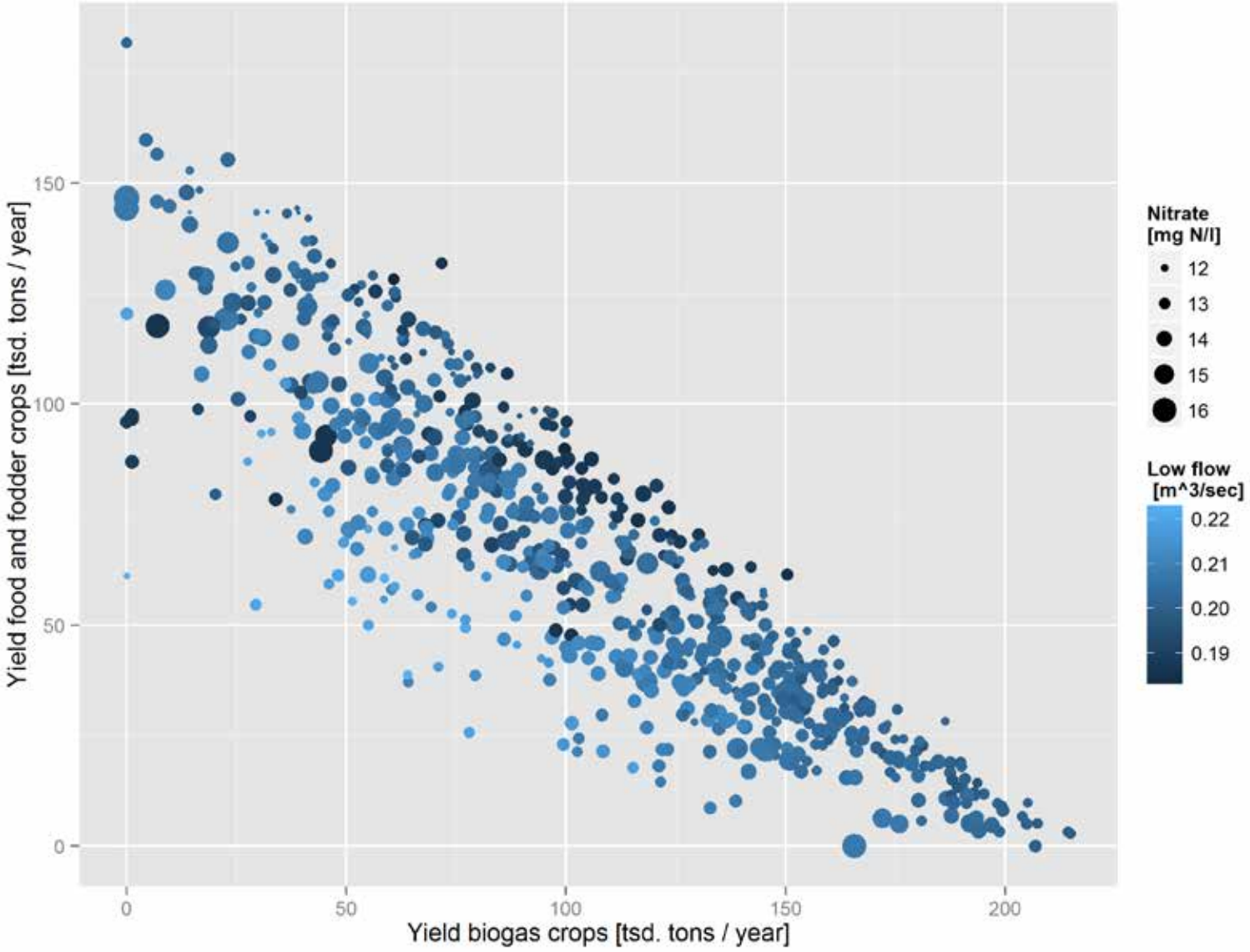
Trade-offs

- Analysis framework -



Optimization results



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