Climate change effects on agricultural production and nutrient losses

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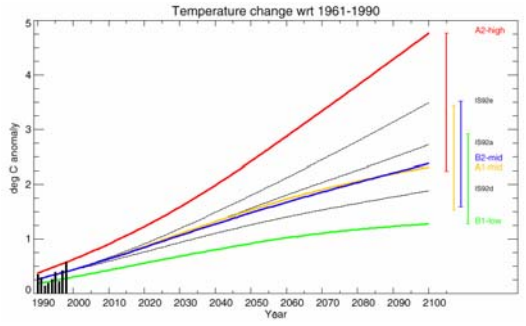
Climate change and agricultural production

Climate change is not believed to threaten world food security. However, this will require efficient adaptation to climate changes.

Large displacements in agricultural production patterns are expected, both continentally and regionally, and there will be winners and loosers. In Europe, winners will be most abundant in Northwest Europe and loosers most abundant in Southern Europe.

Changes in crop productivity and climate will also affect nutrient loss pathways.

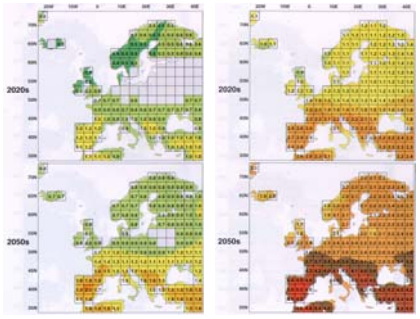
Historisk udvikling i drivhusgasser



IPCC (2001)

Change in summer temperatures (scenarios)

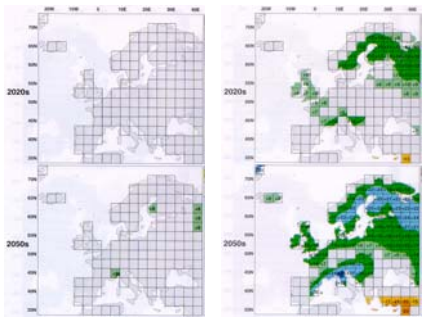
B1 A2



ACACIA (2000)

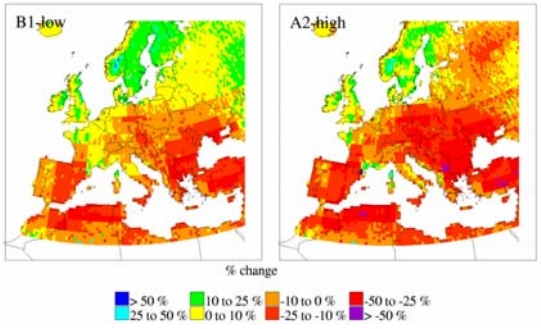
Change in winter precipitation (scenarios)

B1 A2



ACACIA (2000)

Change in water balance in 2050's

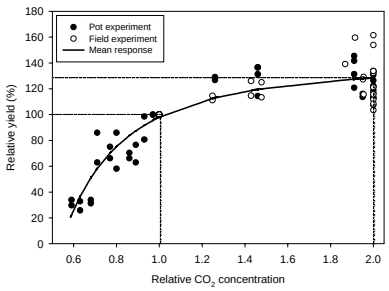


ACACIA (2000)

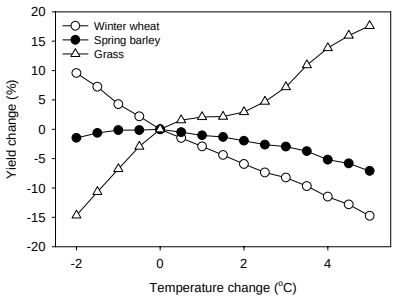
Effects of climate change

Component	Factor		
	CO_2	Temperature	Rainfall/wind
Plants	• Dry matter accumulation • Water use	• Duration of growing season	• Dry matter accumulation
Animals	• Fodder yield	• Growth and reproduction	• Health
Water	• Soil moisture	• Irrigation need • Salinity	• Water table
Soil	• C/N ratio of plant residues	• Soil OM turnover • Nutrients	• Wind and water erosion
Diseases pests	• Quality of host biomass	• Generation time • Earliness of attacks	• Spread of bacteria and pests
Weeds	• Competition	• Efficacy of herbicides	

