Silphium perfoliatum:
2nd generation biomass crop

REGECON

University of Bayreuth

Regional Economic Evaluation of Adaption Measures in Agricultural, Forestry, and Bioenergy Production Under the Influence of Climate Change

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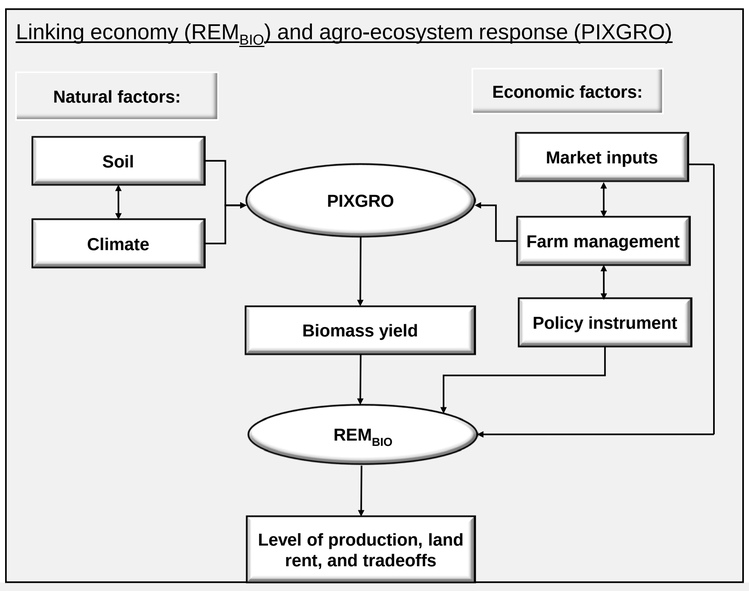
Project aim:

- develop a regional economic model for agriculture and forestry (REM_{BIO}) integrated with the crop production simulator PIXGRO to examine the effects of climate change on agricultural production, including bioenergy crops along with potentials for response in land use planning.

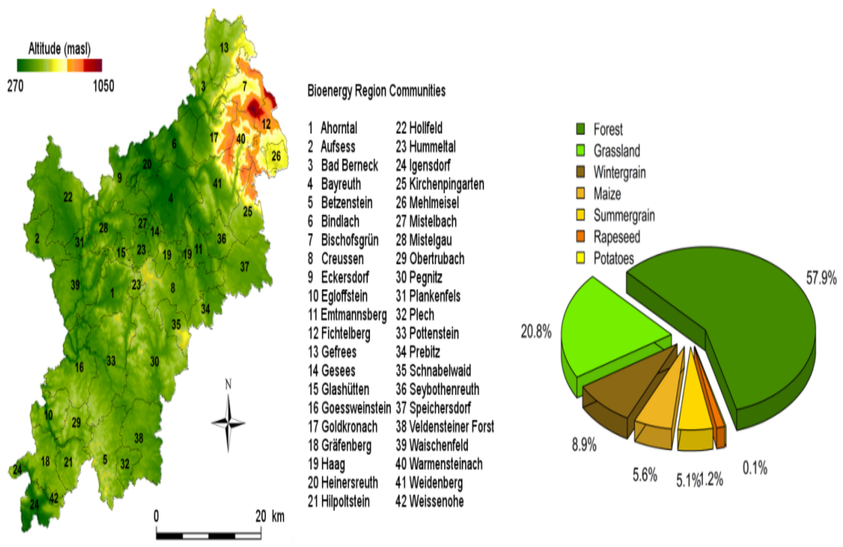
Objectives:

- To obtain spatially-explicit biomass production estimates for several scenarios of climate and land use changes
- To determine economically favorable land use in production in the context of different adaptation strategies to climate change (including policy options)
- To examine potential effects of climate, land use modification and policy changes on the welfare of farmers
- To evaluate the tradeoffs between crop production for food and for biomass, as well as between 1st and 2nd generation biomass crops in terms of farm income