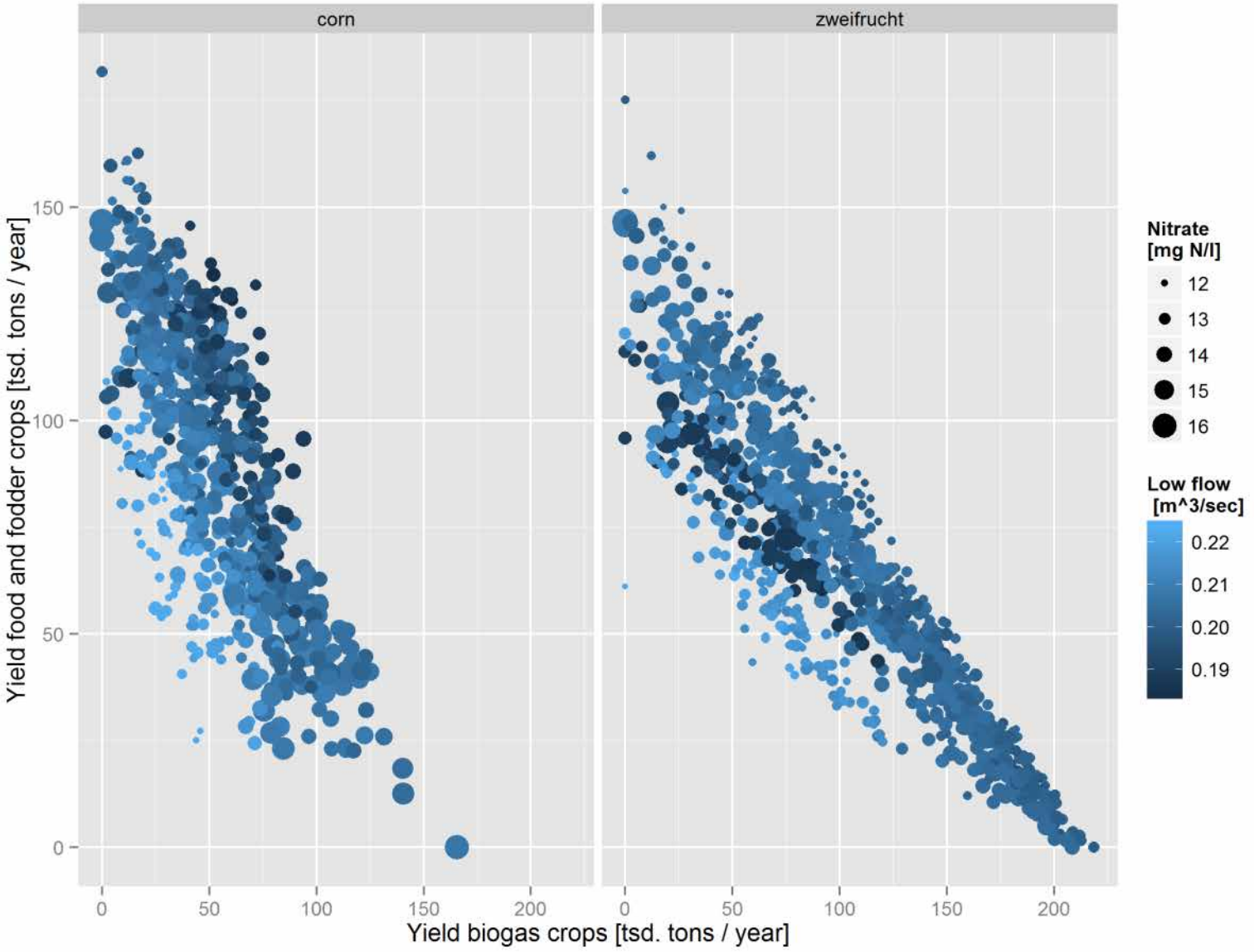
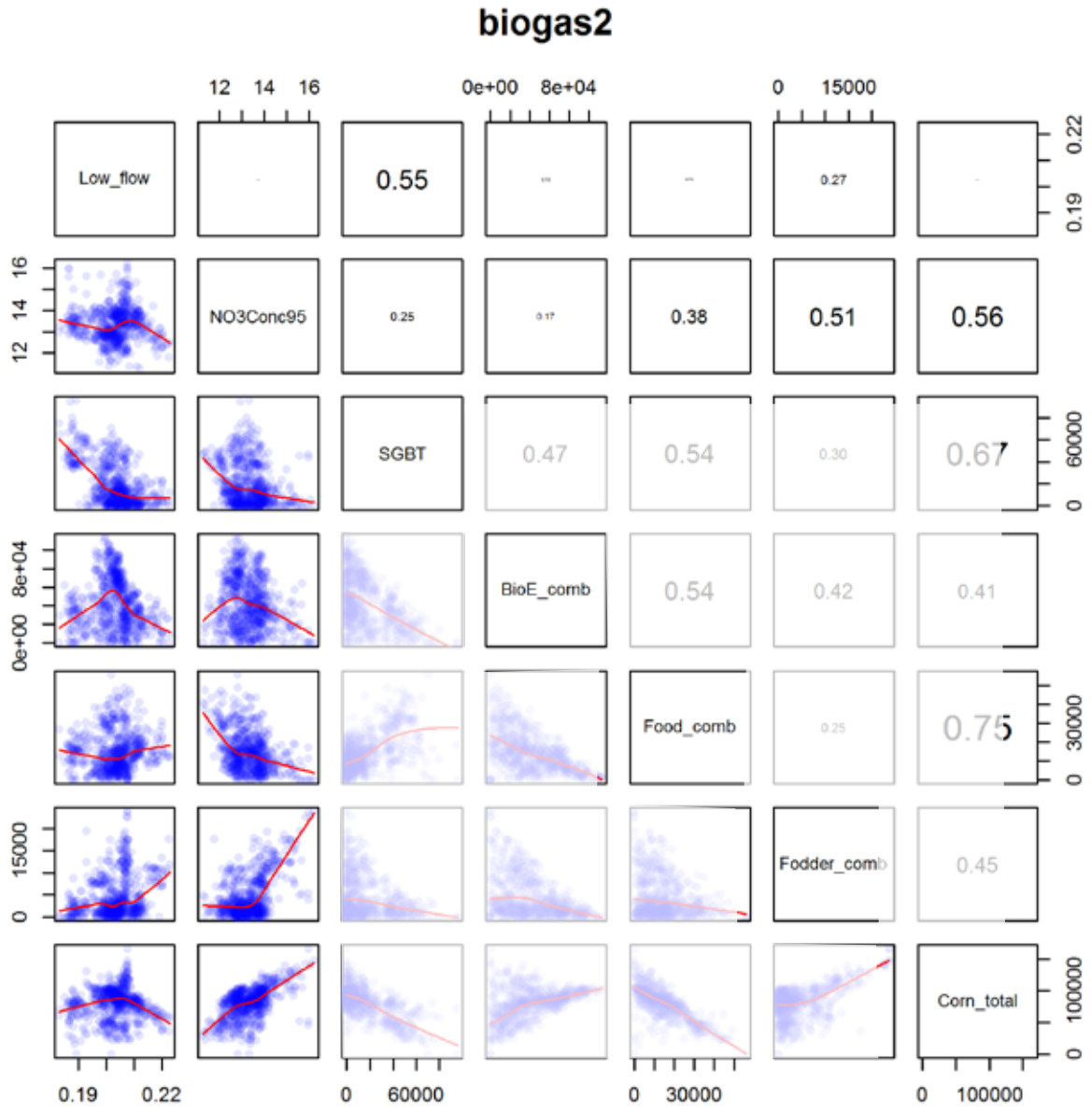
Optimization results



What is the effect of the different crops?



