Climate change impacts on wheat yields in the North-West of Tunisia

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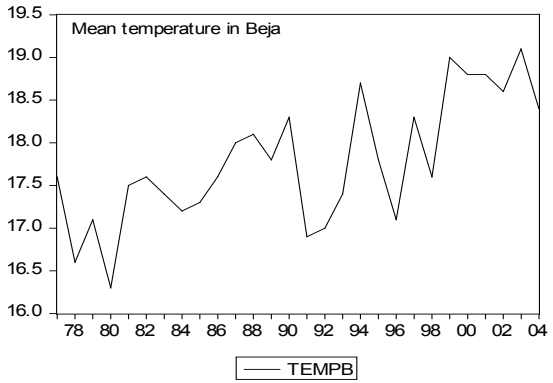
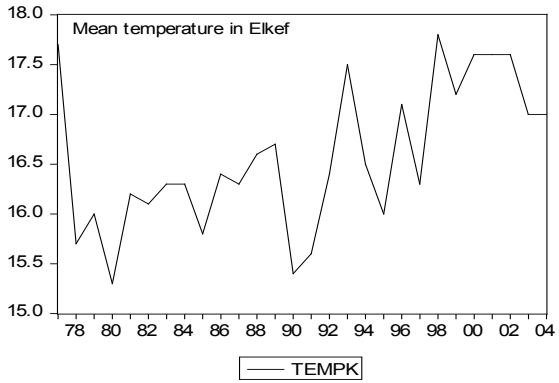
Outline

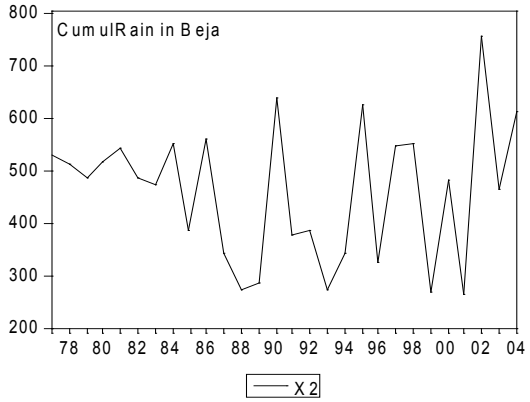
- Introduction
- Study districts
- Econometric model
- Estimation Results and Interpretations
- Conclusions