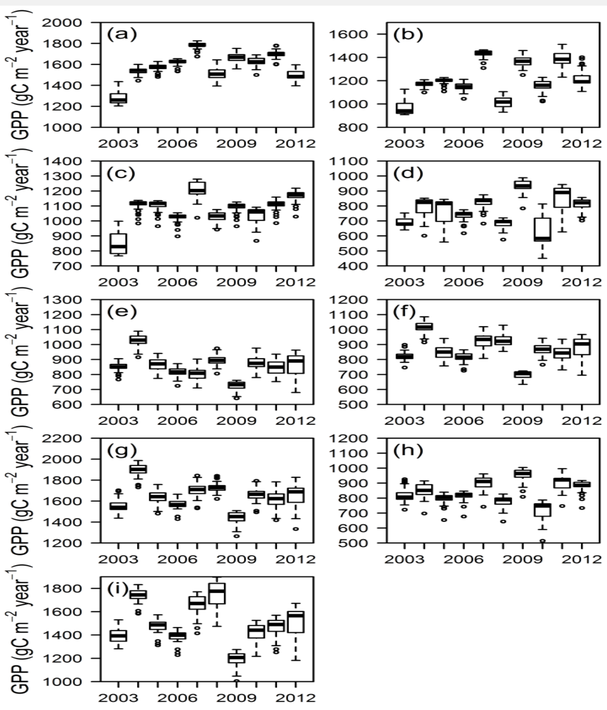
Research Approach:



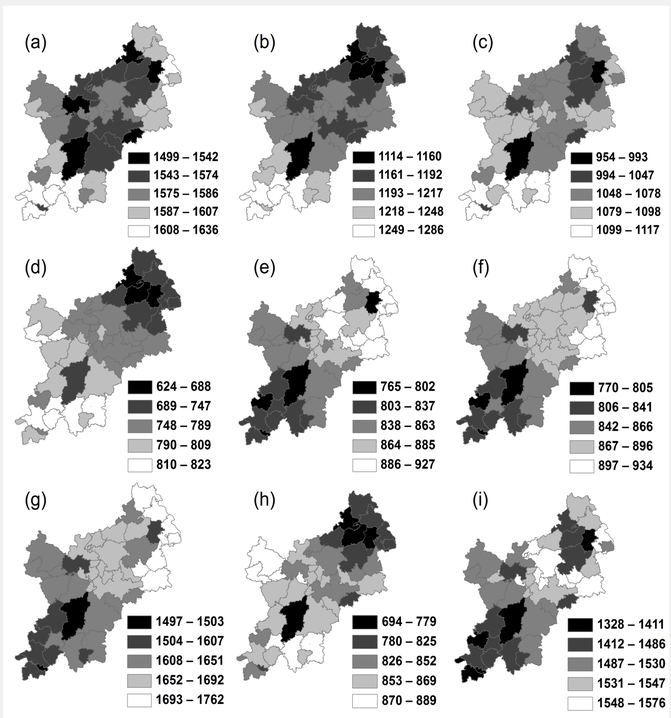
Topographic Map and Land Use in the Bioenergy Region Bayreuth



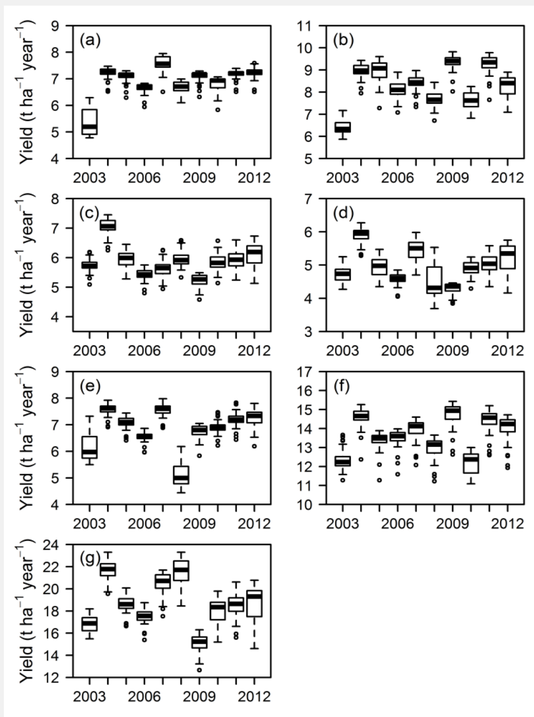
Results from the PIXGRO model:



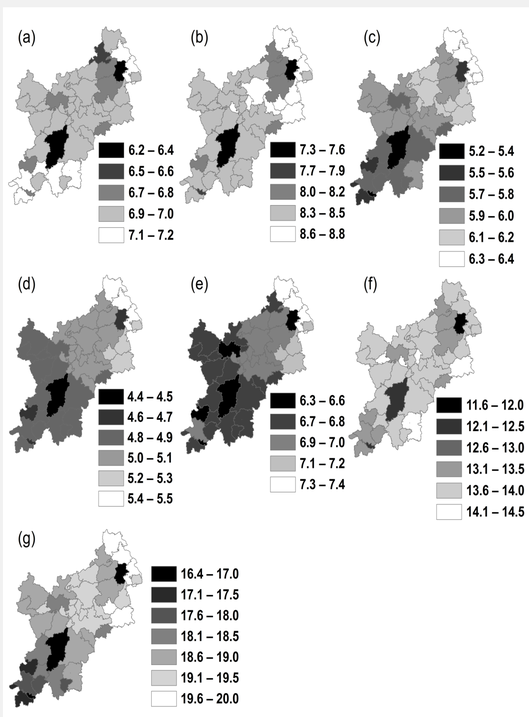
Simulated interannual variation of GPP from 2003 to 2012 (n=42 communities) for (a) coniferous forest, (b) deciduous forest, (c) grassland, (d) potato, (e) summer grain, (f) winter grain, (g) winter rape, (h) maize, (i) *S. perfoliatum* (y-scales vary between land uses).



Simulated 10-year average annual GPP (gC m^{-2} $year^{-1}$) for (a) coniferous forest, (b) deciduous forest, (c) grassland, (d) potato, (e) summer grain, (f) winter grain, (g) winter rape, (h) maize, (i) *S. perfoliatum*

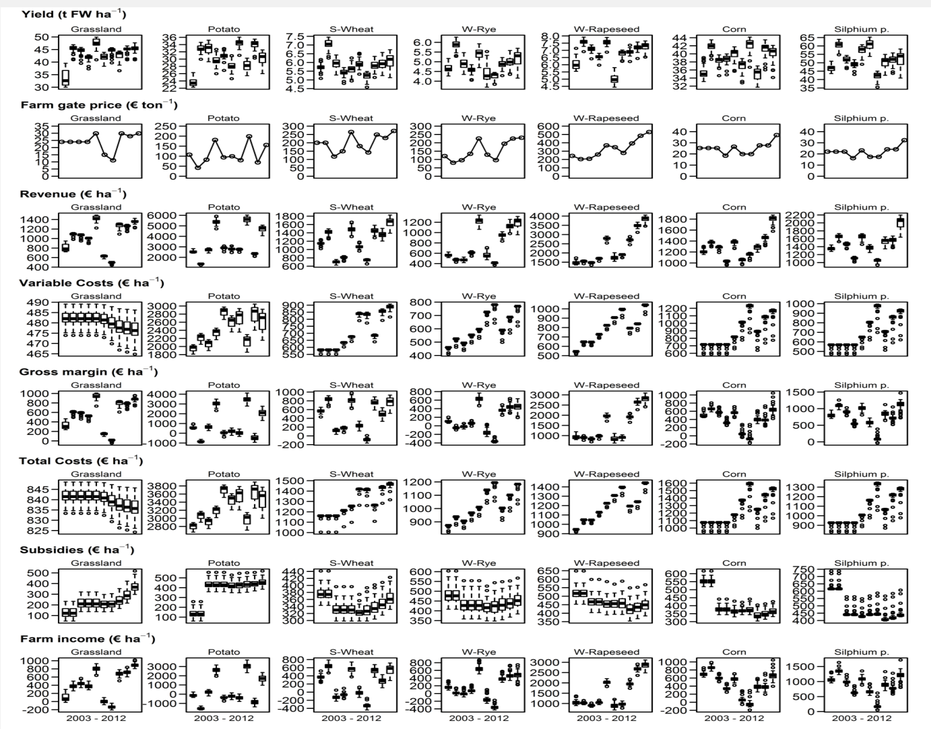


Distribution of total yields from 2003 to 2012 in 42 communities for (a) grassland, (b) potato, (c) summer grain, (d) winter grain, (e) winter rape, (f) maize, and (g) *S. perfoliatum*.