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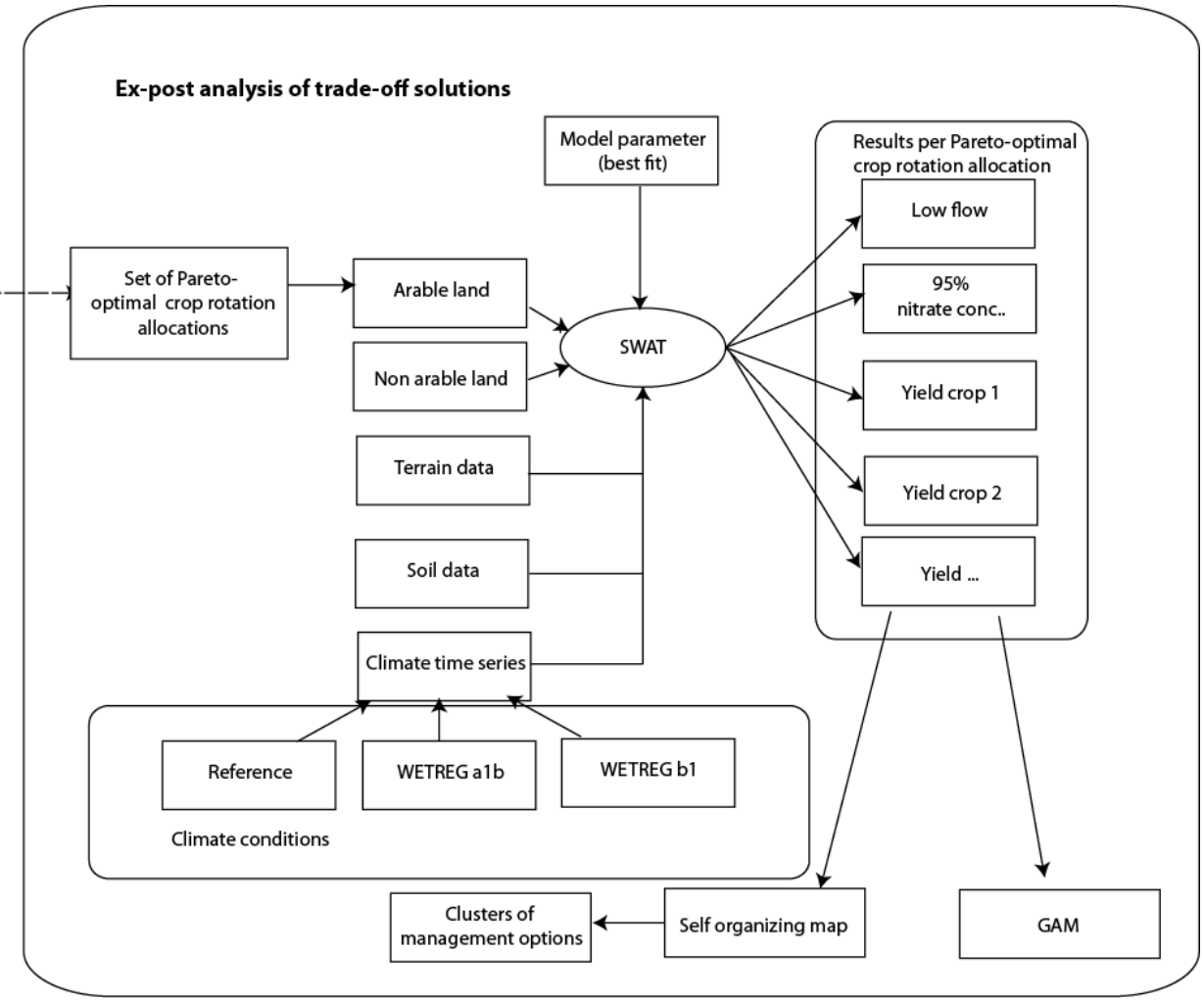
Simplifying the complexity



