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Effekten av värme och torka på skörden, modellering

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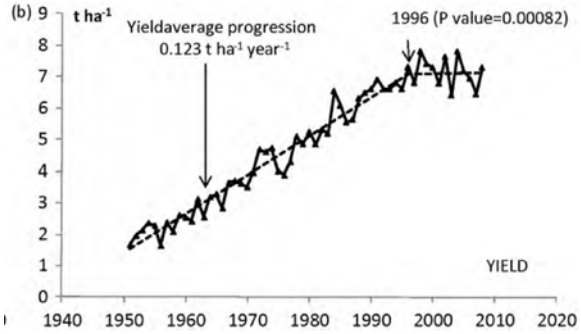
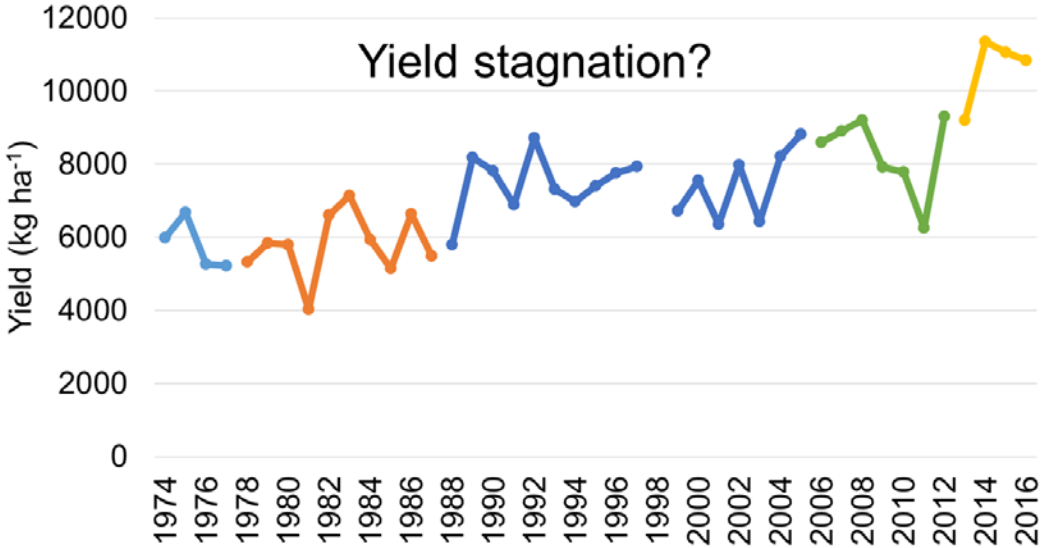
Introduction

- Cereals are a major crop in Europe, and significant gains in terms of yield were accomplished during the last decades. However, as with other major crops worldwide, the yield increment rate is decreasing despite optimizations in terms of nutrients management, phytosanitary conditions and genotypes.

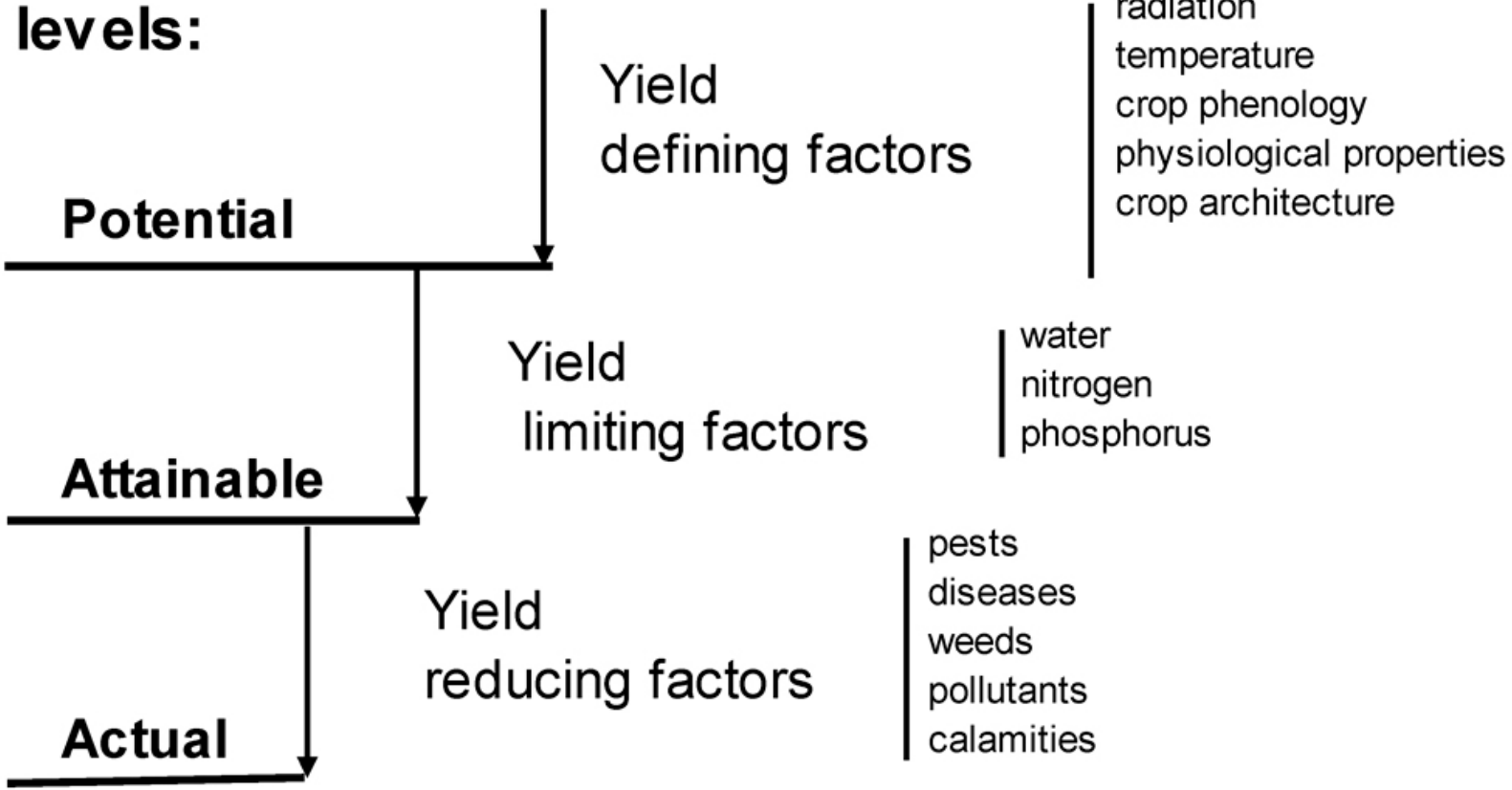


Annual evolution of bread wheat yield in France. Source: N. Brisson et al. / Field Crops Research 119 (2010) 201–212