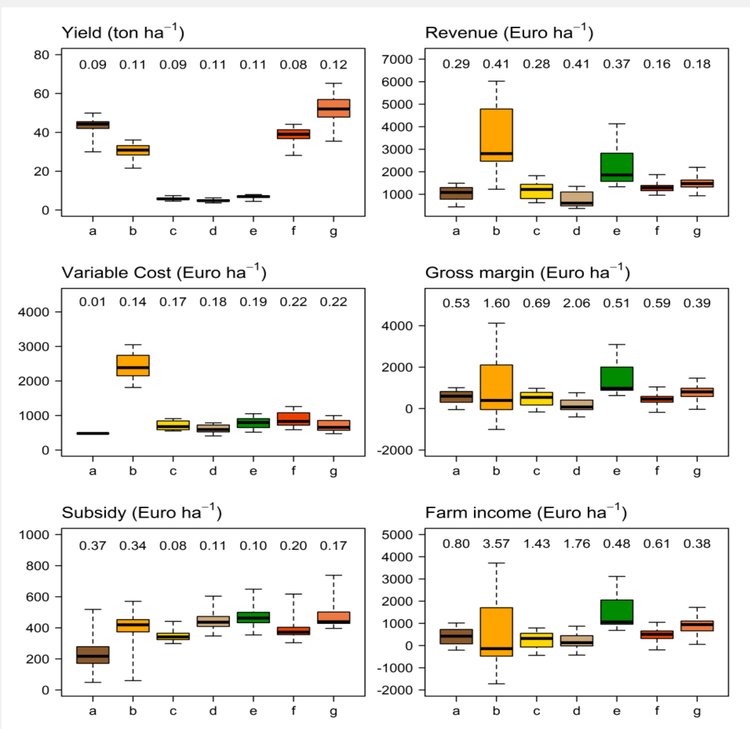


Simulated 10-year average total yield (t ha^{-1} $year^{-1}$) for (a) grassland, (b) potato, (c) summer grain, (d) winter grain, (e) winter rape, (f) maize, (g) *S. perfoliatum*

Initial results from the REM_{BIO} model



Temporal volatility of simulated yields, farm gate prices, revenues, costs, subsidies, and resulting farm income for seven major land use types. Each boxplot represents the distribution within the region (n=42 communities).



Temporal volatility of simulated yields, farm gate prices, revenues, costs, subsidies, and resulting farm income for seven major land use types. Each boxplot represents the distribution within the region (n=42 communities).

Summary of the New Insight Gained

- **Summer drought events are likely to affect crop yields strongly even in the Bioenergy Region Bayreuth.**
- **Mild winter and spring temperatures support increased yields of winter crops, early planted summer grain and perennial crops.**
- ***S. perfoliatum* will likely have environmental and economic benefits due to promising characteristics such as cold-resistance, rapid growth in early spring and overall higher yield compared to the conventional annual maize cultivation.**
- **Profitability of bioenergy crops is much higher as compared to food crop production.**
- **Subsidies currently contribute a significant portion to farm income and reduce farm income volatility.**
- **Bioenergy crops show lower farm income volatility as compared to food crop cultivation.**

Publications

1. Ruidisch, M.,Nguyen, T.T., Li, Y., Geyer, R., Tenhunen, J., 2015. Estimation of annual spatial variations in forest production and crop yields at landscape scale in temperate climate regions. *Ecological Research* 30, 279-292
2. Nguyen, T.T., Tenhunen, J., 2013. Climate change and crop production for bioenergy linkage at local scale: Challenges and implications. *International Journal of Climate Change Strategies and Management* 5, 324-343.

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