Wheat yield at increasing CO_2 concentration

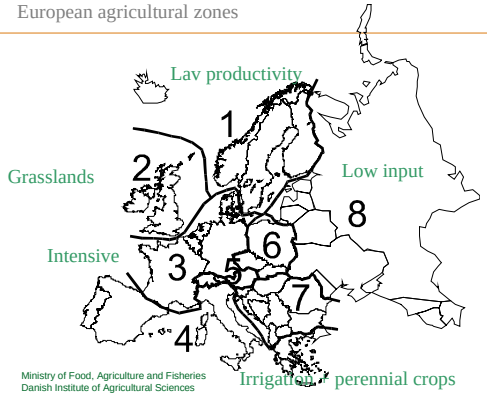


Yield response to temperature depend on crop species

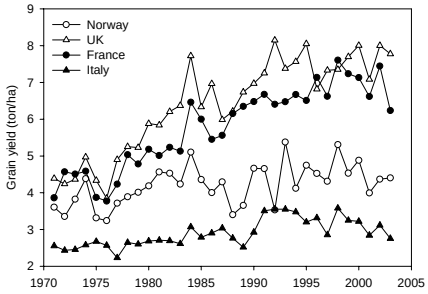


Simulations with CLIMCROP model

European agricultural zones

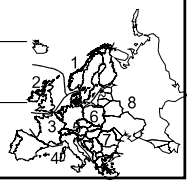


Increasing wheat yields in most of Western Europe

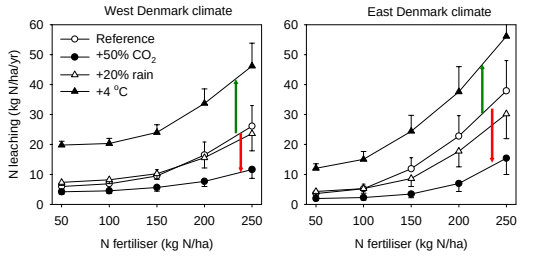


Wheat production (million ton)

Region	Production 1995-99	Yield gap	Climate change 2050
1. Nordic	3	0	1
2. British Isles	16	5	5
3. West	62	9	16
4. Mediterranean	15	10	5
5. Alpine	2	1	1
6. North east	12	14	6
7. South East	16	12	5
8. East	52	183	42
Total (regions 1-8)	178	234	79
Regions 1-5	96	25	26
Regions 6-8	81	209	53



N leaching for increased N fertiliser to winter wheat



Increased leaching at increased temperature

Decreased leaching at increased CO_2

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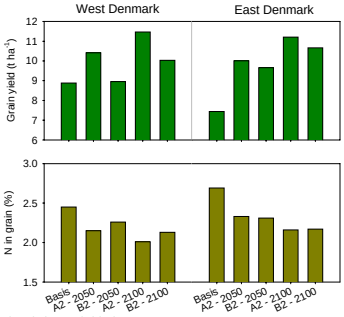
Simulations with Daisy model

Scenarios for effect on wheat yields in Denmark



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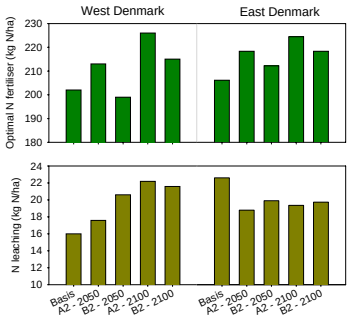

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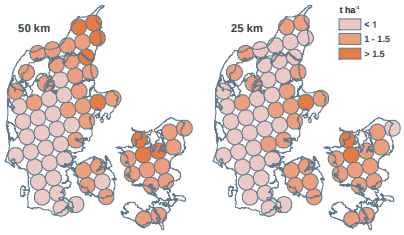
Simulations with Daisy model

Change in wheat yields for 2080 – A2

HIRHAM model med 2 spatial resolutions



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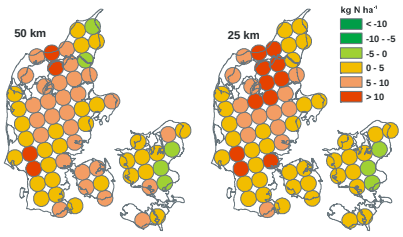
Change in N leaching from wheat in 2080 – A2

HIRHAM model with 2 spatial resolutions



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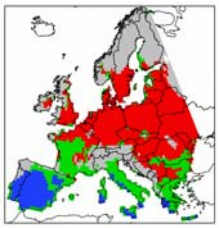
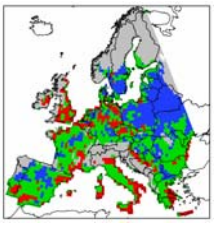
Wheat in 2080 – uncertainty for 9 RCM for A2

Yield change



Change in N-leaching



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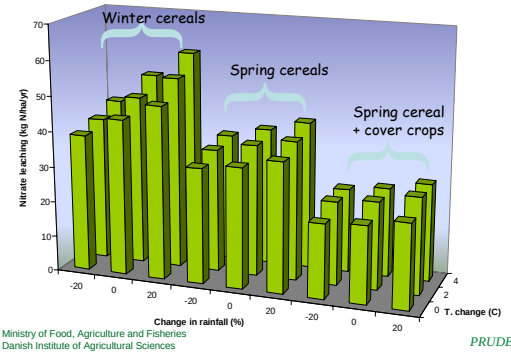
Crop rotations may mitigate N leaching losses



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Phosphorus losses to the environment

- P losses depend on erosion and on leaching events
- Increased high intensity rainfall events are likely to intensify all P loss pathways
- Mitigation measures include buffer strips and reduced tillage practices
- Need to reduce excessive P load to agricultural soils NOW!