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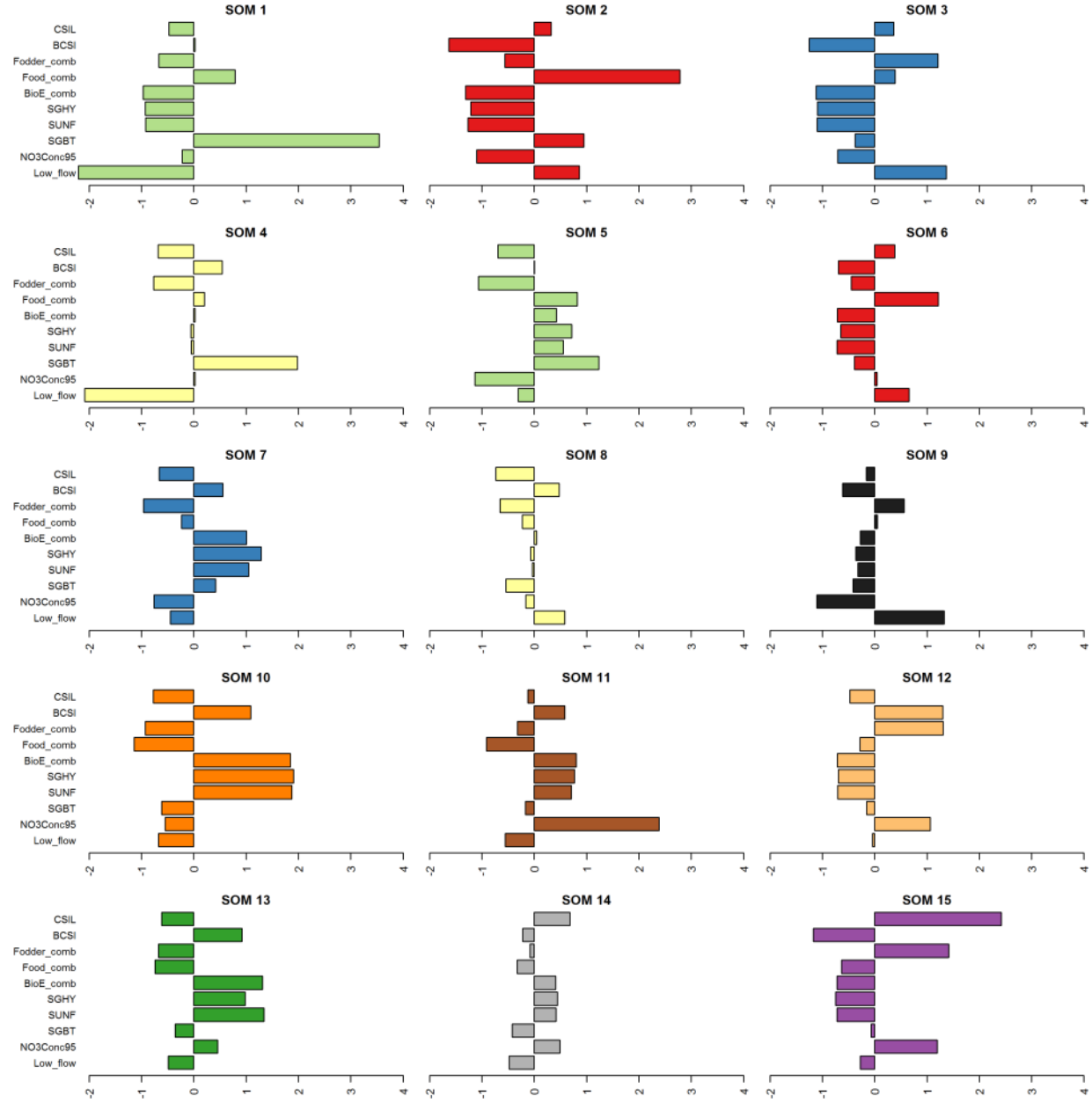
Cluster centers - scaled



CSIL
BCSI
Fodder_comb
Food_comb
BioE_comb
SGHY
SUNF
SGBT
NO3Conc95
Low_flow

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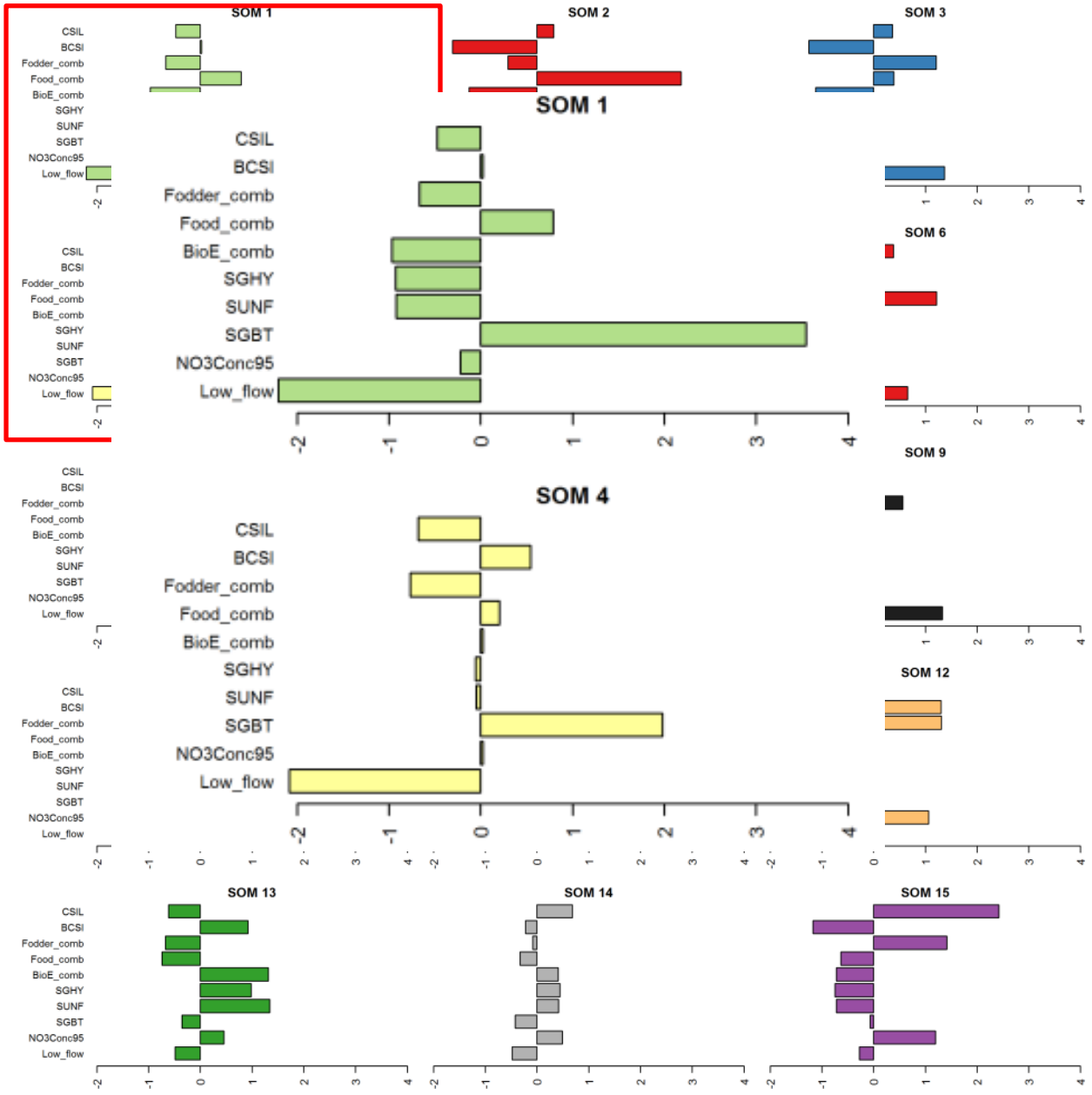
Cluster centers - scaled