Cultivar experiments in Sweden (NFTS)

Production levels:



Rabbinge, 1993; van Ittersum and Rabbinge, 1997

Drought

- A temporary decline in water availability;

- Is a gradually developing event, so a precise determination of its onset and end is difficult;

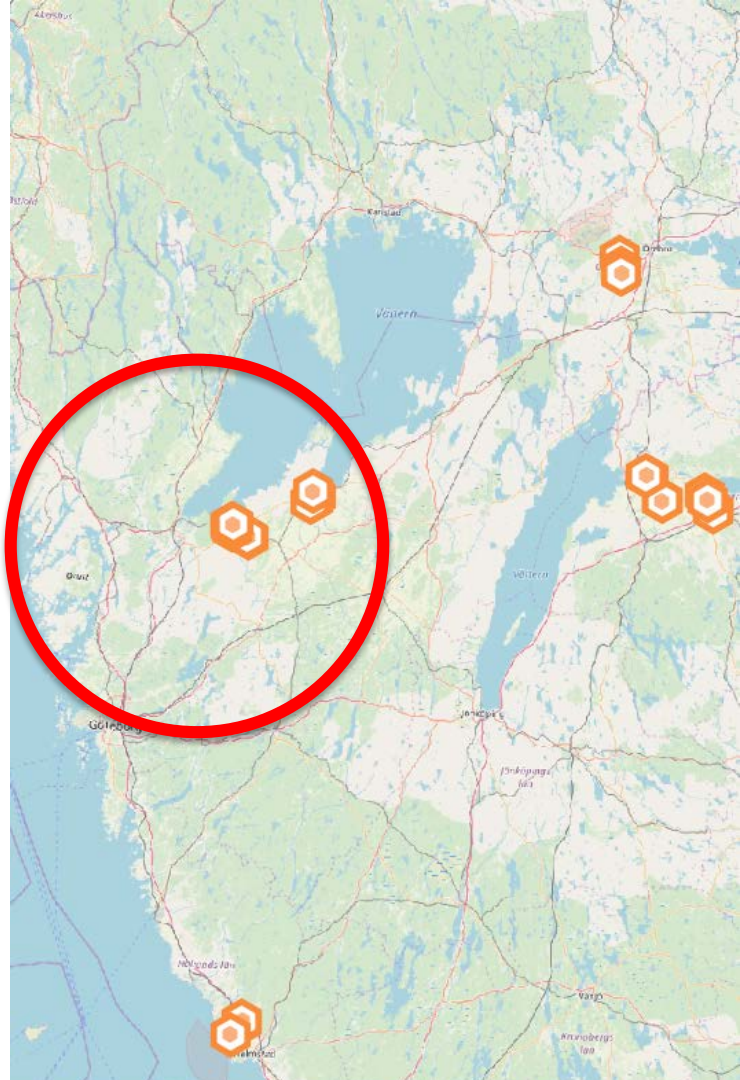
- For crop production, intra-seasonal limitation is more important than total precipitation.

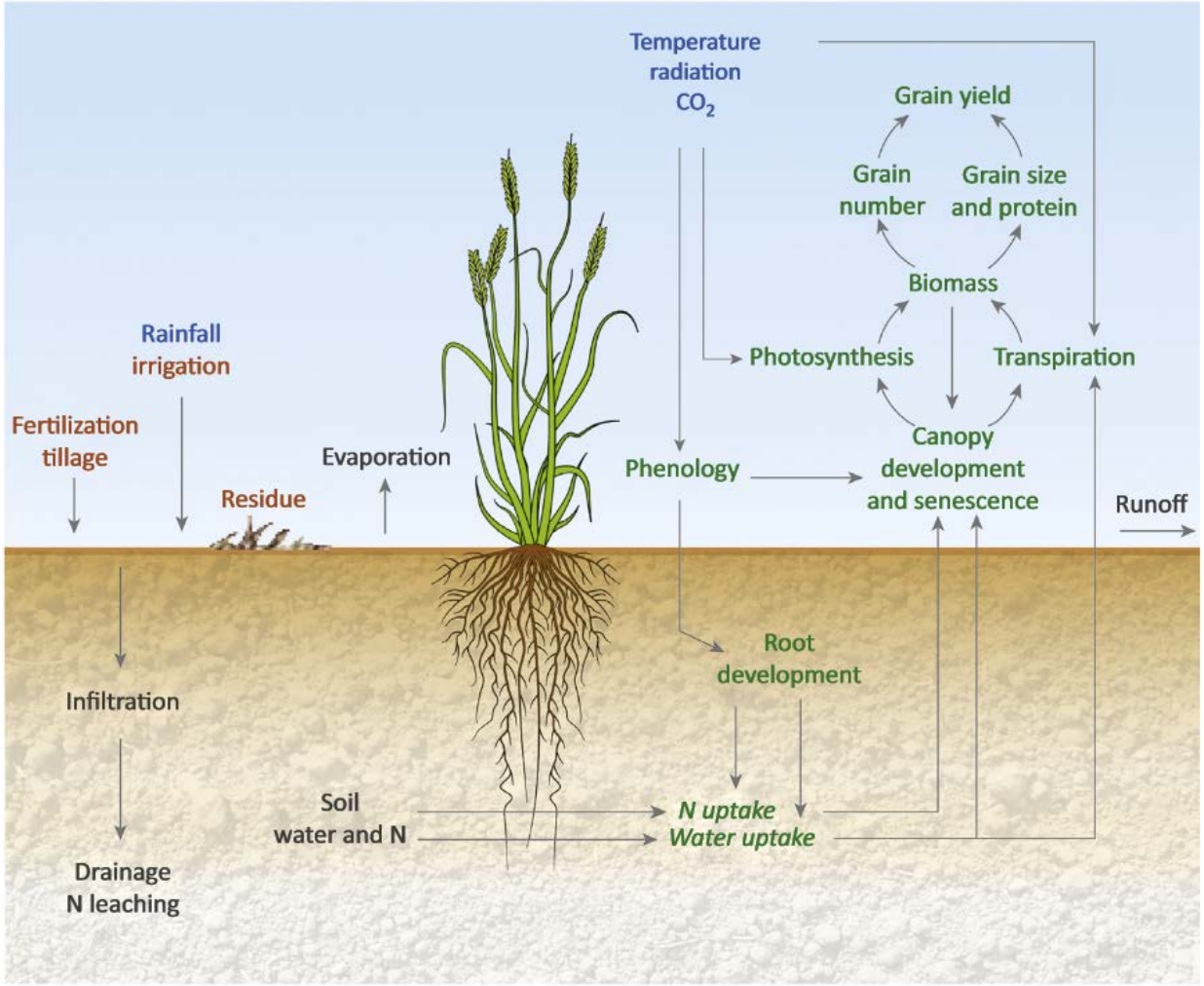
Objective

- To analyze the drought of 2018 impact on cereals (focus on winter wheat and barley), so as to understand how does it affects yield.

