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Drought risk assessment for UK winter wheat under climate change

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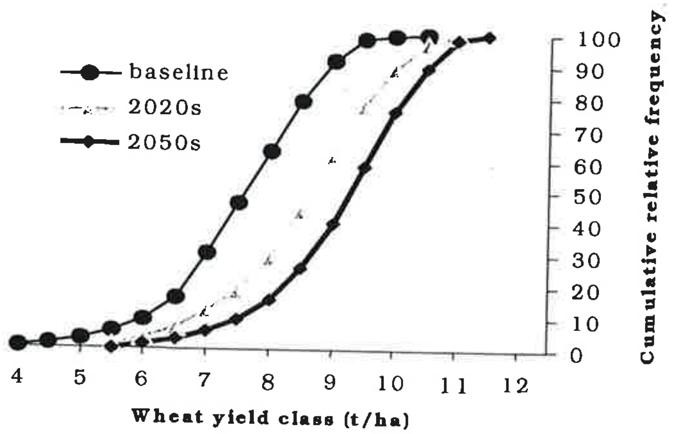
limate change scenarios predict an increase in average air temperature and rainfall variability as well a rise in atmospheric CO_2 concentration. By 2050, widely accepted UK climate models (e.g. HADCM2 edict a 15% increase in the annual amount of water removed from the soil by soil evaporation and plan anspiration (evapotranspiration) and 16% less summer precipitation. This will enhance the risk o ought in the UK. IACR has conducted three years of research, funded by DEFRA, analysing the relativ fect of these factors on crops using simulation models. Overall, our objective is to assess the impact o imate change on wheat and sugar beet yields across the UK.

ur method combines regional data for soil and weather with simulation models of wheat and sugar beet. Actua elds are used to evaluate and calibrate the model response to a range of imposed (drought) and naturall curring growth conditions. A random weather generator (LARS-WG) was used to generate baseline climate an mate change scenarios, which were constructed using the "HADCM2" climate model output for the main U gions. Finally, multiple simulations were run for each region using climate scenarios, representative soils an op management (e.g. sowing date).

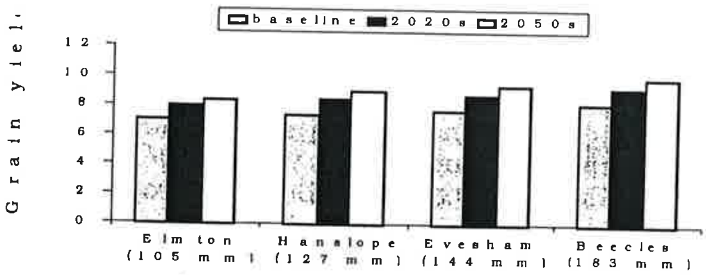
ne of the models used (SIRIUS), described drought sponse well in field experiments and could be lidated against on-farm trial experiments conducted ADAS. In a drought-prone environment the riation of regional yields could largely be explained, ereas the small range of natural yield variation in UK (1-2 t ha^{-1}) could not be reproduced. The owing simulation results are valid under the nstraint that the increase of radiation use efficiency UE - the amount of dry biomass produced per unit of ercepted light) and drought, are major processes and er impacts (e.g. disease) are not included. **Fig. 1** strates the shift in distribution of wheat yields for East Midlands from a mean of 7.5 t ha^{-1} (1961-90, eline) to 9.1 t ha^{-1} (circa 2050).

Figure 1: Past and future distributions of grain yields (dry matter) for East Midland region



ur soils were selected to represent the benefit of ger water storage capacity in the soil. The future d increase was smaller on droughty soils than on d soils (1 t ha^{-1} and 2 t ha^{-1}, respectively (**Fig. 2**). s result should be taken with caution however, ause the Soil Survey data do not include an mate of spatial variability and soil degradation, and negative impact of shallow soils may not be esented adequately.

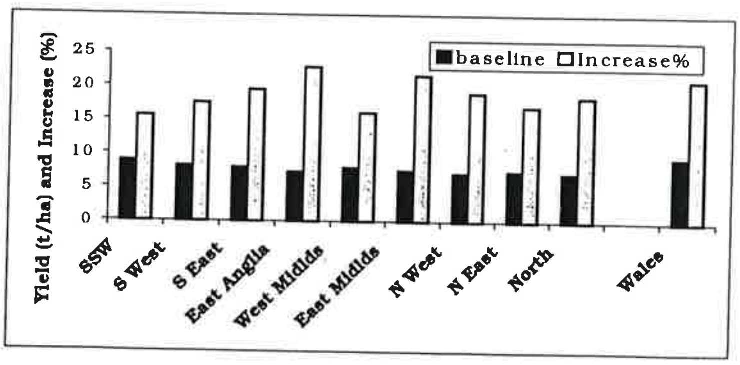
Figure 2: Impact of soil water availability (mm) on average yields



main results can be summarised:

- Average wheat yield in the given regions is likely to increase ~~by~~ between 1 and 2 t ha^{-1} (**Fig. 3**) due to a higher RUE. — GIVE IN FULL FIRST TIME
- Without the rise of atmospheric CO_2 and its effect on RUE, yields are likely to decrease assuming a similar precipitation and evaporation regime.
- Higher temperatures will shorten the grain filling period unless plant breeders create adapted varieties.
- Due to accelerated crop maturation the evapotranspiration will decrease in the future, however, because of CO_2-increased RUE, the water use efficiency will rise.

Figure 3: Regional mean wheat yields in the past (baseline; 334 vpm CO2) and future increase (2050s; 544 vpm)



future task in the project is to scale the prediction of the process models for phenomena not included. onal yield data indicate that rain and the proportion of wet days from terminal spikelet until grain filling, ces UK yields. However, when including a simple correction to account for this in the model, low yields in dry hot years were not explained. This suggests that better impact assessment models need to include the o-) climatic effects on diseases as well as sink limitation. Extreme temperatures affect the latter, and the ability of exceeding threshold temperatures during anthesis and grain filling (31° & 25°C) will rise by a factor ll 2050.

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