MACSUR - Modelling European Agriculture with Climate Change for Food Security; what's in it for farmers and policy makers?

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Modelling European Agriculture with Climate Change for Food Security

Why care about modelling?

In a world of long-term developments, counterfactual situations and policy options, our brains is lost. Models can quantify complex interactions and feedbacks at various systemic, temporal and spatial scales to support policy design and improve system understanding

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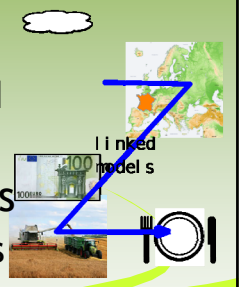
There are no perfect models, but there are useful models, and MACSUR aims to make them more useful

MACSUR's aims

- To analyse the effects of climate change for farming conditions in European regions
- To identify risks for farmers, to jointly develop mitigation and adaptation options
- To analyse consequences of mitigation and adaptation for farming competitiveness, the environment and rural development

MACSUR's mission

- improve and integrate models - crop and livestock production, farms, and national & international agri-food markets
- demonstrate integration and links - models for selected farming systems and regions
- provide hands-on training - young and experienced researchers in integrative modeling



MACSUR's approach

- Integrate expertise of stakeholders (farmers and extension services) to identify knowledge needs and risk perceptions with regard to climate change impacts
- Include regional specifics in the analysis
- Model the expected strengths and weaknesses of a choice of adaptation measures: yields, revenues, environmental impacts and rural development options

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Improvements through linkages of the model CAPRI to crop growth models

- Impact of climate change on yields: climate model → crop growth model → economic model

  Variables: Yield changes compared to reference run
- Drivers of global demand → long-term projections

  Variables: GDP, population development, biofuel demand
- General (and sustainability) constraints (e.g. land, fertilizer need, policies)

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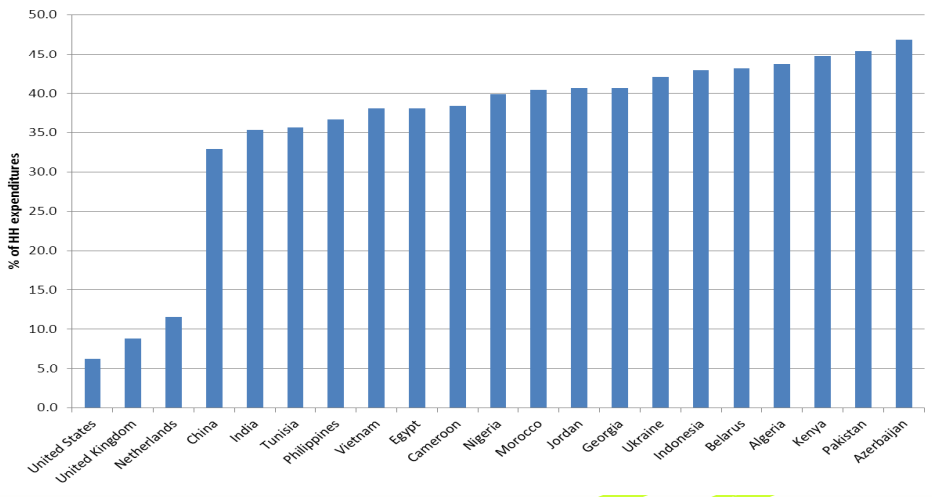
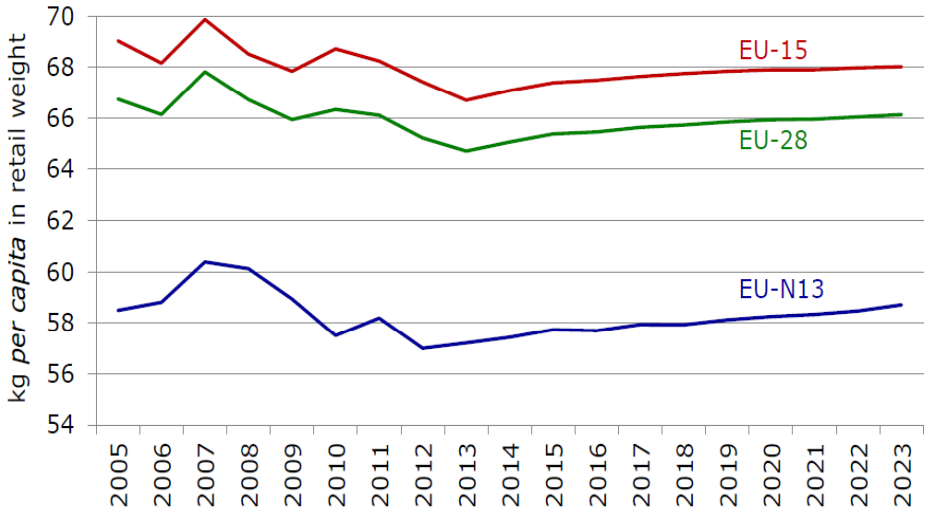
Food Security