Methodology

- DSSAT crop model
- Calibration data:
  - Field diseases monitoring for phenology (Jordbruksverkets)
  - Yields (Jordbruksstatistisk årsbok 1965-2012)
  - Yields (Sortval 1967-2016, Andersson, A. (2013), NFTS)
- Soil data:
  - Sveriges geologiska undersökning/WISE
- Weather data:
  - LANTMET and SMHI

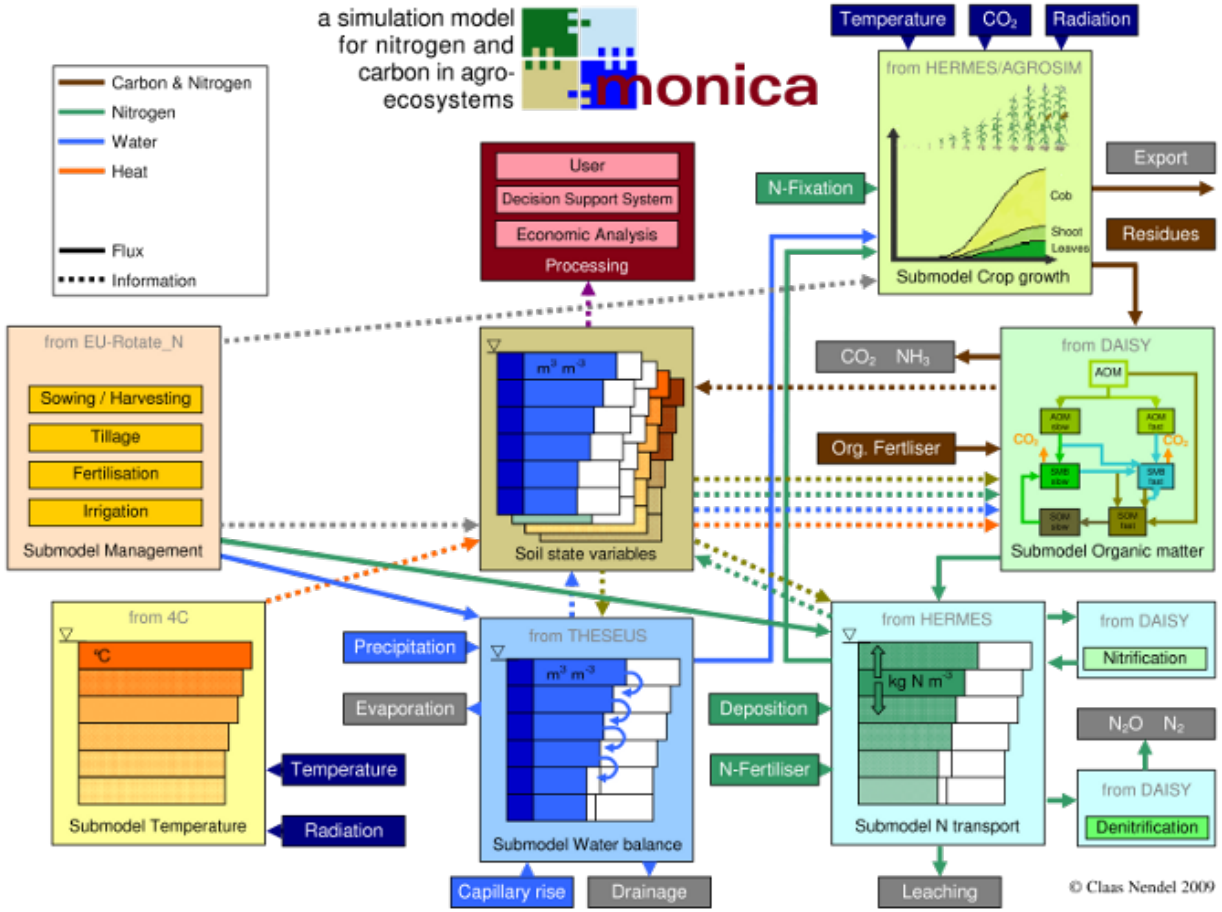




http://dx.doi.org/10.1016/j.tplants.2017.02.003

Trends in Plant Science

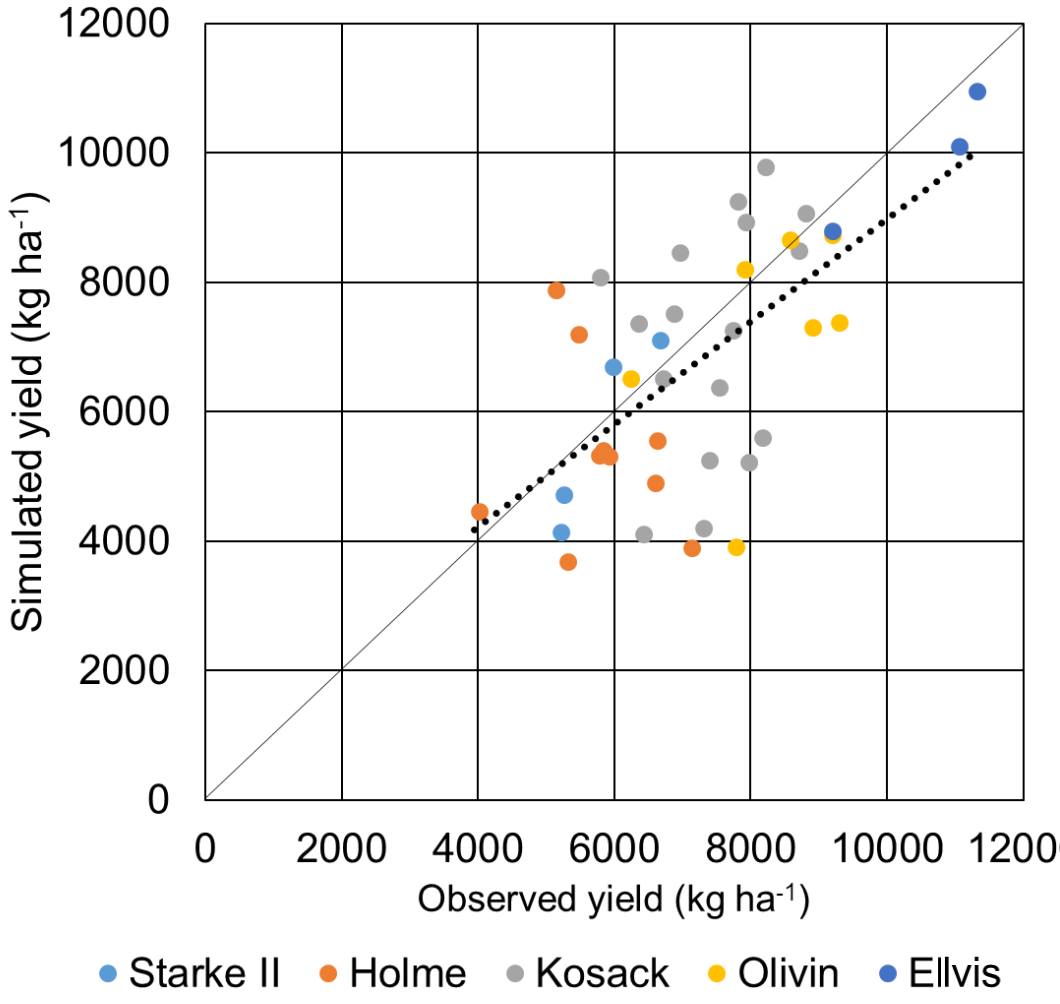
Example of a biophysical, process-based model (MONICA)