Sugar beets ++
Low flow --

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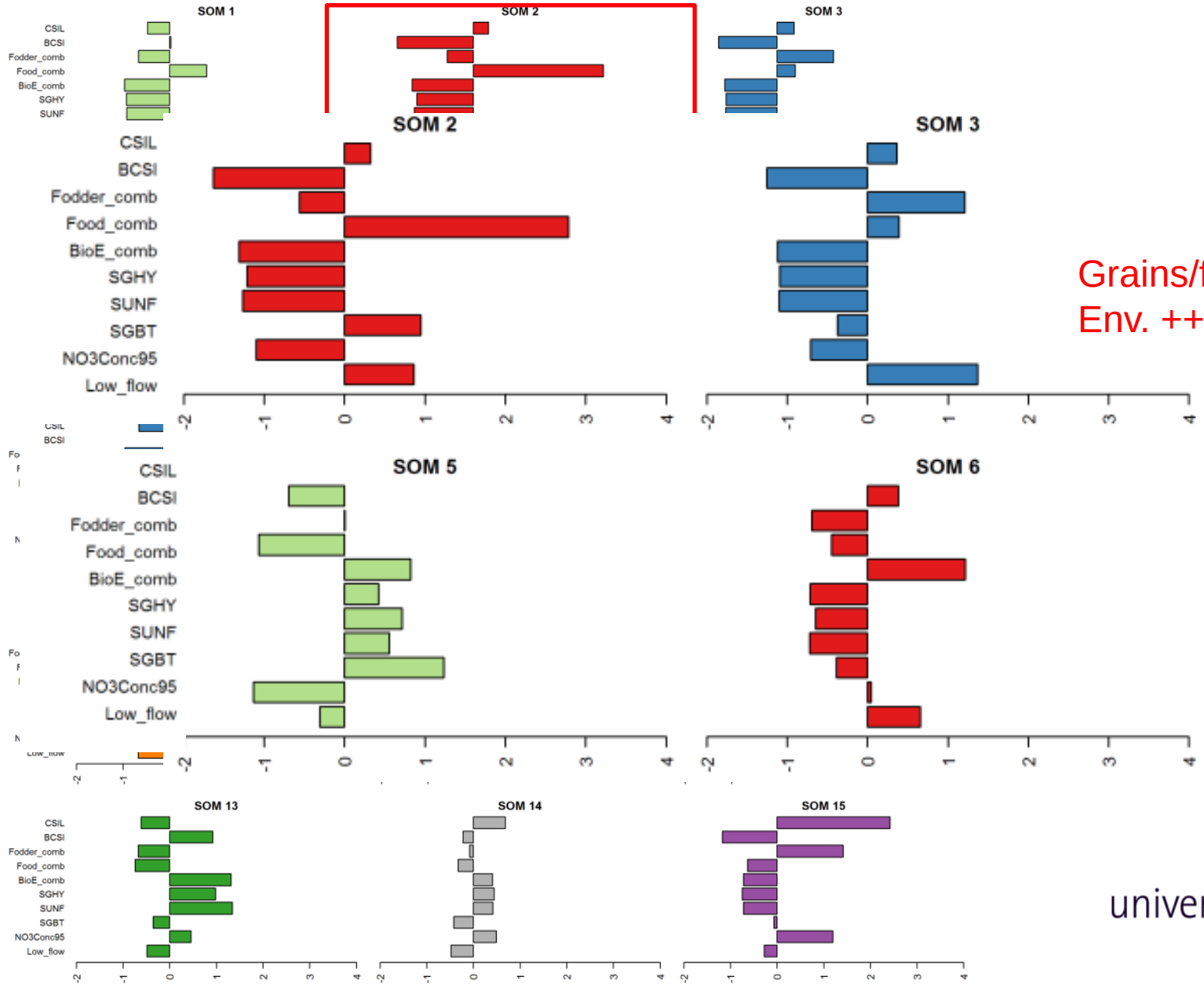
Cluster centers - scaled