Food and nutrition security exists when all people at all times have physical, social and economic access to food, which is safe and consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life (FAO, 2012)

Share of food expenditure in household expenditures (%)



EU-28 per capita total meat consumption to recover from the 2013 historic low but not beyond 2011 level



Source: EU, 2013: Medium-term prospects for agricultural markets and income

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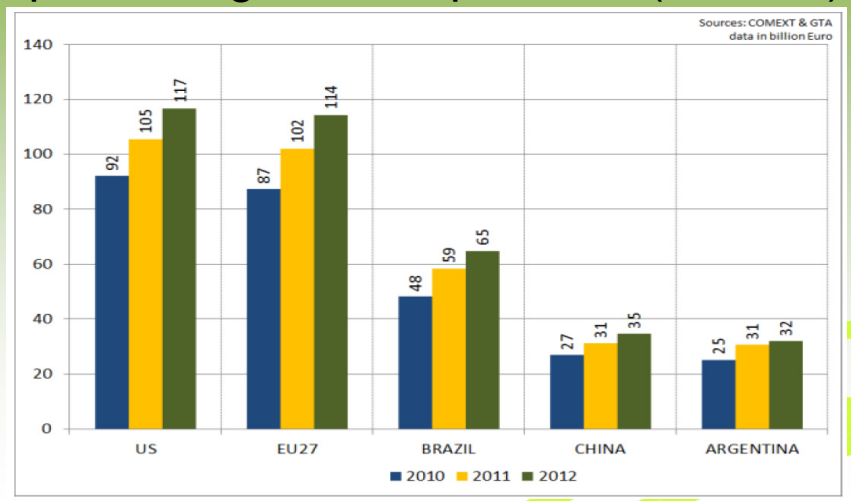
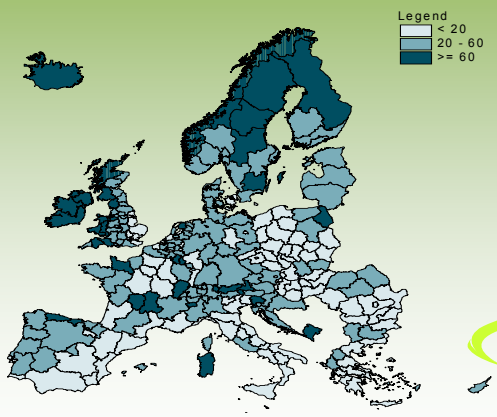
Exports of agricultural products (billion €)

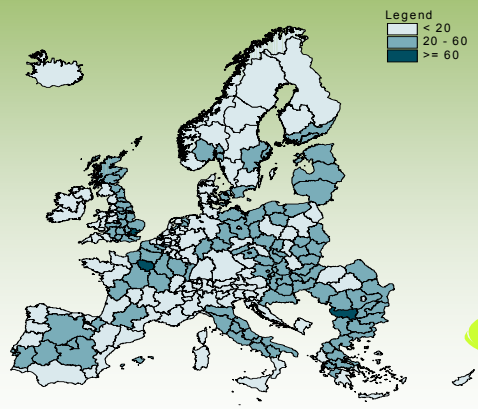


Source: EU, 2013: Monitoring Agri-trade Policy Agricultural trade in 2012

Share of specialist grazing livestock in total standard output by region in 2010 (%)



Share of specialist field crops in total standard output by region in 2010 (%)



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Challenges for food systems

- more resilient production systems
- reduce dependency of the food chain on fossil fuels
- enhance ecosystem services (i.e. biodiversity, soil and water)
- radically reduce GHG emissions from food system
- feed challenge

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Feed demand is increasing

- World production of meat, milk and eggs – 1025 million tonnes (2007)
- Use of feed concentrate – 1250 million tonnes (2005)
- By 2050: *additional* requirements
  - 430 million tonnes livestock feed
  - 480 million tonnes human food (IAASTD 2009)

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Demand on land is increasing