Validation

(only for wheat now)

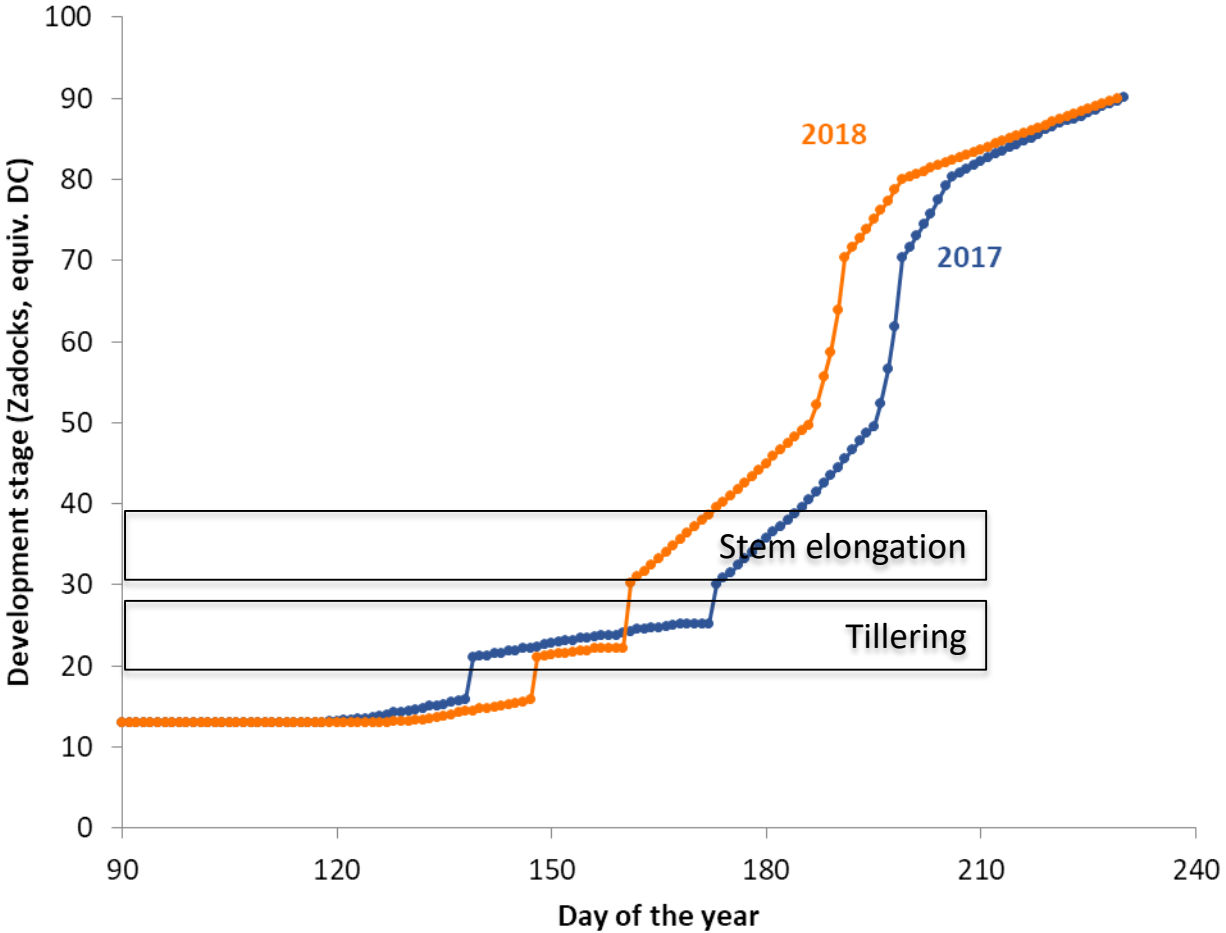
	RMSE	R^2	IA	MAE
Starke II	13%	0.89	0.02	691
Holme	18%	0.16	0.06	913
Kosack	19%	0.15	0.02	1157
Olivin	9%	0.55	0.04	533
Ellvis	6%	0.92	0.06	585
TOTAL	16%	0.62	-0.04	903
1:1	0%	1.00	0.00	0.00



Results

Temperature

- Warmer-than-average conditions were present across much of Sweden during May 2018, with several locations experiencing their warmest May on record;
  - Stockholm, a new maximum May temperature of 16.1°C.
  - On May 30th, 31.1°C in Göteborg.



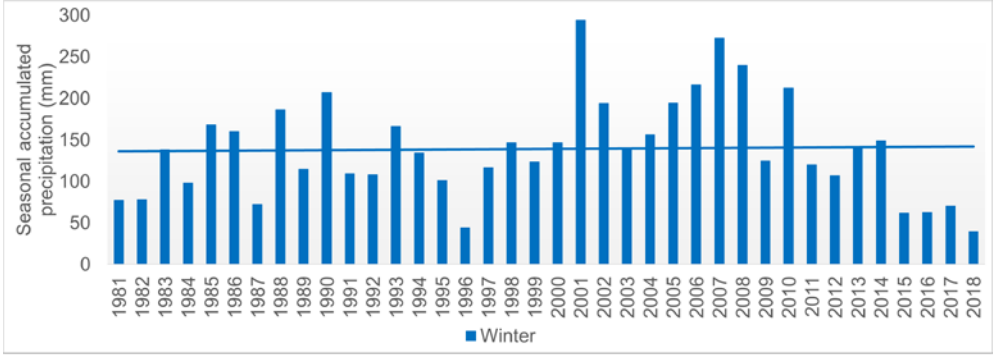
Comparison of the phenology of barley in Southwestern Sweden in 2017 and 2018. Note that the 2018 season (orange line) experienced an advancement in the phenology.