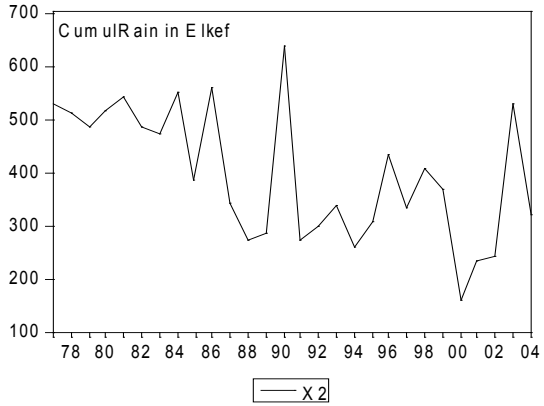
Study Districts

Evolution of climatic factors



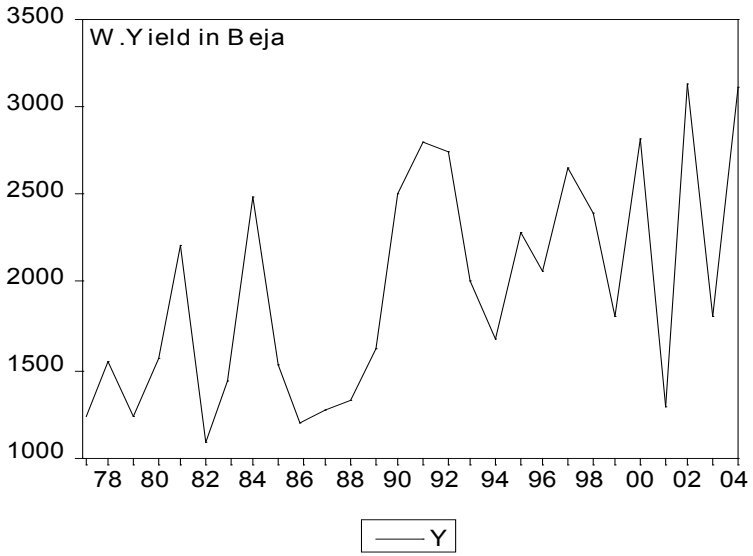


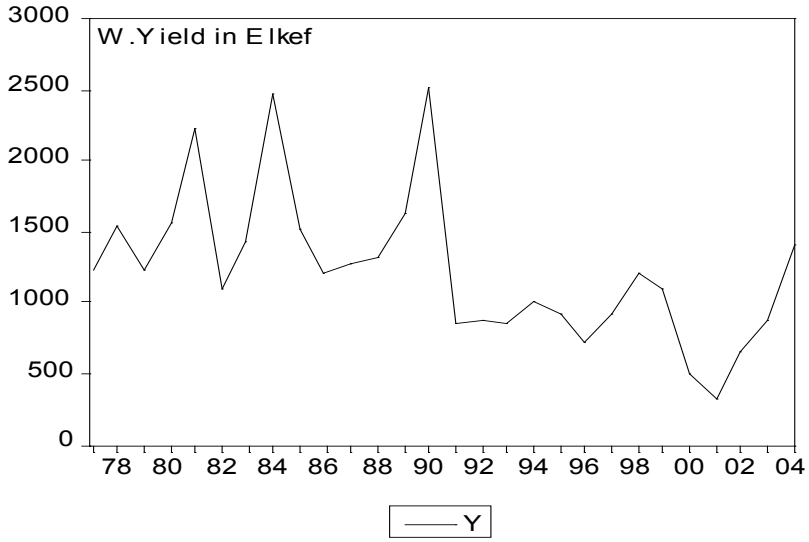




Temperature increase and rainfall decrease in the two districts.