Grains/food ++
Env. ++

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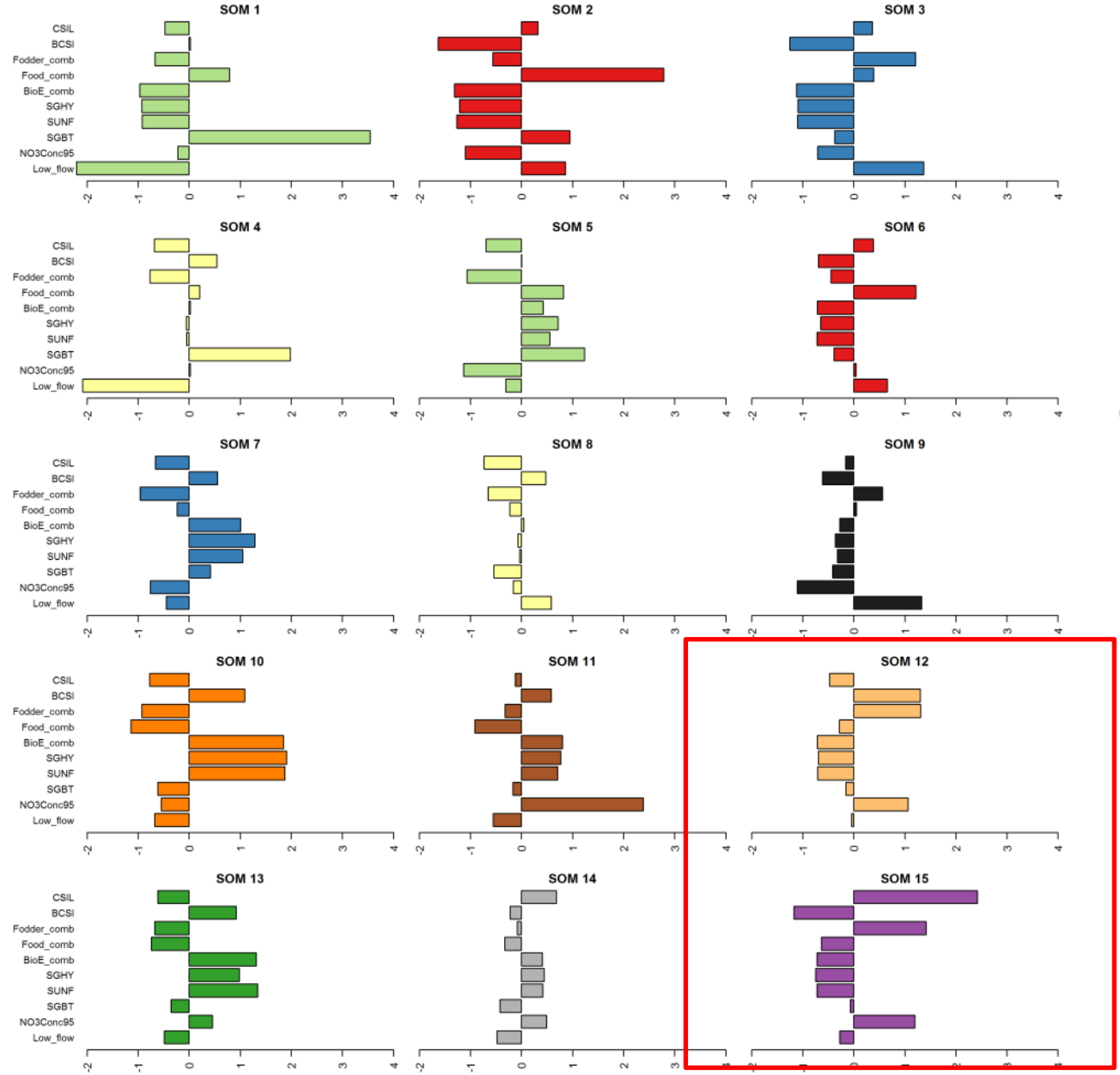
Cluster centers - scaled



Corn (food or bioE)++
Nitrate ++

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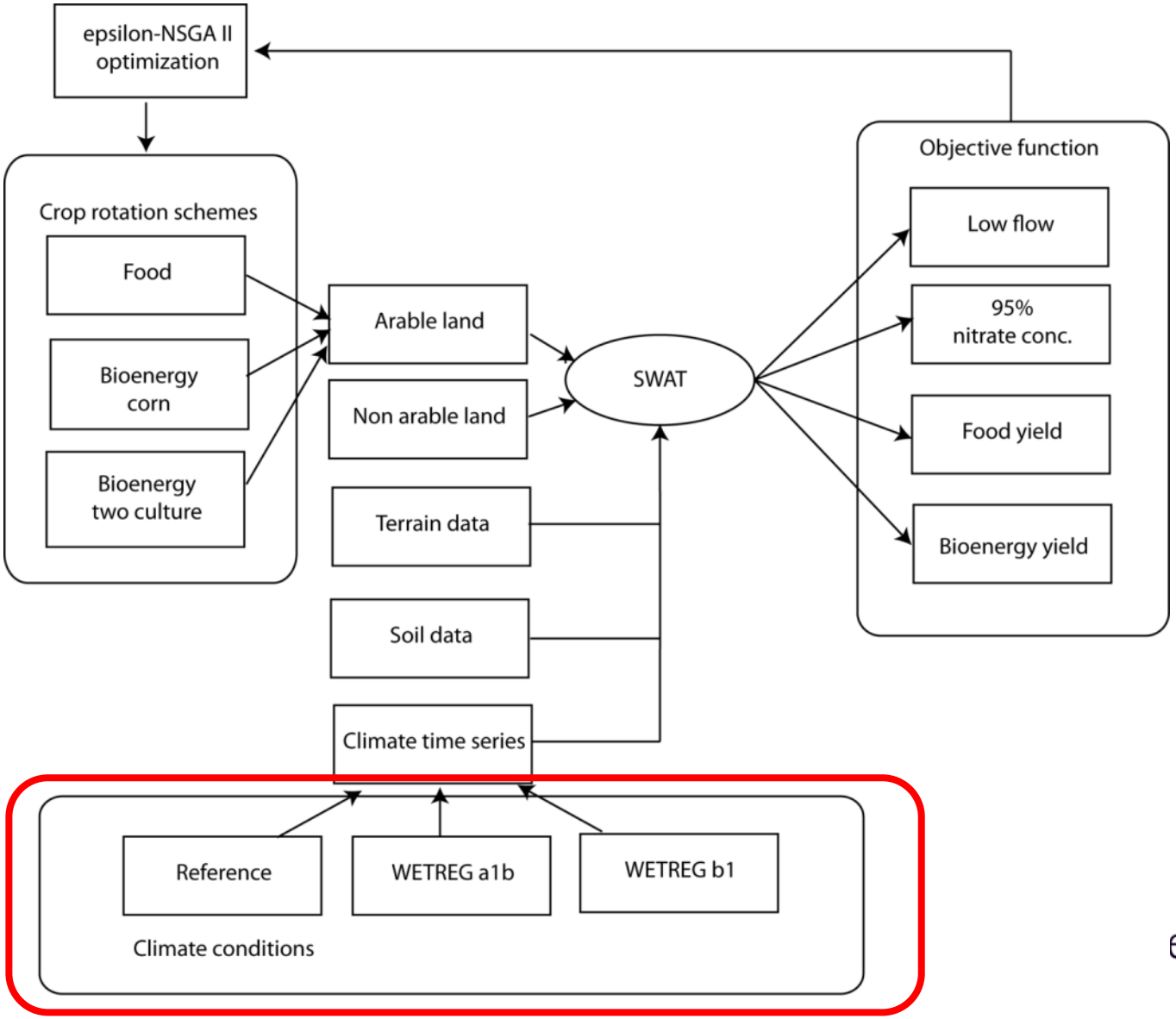
Trade-offs

