

SCENARIOS OF CLIMATE CHANGE EFFECTS ON SUGAR BEET IN NORTHERN AND CENTRAL ITALY

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Introduction

The yield potential of the areas in which sugar beet is cultivated in Italy is lower than in Central Europe. Hence, the profitability of the crop is also lower, and a shift in climate may put at risk the sugar processing industry.

General circulation models (GCM) project the patterns of future climate change due to anthropogenic greenhouse forcing (primarily CO₂) of the atmosphere. The latest available GCM simulations allow researchers to also consider the effects of sulphuric aerosols on future climate.

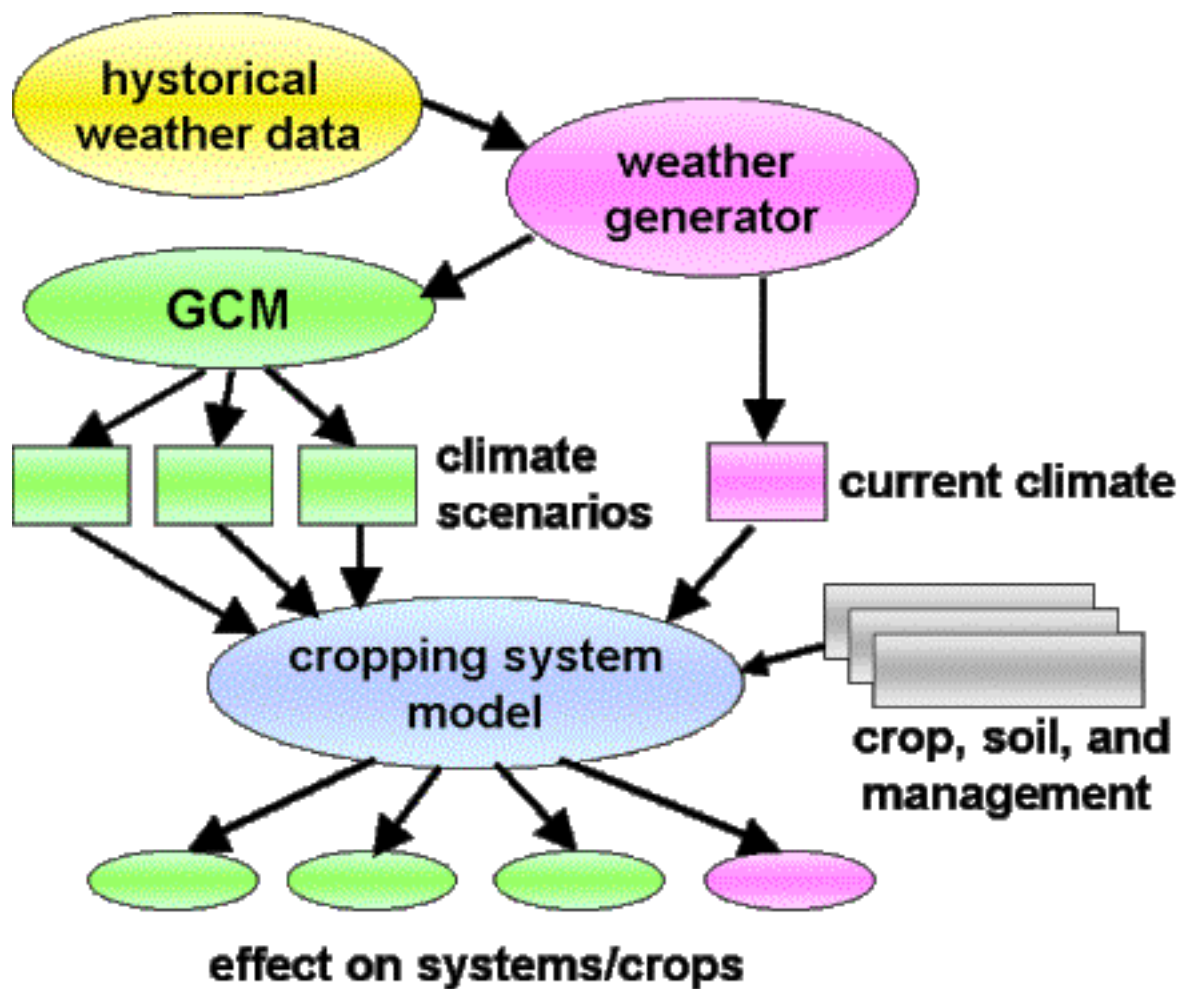
Cropping systems models analyze the effects of weather and management on crop yield. They also have been improved and tested in a variety of conditions.

