GUIDELINES

Adaptation to Climate Change in Mediterranean Agricultural systems

www.aclimas.eu

Adaptation to Climate Change of Cereal production systems in Central Morocco

Target area description

Case Study Area

Central Morocco
Chaouia Ourdigha Region

General Characteristics	
Location	Chaouia Ourdigha
Main crops in the area	Wheat (73%), Barley, chickpea, and lentil
Annual rainfall	350 mm
Crop growing season evapotranspiration	300 mm

Agro-efficiency Performance (means)

Indicator	Value
Yield (t/ha)	1.5
Water Productivity (kg/m3)	0.9
Cereal area (ha)	700,000 (virtually all durum wheat)
Legumes area (ha)	200,000 (mainly Lentil, chickpea)
Irrigated area (%)	3
# D. wheat varieties	35
# Legume varieties	45 (Lentil, chickpea)

Target Agro-efficiency Performance

Indicator	Value
Yield (t/ha)	3
Water Productivity (kg/m3)	1.5
Irrigated area (%)	3
# D. wheat varieties	30
# Legume varieties	20 per legume species

Guidelines elaborated by
INRA, Settat-Morocco
UdL, University of Lleida-Spain

Target Region Contact Person
Dr. Hassan Ouabbou; INRA, Settat-Morocco
E-mail: hassan.ouabbou@gmail.com

Funded by

Implemented by

SWIM (Sustainable Water Integrated Management) - Demonstration Project

CIHEAM IAM BARI

Theme: Water and Climate Change

"European Neighborhood and Partnership (ENP) financial co-operation with Mediterranean countries"
EuropeAid/131046/C/ACT/Multi

Project Duration: 29/12/2011 - 28/12/2015

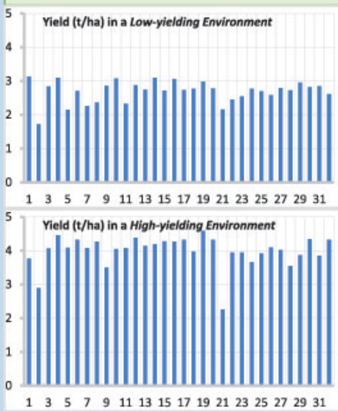
Environmental Characteristics

- Increasing Temperature
- Decreasing rainfall
- increasing soil degradation
- Poor management practices

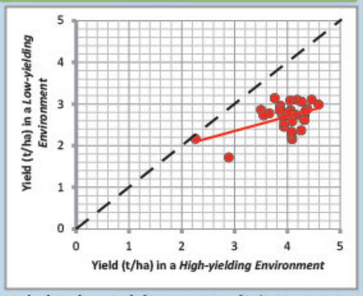
Directly Involved Actors

- Farmers
- Advisors
- Engineers and technicians
- Stakeholders

VARIETIES

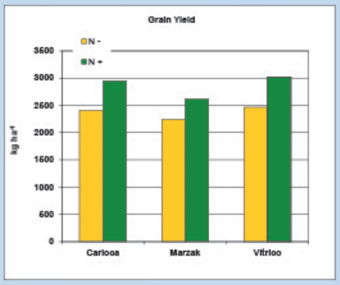


There is a rather large degree of variation in performance between commercial cultivars available in the region, both under relatively low- and high-yielding locations (data for 32 different cultivars averaged across 3 growing seasons)



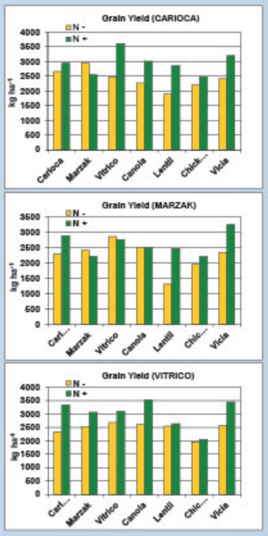
Although yields under low- and high-yielding conditions are interrelated, there is room for improvement by selecting the best performing variety for each particular location and growing condition