- Analysis framework -



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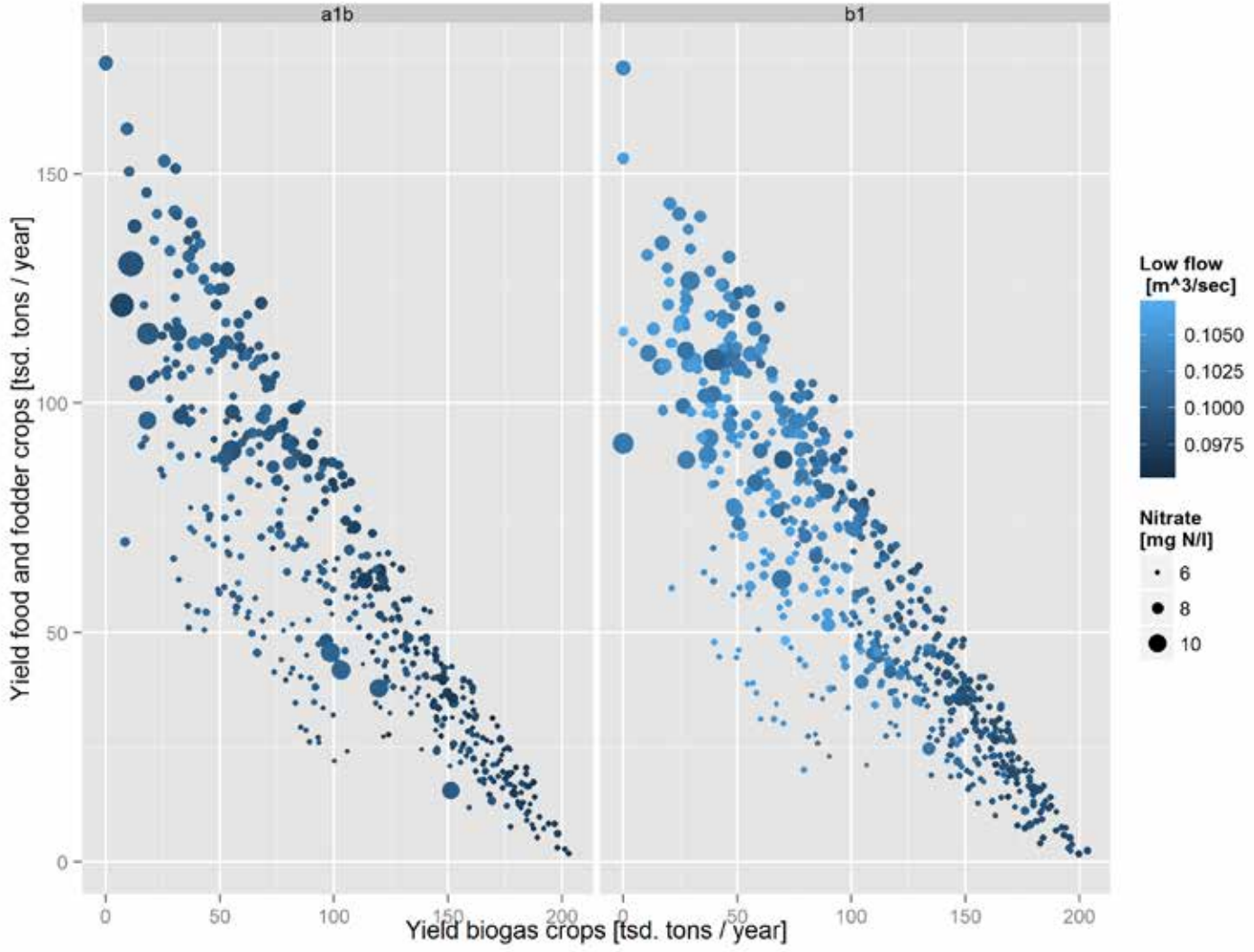
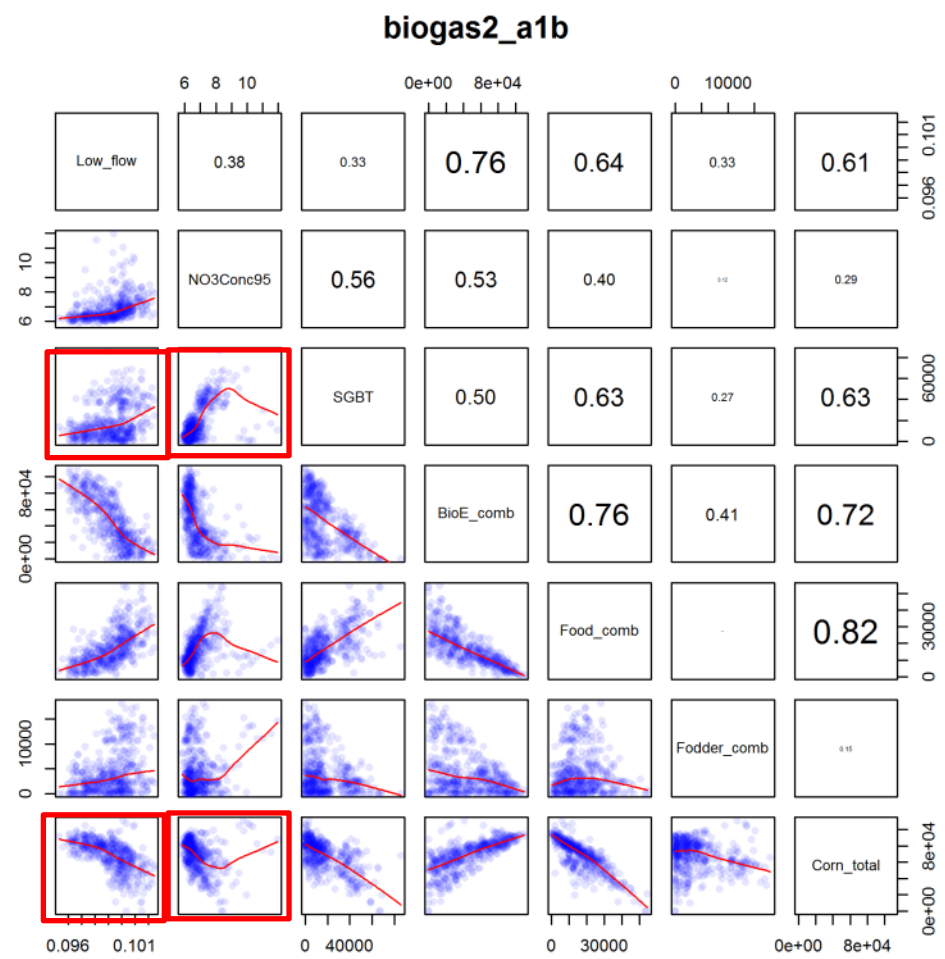
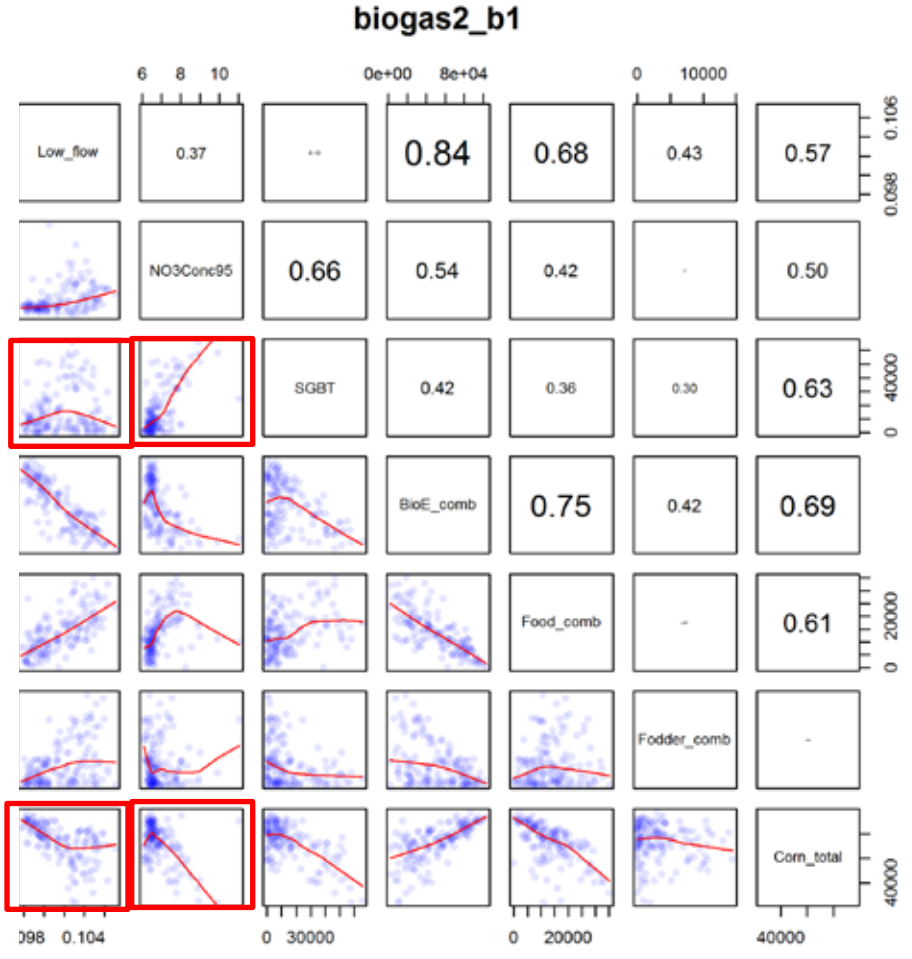
Differences between the climate scenarios



Effect of crops under different climate





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Conclusions/Outlook/Vision

- Multi-objective optimization is a neat thing to do
  - Can get you functional trade-offs between objectives
- There is a range of options to pick from
- Interpretation of results might give you a headache first
  - Tools like SOM might help to reduce complexity
  - Hierachical approach for selecting suitable solutions might be beneficial
- Biogas cropping systems have different trade-offs
- Changing climatic conditions change trade-offs

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Thank you for your attention

Questions?

Drawing by Martin Volk, 2013

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