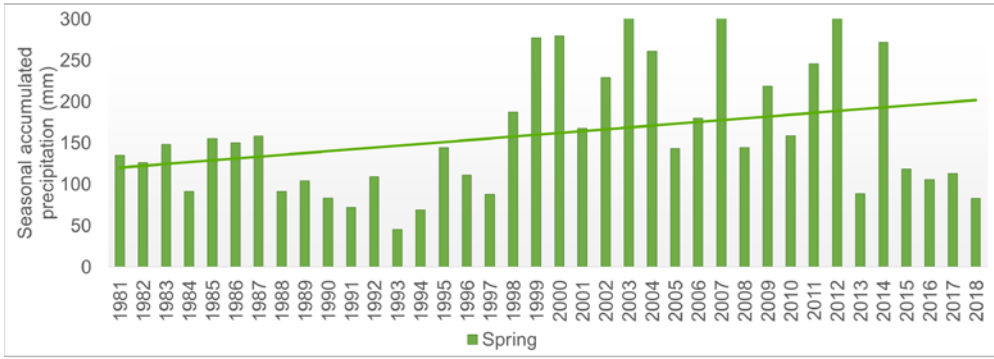
Results

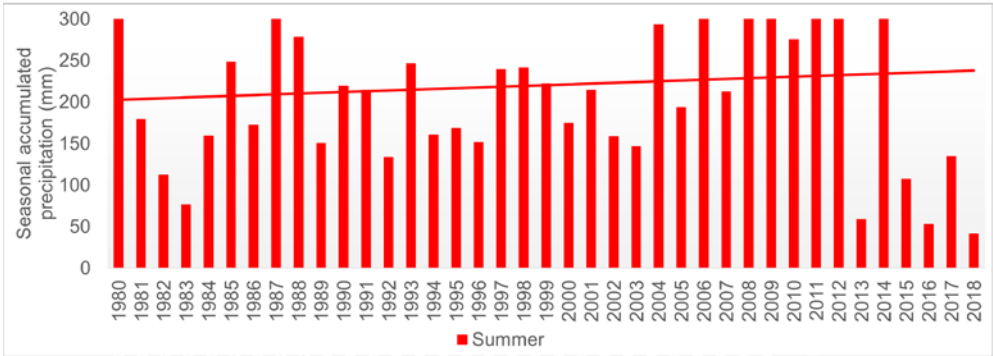
Precipitation

- In 2018, drier-than-average conditions affected much of Sweden during May 2018. Several locations had record or near-record dry conditions.
  - Visby, Gotland, had its driest May since records began in 1859, with a precipitation total of 1.7 mm for May 2018.

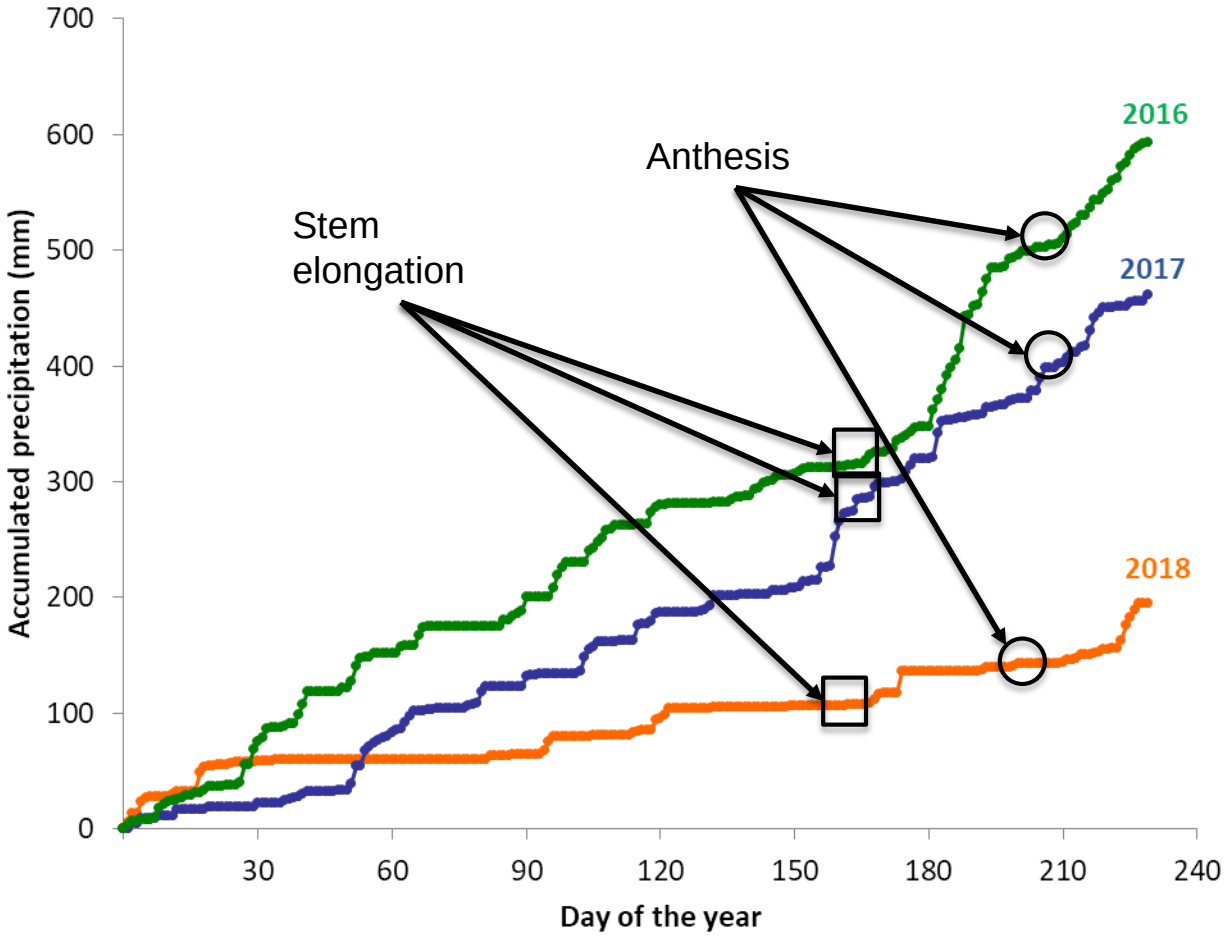
Weather stations 540 and 520 (SMHI) (interpolated)