Alternative Technology Scenarios		
crops	**Technologies**	**Objective**
Wheat	Adapted varieties	Yield improvement, food security ,poverty alleviation
	Heavier N fertilization	Yield increases, grain quality, higher water productivity
	Conservation agriculture	Production stability, drought mitigation, higher water availability
Legumes	Adapted varieties	Increase of protein production, soil health improvement
	Weed and disease control	Profitability enhancement



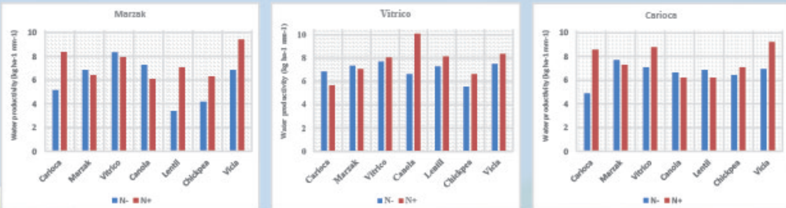
Yield under two contrasting N fertilization rates (50 and 174 kg N ha^{-1} of total soil N availability).

Evidences show that even under very dry, low-yielding conditions, N availability may be limiting yield (in co-limitation with water) and that farmers may on average benefit from a more intensive N fertilization scheme than that usually used.



Grain yield for Carioca, Marzak and Vitrico under low (yellow) and high (green) nitrogen availability and for different previous crops.

In general, grain yield was higher under high than under low nitrogen availability, although in some cases minor differences were found. Wheat yields in the three genotypes were higher after Vicia and Canola and minor effects were found after lentil or chickpea when compared with wheat as a previous crop.



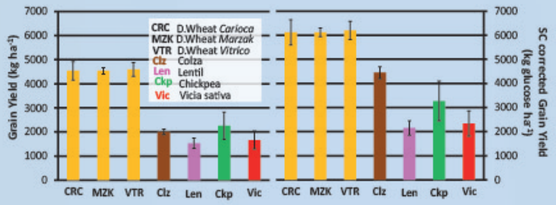
Water productivity values were between 3. 4 and 10.1 kg ha^{-1} mm^{-1}. The values were slightly higher with high N availability and with legumes as previous crops, even under very dry conditions (216 mm).

Water productivity (grain yield/ETc) for Marzak, Vitrico, and Carioca under low (blue) and high (red) nitrogen availability and for different previous crops.

ETc was calculated as ETo x Kc . The values of Kc were obtained from Kahrrou *et al.* (2011).

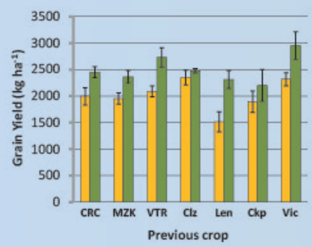
DEMONSTRATION & IMPLEMENTATION FACTS

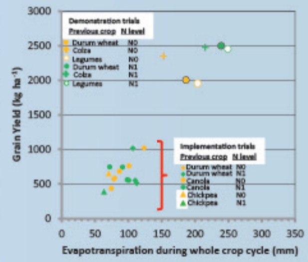
During the ACLIMAS project we have developed demonstration and implementation activities. Demonstration work was carried out in the main experimental station of INRA-Settat (Sidi El Aidi) where we have compared the performance of wheat and alternative (oilseed and legume) crops in the first growing season and then the performance of wheat in response to the preceding crops (tested in the first season). In both growing seasons we have included three different wheat cultivars. For the implementation work we run in parallel similar comparisons (though less comprehensive and with fewer determinations) in collaboration with farmers in their fields across different locations



In the growing season considered, wheat yielded consistently more than canola and the legumes, and the difference was not restricted to the quality of the grains (as correcting for the caloric content of the grains and expressing yield in equivalents of glucose reduced, but did not eliminate, the difference in yield). Canola tended to perform better than the legumes.

