Climate change as a driver of European agriculture

Jørgen E. Olesen, Aarhus University

Europe’s rural areas in action - Facing the challenges of tomorrow
Limassol, Cyprus, October 16-17, 2008
Climate change as a driver of European agriculture

Jørgen E. Olesen
The changing food and demand situation

- The biofuel boom
- The changing energy prices
- Income growth and high demand on food and feed
- Growing scarcity of water and land
- Slowing agricultural productivity growth
- Climate variability and climate change
The challenge of a growing world population

- The world population is increasing and will peak at about 9-10 billion (from currently 6 billion).
- Increasing wealth causes changes in lifestyle towards more meat and milk in the diet – and in the longer term for higher quality foods.
- The global livestock production is increasing rapidly (meat production will double from 2000 to 2050) (FAO projection).
- World grain production also has to double by 2050.
- Agriculture accounts for 20-30 % of global greenhouse gas emissions.
Climate change as a challenge

Emissions are local, but effects are global (spatial separation)
Impacts occur much later than the emissions (temporal separation)
The spatial and temporal separation between emissions and effects make climate change the most challenging political issue of our time.

Agriculture and climate change:
- Greenhouse gas emissions
- Reducing emissions
- Resilience to climatic variability
- Adaptation to climate change
Agriculture’s contribution to greenhouse gas emissions

Cool Farming, Greenpeace
Biogas on animal manure

- Energy production (substitution of fossil fuels – depend on addition of additional organic matter)
- Reduced methane emissions (requires collection of methane after the biogas reactor and small losses in gas energy utilisation)
- Reduced nitrous oxide from applied manure
- Less carbon added to the soil
Perennial energy crops have better environmental profile than annual crops

70% lower nitrate leaching
60% lower pesticide use
60% higher GHG emission reduction
But be careful with bionergy

Several issues need specific evaluation to avoid adverse environmental effects:

- Soil organic matter
- Water use
- Landscape impact
- Biodiversity losses

Bioenergy is NOT the solution to the GREAT Climate Change Challenge - But only provides a small contribution – We need to REDUCE energy use
Temperature changes

Winter temperature
(2071-2100) – (1961-1990)

Summer temperature
(2071-2100) – (1961-1990)
Precipitation changes

Summer rainfall (% change) (2071-2100) – (1961-1990)
Increased variability

Precipitation

% change interann spread DJF precip

Temperature

% change interann spread DJF 12m

% change interann spread JJA precip

% change interann spread JJA 12m

Winter

Summer

PRUDENCE
Climate change impacts on agricultural production

- Effects of climate change on European cropping systems have already been observed (e.g. maize, grapevine)
- Future effects will largely be an extension of current trends
- Higher climatic variability (temperature and intense rainfall) will have particularly large negative effects – and impose difficulties in adaptation
- Northern Europe will largely see positive effects:
  - Advantages: New crop species and varieties, higher crop production and expansion of suitable areas for crop cultivation
  - Disadvantages: Increase in plant protection, risk of nutrient losses, depletion of soil organic matter
- Southern Europe will largely see negative effects:
  - Advantages: Some crops may be cultivated during winter
  - Disadvantages: Increased water shortage, higher risk of extreme weather, higher yield variability, reduction is suitable area for traditional crops
- Agriculture in the Mediterranean appear to be the most vulnerable in Europe
- Adaptation measures need to consider both short- and long-term effects. In both cases care should be taken to increase resilience of the agro-ecosystems by increasing system diversity and improving soil fertility.
Grain maize (current and future trends)

Current trends in yield and area

Projected increase in suitability (2080)

Belgium

Germany

France

Italy

Baseline suitability (1961-90)

Increases in all model runs

Increases in some model runs
The 2003 summer heat wave in Europe

30% reduction in gross primary production of terrestrial ecosystems
Large reductions in agricultural production (13 billion €)
Many very large wildfires
Large CO₂ emissions from soils
Record low river flows affecting ecosystems, navigation and cooling of power plants
Reduction of 10% transportation capacity on the Rhine (200 mil. €)
Extreme glacier melt in the Alps prevented extremely low flows in the Danube river
Excess deaths due to very hot temperatures (about 35,000)
Observed and projected temperature in Central Europe

Schär et al. (2004)
Drought effects on vegetation in France

Sequin based on SPOT
Is irrigation a solution to increased drought?

Irrigation is efficient for limiting yield losses, but:
- restricted to a small part of the area
- higher water consumption in dry years
- increasing competition with other uses

so that the extent of surfaces for irrigation is questionable in the context of diminishing water resources!!
We need to increase water use efficiency

- Efficiency of irrigation systems (more crop per drop)
  - Trickle irrigation systems to target crop demand and avoid evaporation
  - Irrigation systems that induce partial stomatal closure
- Water harvesting systems (avoiding excessive runoff)
- Increasing soil water retention (soil structure, organic matter)
- Avoiding soil evaporation (e.g. through mulching)
- Drought tolerant crop species and cultivars

- Combinations of these measures are needed!!!
Agriculture must adapt to climate change ---

- Generally increasing temperatures
- Increasing rainfall intensity
- More frequent droughts (in currently dry regions)
- More variable climate (in many areas)

This requires ---

- Higher resilience to climatic variability
- Better use and management of water

And can be achieved through ---

- Maintaining fertile soils with high water holding capacity
- Improving crop genotypes (drought tolerance)
- Diversifying crop rotations and cropping systems
- Cover crops and intercrops to improve fertility
- Adapting crop management to improve water use efficiency
Agriculture must reduce emissions of ---

- Methane from livestock, manure management and paddy rice
- Nitrous oxides from manure and nitrogen fertiliser use
- Carbon dioxide from cultivation of new land and peatlands
- Carbon dioxide from fossil fuel use

This requires ---

- Increasing efficiencies in the food production chain
- Implementation of new technologies and management
- Prudent production of biofuels (perennial crops, wastes)
- Abandong certain practices (e.g. cultivation of peatlands)
- Combination of many measures to achieve sufficient effect

And can be achieved through ---

- Directing research, advice and innovation towards these issues
- Focusing existing and new incentive schemes on GHG emissions (financial support, taxation, codes of practice)
Conclusions

- Adaptation has to deal not only with changing temperature and rainfall, but also by increasing variability and more extremes.
- This means that adaptation should include increased resilience to change and climatic variability.
- Water will become an increasing problem (too little and too much) – emphasis on water resource management.
- Climate change puts additional stresses on soils – need for better protection of soils and soils with little GHG emissions.
- Research, development, innovation within technological and social structures need to address issues dealing with both adaptation and mitigation to climate change.