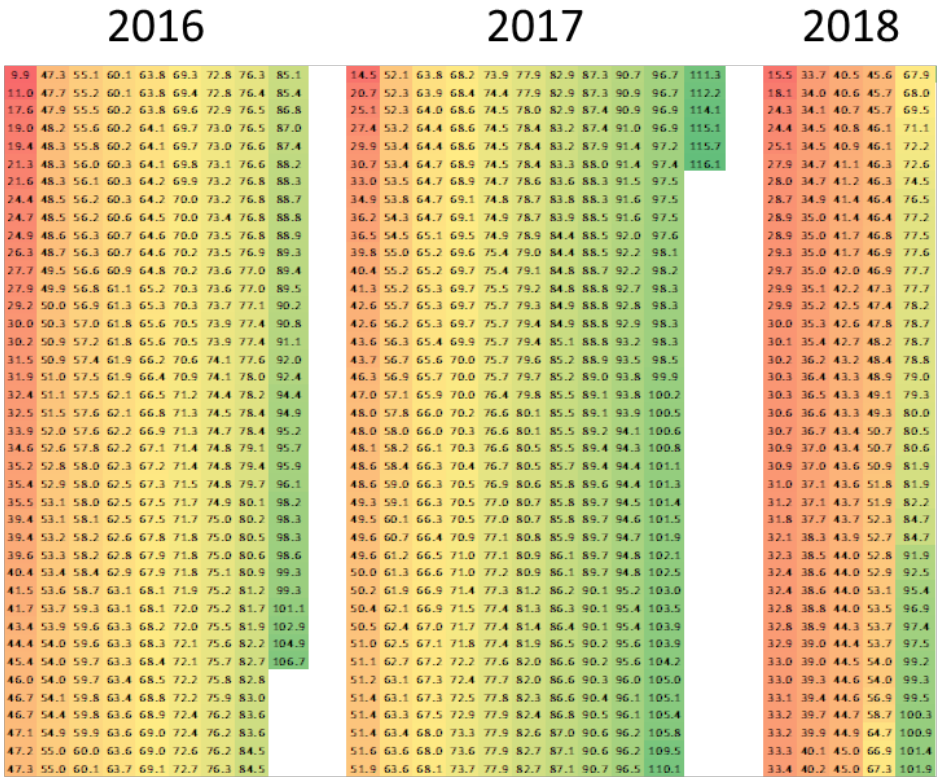
Average accumulated precipitation during the cropping season in Southwestern Sweden (2016-2018)