Objective

To evaluate the impacts of scenarios of climate change on sugar beet production.

Methods

The transient climate simulations of the Hadley GCM (with aerosols effects), and the cropping system model CropSyst, were used to estimate the impact of climate change on sugar beet, according to the diagram below.



Climate scenarios were generated referring to the year 2040 (projected CO₂ concentration 415 ppm) and to the year 2090 (estimated CO₂ 615 ppm).

Fifty years were simulated sequentially for each location and scenario. Two soils (deep silty-clay, and shallow silty-sand) were used as model inputs in each case. Different sowing times and irrigation/no irrigation were also tested as management options in order to maximize yields under each scenario.

The locations selected, although not geographically distant from each other, have temperature/rainfall patterns which are remarkably diversified. The climate scenarios produced by the GCM show a consistent increase of temperature at all sites. The projected warming becomes substantial by 2090, despite the mitigating aerosols effects. Rainfall projections show a substantial increase during the autumn-winter months. During the summer months changes are opposite in sign, with a moderate increase projected for 2040, but a significant decrease for 2090.



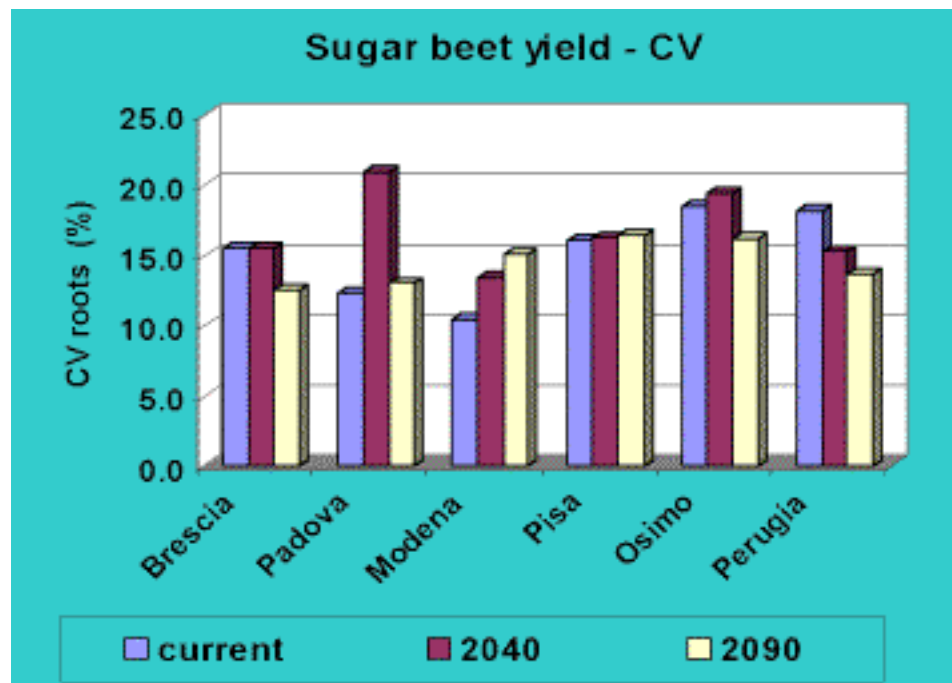
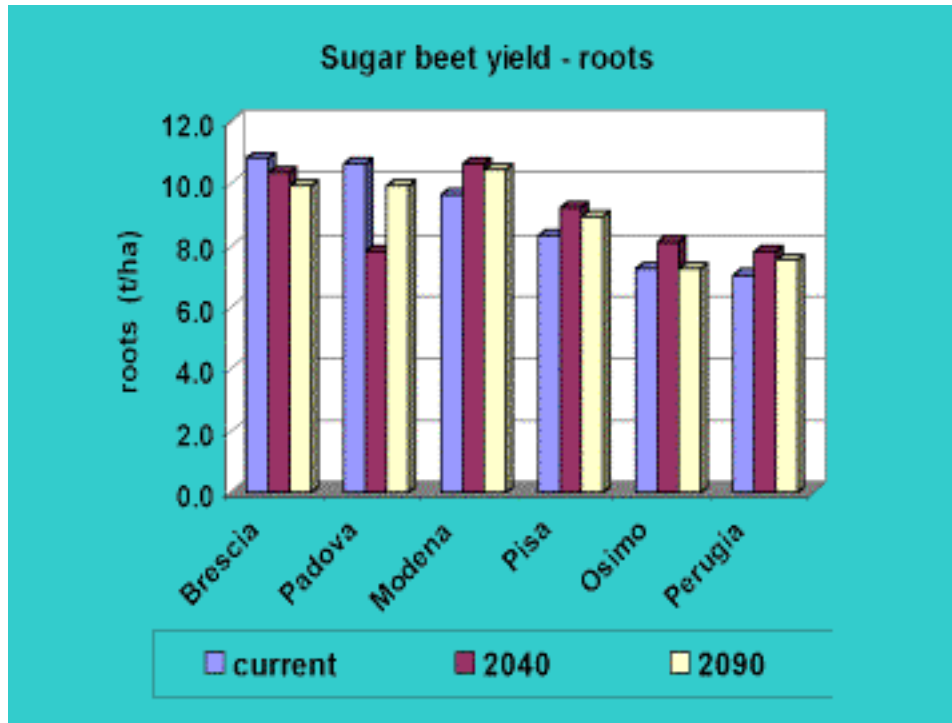
GCM estimates of weather change (average across locations)

	Oct-Jan		Jun-Sep	
	2040	2090	2040	2090
Tavg (C)	+0.88	+3.43	+1.23	+4.42
Rain (mm)	+72	+41	+6	-27