- Global area of agricultural land
  - 1970 – 4.59 billion ha
  - 2010 – 4.89 billion ha
- Per capita agricultural land
  - 1970 – 1.24 ha/person/year
  - 2010 – 0.72 ha/person/year
- Major technological improvements in crop and livestock

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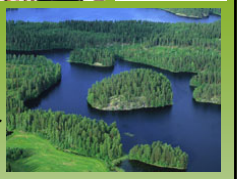
Focus on crop yields

Yield gaps. Relatively large gaps between potential and actual yields. This gap is highly variable and driven by weather conditions, various bio-physical as well as socio-economic factors. Exacerbated by technical knowledge/access and economic limitations

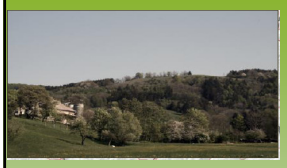
Reducing yield gap and increasing potential yield could increase crop production on existing land by 50% by 2050[1]

[1] Jaggard et. al. (2010) *Phil. Trans. R. Soc. B.* 365

Northern Savo, Finland



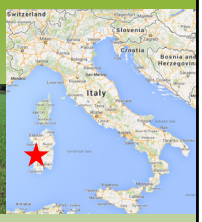
- Increasing grass growth benefits dairy and beef
- Inter-annual volatility of grass yield increases
  - Managing grassland yield variation at the farm level – cost of drought risk may increase
- winter damages, feed quality losses, soil compaction, wet conditions more frequent
- Increase in yield potential of cereals and oilseeds is uncertain, more frequent droughts on sandy soils
- Positive market development + more flexible and encouraging policies needed for adaptation
  - adaptations require medium/long-term investments – drainage, soil structure, cultivars
  - winners know all this, are adapting already…



Mostviertel - Austria

- Farmers may benefit from climate change in several regions of Austria, although effects seem to be mixed for farmers specialised in crop production
- Climate change induced intensification of land by removing landscape elements and increasing use of fertilizers. Benefits result from participation in agri-environmental programs
- Benefits of climate change (through productivity gains) will increase opportunity costs for participation in AEP. Payments may have to increase for such farmers

Sardinia, Italy



- Rainfall is reduced by 30% in 2030 and average temperature increased by 1°C. Yields of forage crops are reduced, causing notable income drops for livestock farming. Rainfed hill sheep farming is under threat of abandonment.
- Irrigation costs increase in regions with collective water networks and volumetric water pricing; the use and salinization of groundwater will increase elsewhere
- Increased heat wave frequency will affect welfare, milk quality and quantity and mortality of dairy cows
- Higher temperatures during autumn and winter will provide income opportunities, but farmers need to understand the crop yield changes

Brandenburg, Germany




- Climate change may aggravate water stress for plant growth
- Rising prices for agricultural commodities can make irrigation profitable
- Irrigation may reduce seasonal variations of crop yield and may increase crop yields by up to 40% for maize and up to 20 % for wheat and sugar beat
- Models applied: YIELDSTAT, ZUWABE, MONICA, MODAM

Critical attitude of farmers

- Some farmers may claim that climate change adaptation is easy compared to the difficulties caused by policies
  - 'Some policy schemes discourage productivity growth, re-organisation and structural change'
  - Pillar 1 payments keep land supply weak, weak cross-compliance, too many passive farmers, land owners
  - Agri-environmental schemes discourage productivity growth and reward passive norm-based behaviour, farmers' ideas on better land management, e.g. through land-interchange, rejected by policy rules
  - Overall effect of many individual retarding effects accumulate, ambitious farmers get frustrated

Critical attitude of farmers

- Action based on weather observations only, is insufficient for farmers to respond to climate change. Interdisciplinary models and scenario building support farmers in understanding the nature of the issue. Researchers need support from farmers in understanding the responses in practice.
- Policies might be too slow to respond to needs for change in agriculture. Effective solutions and cooperation in land management often not accepted by policy makers, even if significant productivity and environmental gains could be achieved

Concluding remarks

- Winners and losers seem to be observed everywhere. The impacts of climate change is heterogeneous among farm types and regions
- Effects beyond 2050 remain largely unclear, mainly because the effects of extreme events are not considered
- Variability of yields is important to farm incomes, but most studies only consider average changes
- Farmers are ready to design their site-specific adaptation response providing that new knowledge and learning spaces are available. A learning process based on integrated models, assessment of short- and long-term effects, is needed for farmers to adapt to climate change, price fluctuations and policy change.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