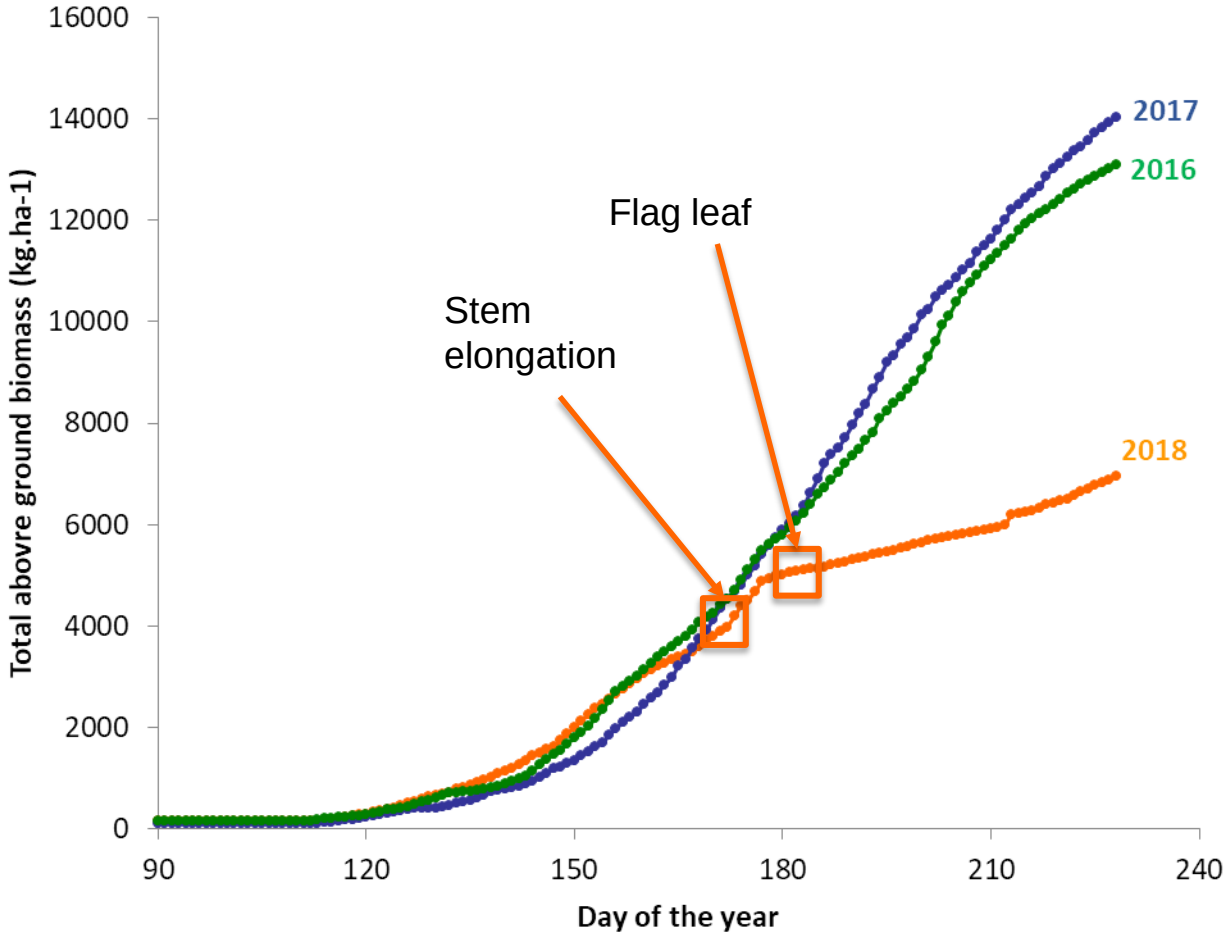


Effects on crop yield

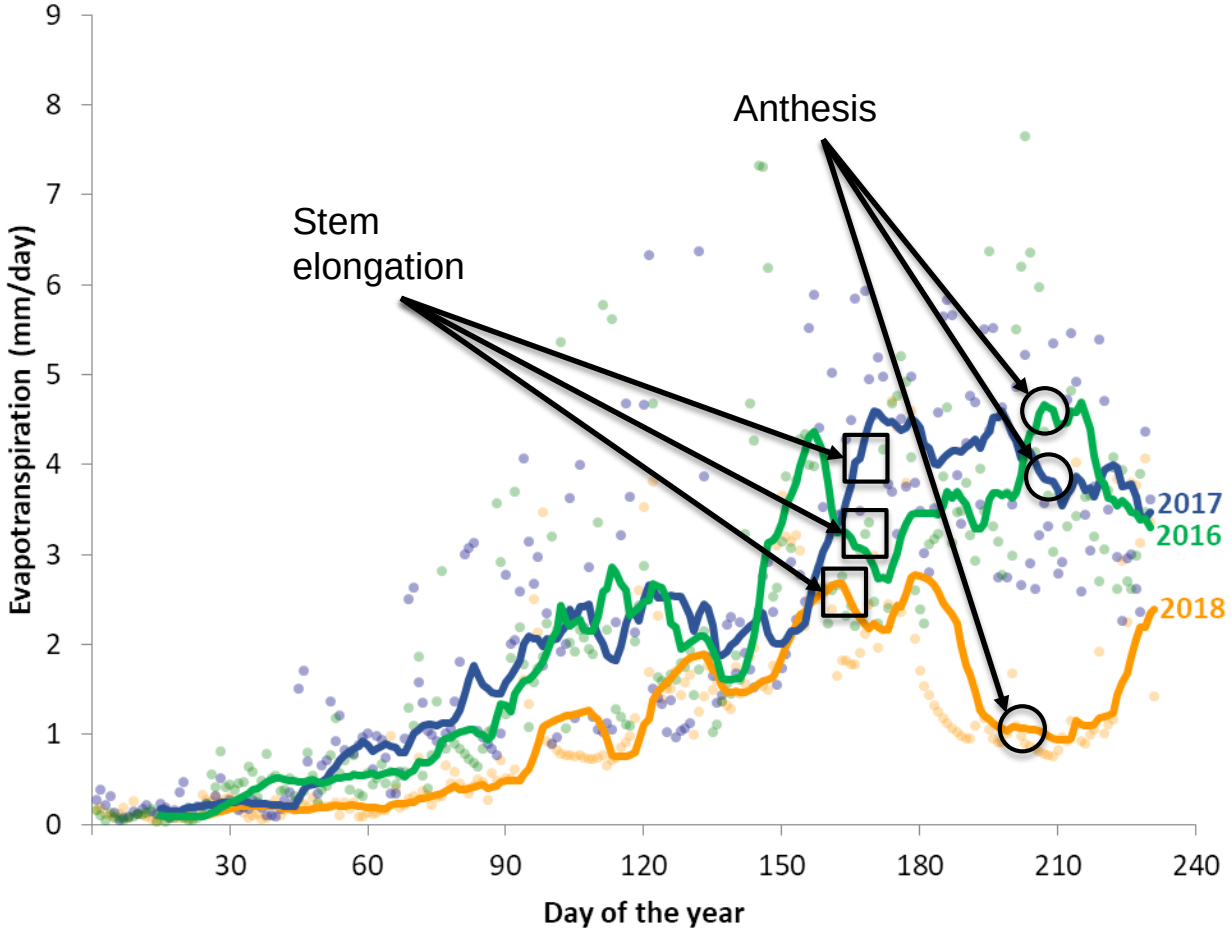
- Field data from 1174 experiments conducted in Sweden between 2016 and 2018 (NFTS) indicate a **consistent reduction** in the current yields.

- Overall, the 2018 yield of winter wheat and malting barley was 32% lower than the previous year.

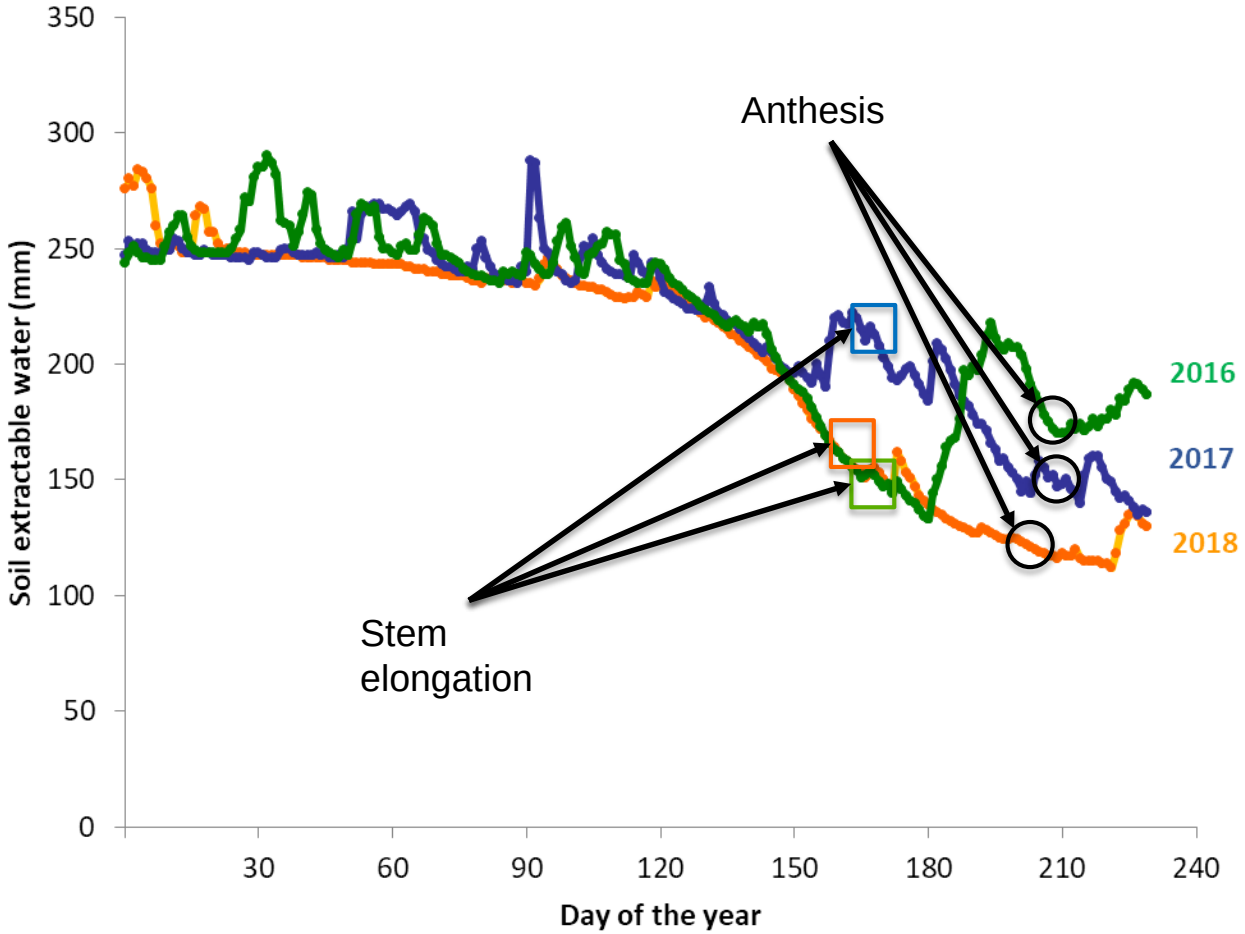




Daily total aboveground biomass of wheat during the cropping season in 2016-2018.