Results

Negative effects of climate change on sugar production were minimized by adaptation of planting date. With adaptation, roots yield and CV showed little change across the scenarios considered. In addition to adaptation, positive effects on crop yield under climate change were: increased photosynthetic activity due to elevated CO₂ levels (sugar beet is a C₃ species); and increased soil moisture recharge during the winter months, accompanied by little change in cumulative rainfall during the growing period, compared to present conditions. An interaction location x scenario was also found, showing mostly as roots yield

CV.



Irrigation stabilizes yield, but overall its expansion under climate change did not appear necessary to optimize sugar production.

Location	current t/ha	2040 t/ha	2090 t/ha
Brescia-rainfed	10.8	10.3	9.9
Brescia-irrigated	12.4	12.7	13.1
Padova-rainfed	10.6	7.8	9.9
Padova-irrigated	11.4	11.6	11.8
Modena-rainfed	9.6	10.6	10.4
Modena-irrigated	10.5	11.0	12.1
Pisa-rainfed	8.3	9.2	8.9
Pisa-irrigated	11.0	11.3	10.5
Osimo-rainfed	7.2	8.1	7.2
Osimo-irrigated	11.3	11.9	11.7

Conclusions

The climate scenarios considered in this study do not appear to threaten sugar beet production in Italy, provided simple adaptation techniques are implemented.

No additional irrigation water is thus necessary to maintain current production levels in the future.

The interaction location x scenario appears remarkable, considering the limited distance among locations.

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