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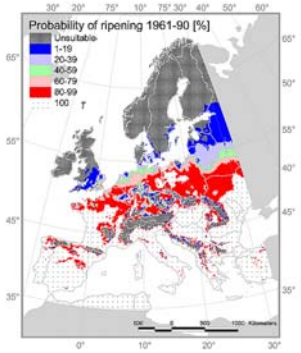
Maize for maturity

Probability of ripening of maize for the period 1961-90



Carter & Frozek (2003)

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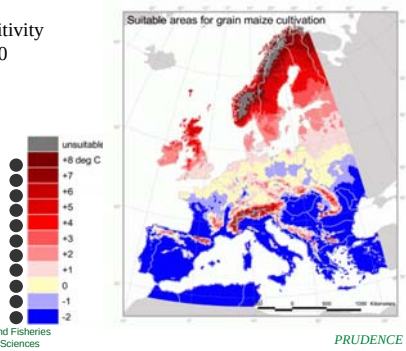
Maize for maturity – suitable areas

Temperature sensitivity relative to 1961-90



Carter & Frozek (2003)

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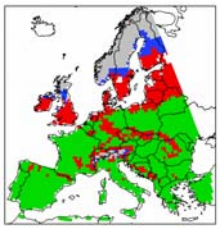
Grain maize 2080 - uncertainty

A2 – 7 RCM driven by HadAM3H



6 GCM for A1FI, A2, B1 og B2

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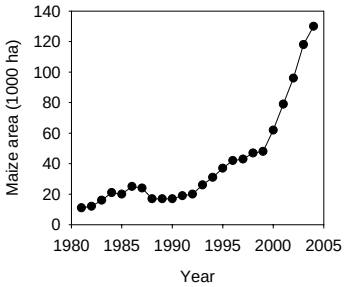
Increasing area of silage maize in Denmark



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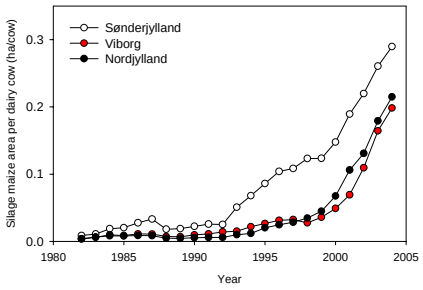
Maize area has increased differently in counties



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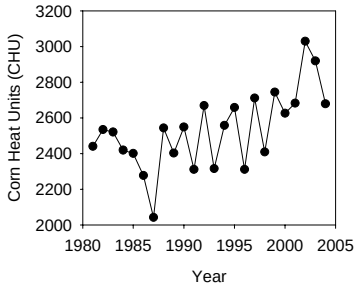
Corn Heat Units (CHU) are also increasing



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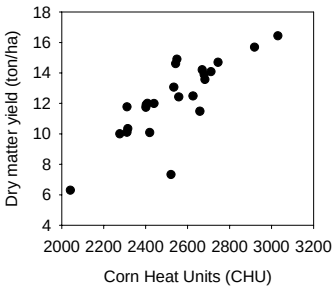
Yields in variety trials with silage maize in Denmark



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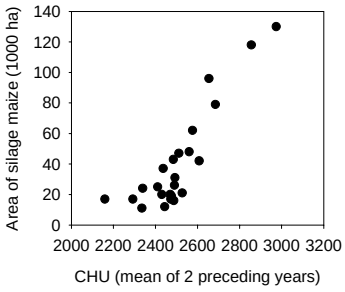
The increasing maize area is an adaptation to climate



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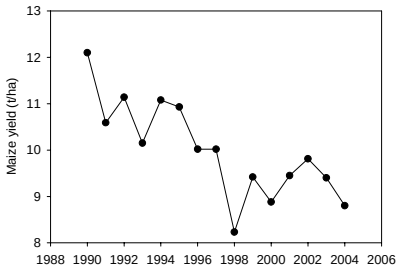
Declining maize yields at the national level



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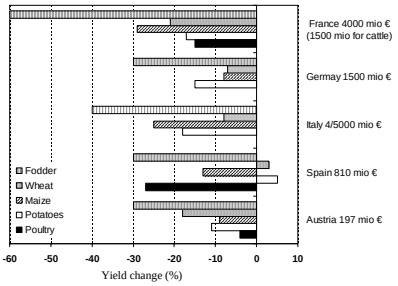
Effects of 2003 summer heat wave



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Conclusions

- Climate change is for real!!!
- Summers like 2003 are going to become much more frequent in future
- Increasing restrictions on irrigation in Southern Europe
- Increasing incidents of high rainfall events may increase erosion and nutrient losses (N and P).
- N leaching may increase or decrease depending on balance of crop uptake versus loss processes.
- Many of the increased losses can be mitigated by adapting cropping practices (cover crops, tillage)

New challenges