Daily evapotranspiration of wheat during the cropping season in 2016-2018.



Soil extractable water during the cropping season in 2016-2018.

How to adapt?

- **To cope with high temperatures:**
  - Breeding: cultivars with higher thermal sum requirements during the cropping season OR shorter thermal sums, so they can have better use of the winter accumulation of water.

- **Drought:**
  - Increase soil water retention capacity: cover crops, strip till?
  - Emergency irrigation?

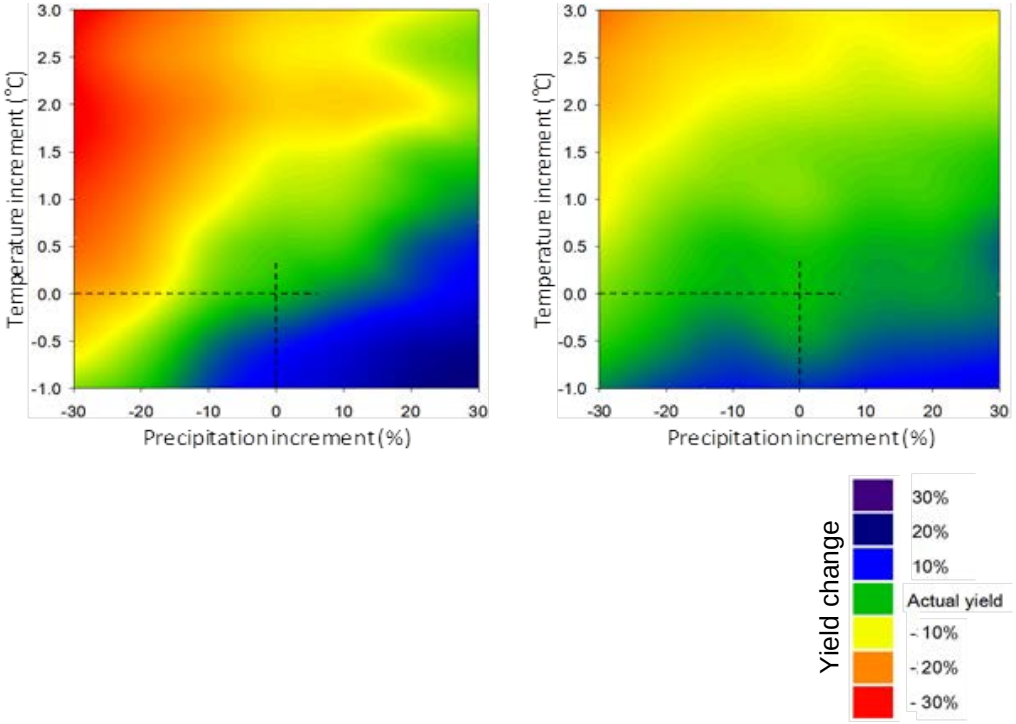
- **Implications for fertilization management:**
  - Reduced capacity to absorb nutrients;
  - High accumulation of N in the plant biomass = high protein levels (e.g. malting barley in 2018);

IMPORTANT: Use appropriate cultivars to ensure crops flower during the optimal period and have accumulated enough dry matter to intercept all incoming radiation by the time of flag leaf emergence.

Next steps

- Fine calibration of crop models to the Swedish cultivars and sites;
- Modelling the effect of:
  - Site (soil characteristics and weather)
  - N management (form, amount, number of applications)
  - Cultivar (different thermal sums)
  - Precipitation and temperature

- Target parameters:
  - Yield
  - Grain protein content
  - Susceptibility to abiotic stresses

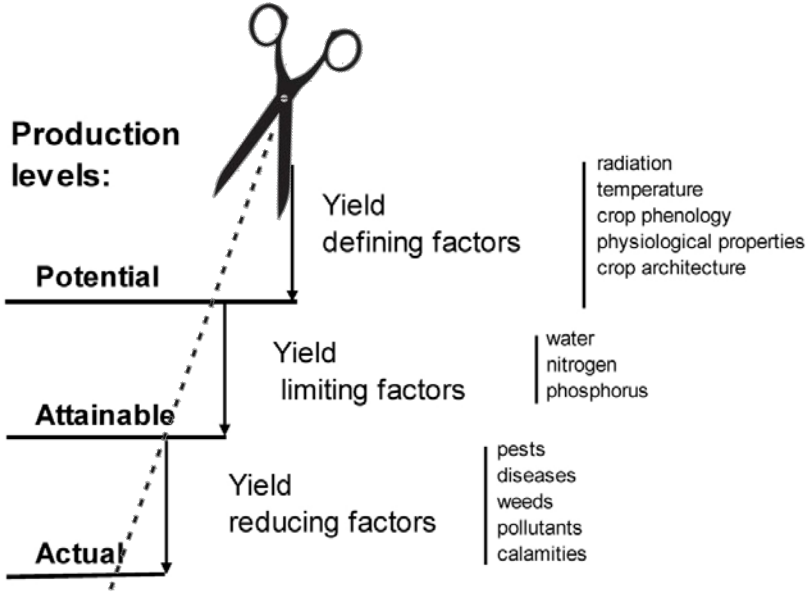


Example for maize: yield changes by variating temperature and precipitation according cultivar.

Lana et al, Agron. Sustain. Dev. (2017) 37:30. DOI 10.1007/s13593-017-0442-x

Final remarks

- Drought impacted yields by:
  - Reducing photosynthesis;
  - Reducing the absorption of nutrients;
  - Increasing plant temperature;



- High temperatures exacerbate the effect of drought:
  - By increasing the evapotranspiration;
  - By reducing the length of important phenological stages (such as tillering, stem elongation or grain filling).

Thanks


Bundesarchiv, Bild 183-48203-0012
Foto: Blumenthal | 18. August 1967