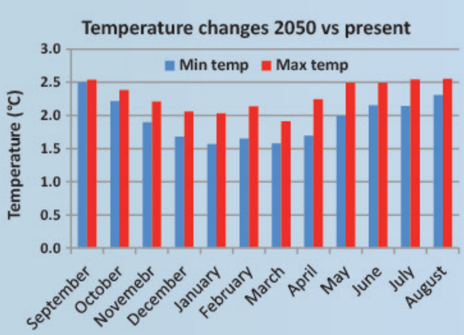
The second growing season was extremely dry and therefore the results could not be extrapolated to regular seasons, as responsiveness to soil N and the pressure from pathogens become irrelevant and the actual value of the previous crop cannot be quantified. In this condition, wheat did not yield better when grown after legumes or canola compared when it was grown after wheat. There was however some response to N, strengthening the comment in this guidelines on the advantage of fertilizing even in dry conditions.

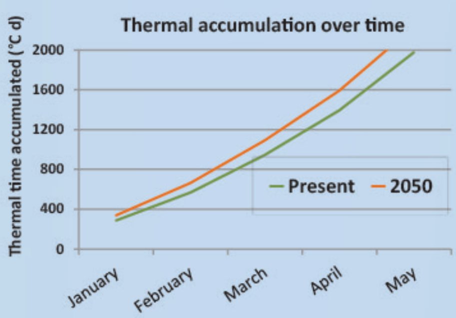


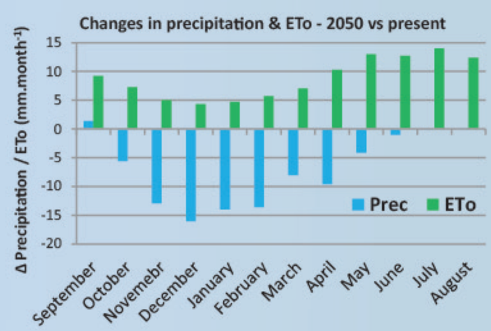


CLIMATE CHANGE IMPACT: year 2050 vs. baseline (1961-2000)

Climate change projections for the medium-term (2050 as average over 2041-2060) were defined for Chaouia Ourdigha as average over 19 Global Circulation Models based on the RCP4.5 scenario, which is a medium emission scenario. For simplicity main results indicate average values, and not uncertainty (especially significant for precipitation). According to these medium-term climate projections, Chaouia Ourdigha will experience an average increase in mean annual temperature of 2.1 °C (1.5 to 2.8 °C according to different GCMs). Seasonally, increases in temperature will be greater in summer and lower in winter. Maximum temperatures would face larger increases than minimum temperatures, especially for winter and spring wherein daily temperature ranges widens. Higher temperatures will lead to increasing evapotranspiration and crop water demand. Increasing temperatures will also raise thermal accumulation over time, measured as Growing Degree Days (°C d, Tbase = 0 °C), shortening crop growing seasons.







The average projected precipitations will show a significant reduction of about 20% for 2050. However, the changes in precipitation projected by different GCMs vary, with uncertainty ranging between -5 to -31%. Reduction of precipitation will be more evident in winter and partial in spring. Higher temperature will increase evapotranspiration and vegetation water requirements. This, together with reduced precipitations, will amplify aridity and soil water deficit. Opportunities to improve soil's ability to capture and store water rely on the application of conservation agriculture package.

Climate variable	Baseline	2040-2060 RCP4.5	Changes vs. baseline	
			Difference	%
Precipitation (mm)	418	335	-83	-19.9
Minimum temperature (°C)	10.5	12.5	2.0	19.0
Maximum temperature (°C)	24.7	27.0	2.3	12.5
Mean Temperature (°C)	17.6	19.7	2.1	11.9
Thermal time accumulated January-May (°C d, or GDD)	2098	2388	290	13.8
Reference ET (mm)	1468	1573	105	7.2

Climate change analyses elaborated by CMCC

This publication has been produced with the assistance of the European Union. The contents of this publication are the sole responsability of the Authors and can in no way be taken to reflect the views of the European Union.