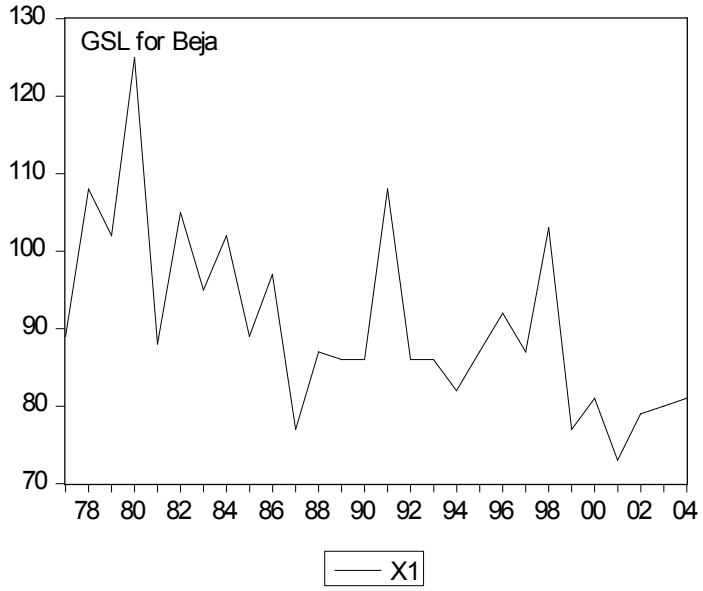
Durum wheat yield variation

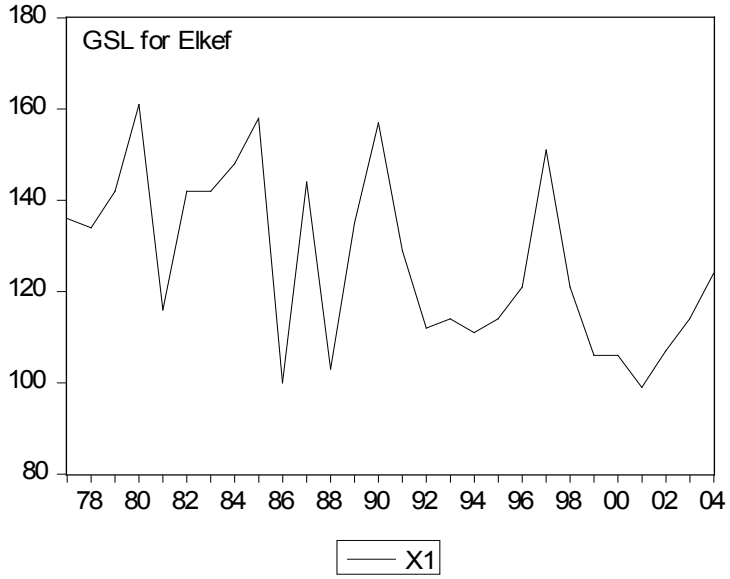




Rising temperatures and rainfall decrease have actually affected crop development and production in the field.

Growth Season Length(GSL) variation





Growing season length for durum wheat crop in Beja and Elkef districts is decreasing.

Econometric model

$$Y = AX_1^{\beta_1} X_2^{\beta_2} \exp(\alpha_1 X_1 + \alpha_2 X_2)$$

$$\frac{\partial Y}{\partial X_1} = \left[\frac{\beta_1}{X_1} + \alpha_1 \right] * Y = 0$$

$$\frac{\partial Y}{\partial X_2} = \left[\frac{\beta_2}{X_2} + \alpha_2 \right] * Y = 0$$

$$X_{1optimum} = -\frac{\beta_1}{\alpha_1}$$

$$X_{2optimum} = -\frac{\beta_2}{\alpha_2}$$

$$\frac{\partial^2 Y}{\partial^2 X_1} \langle 0 \quad and \quad \frac{\partial^2 Y}{\partial^2 X_2} \langle 0$$

and $$\frac{\partial^2 Y}{\partial^2 X_1^2} * \frac{\partial^2 Y}{\partial^2 X_2^2} \rangle \left(\frac{\partial^2 Y}{\partial X_1 X_2} \right)^2$$

where $\frac{\partial^2 Y}{\partial X_1^2}$ *and* $\frac{\partial^2 Y}{\partial X_2^2}$ are the partial derivatives of second order

Empirical model

$$LnY_t = \beta_0 + \beta_1 LnX_{1t} + \beta_2 LnX_{2t} + \alpha_1 X_{1t} + \alpha_2 X_{2t} + \beta_3 X_{3t} + \varepsilon_t$$

where Y_t : cereal yield in (kg / ha);

X_1 : growing season length in days ;

X_2 : cumul of precipitations in mm;

X_3 : time;

ε : random error;

$\beta_0, \beta_1, \beta_2, \beta_3, \alpha_1$ *et* α_2 are the coefficients to estimate.

$\beta_1 \rangle 0 \quad \beta_2 \rangle 0 \quad \alpha_1 \langle 0 \quad \alpha_2 \langle 0.$

Estimation results

Tab.1. Regression results for durum wheat yield in Beja district using time series data (1976/1977-2003/2004)

variables	coefficients	Std.errors	t-statistics	probability
Ln A (β0)	-24.52	20.43	-1.20	0.20
Ln growing season length (β1)	8.87	5.81	1.52	0.10
Ln rainfall (β2)	0.12	0.15	0.77	0.44
Growing season length (α1)	-0.08	0.05	-1.41	0.10
Rainfall (α2)	-0.00008	0.00007	-1.21	0.23
time (year number) (β3)	0.03	0.008	3.72	0.00
DW = 1.99 GSL = 110 days R^2 =0.46				

Tab.2. Regression results for durum wheat yield in El-Kef district using time series data (1976/1977-2003/2004)

variables	coefficients	Std.errors	t-statistics	probability
Ln A (β0)	-130.74	72.17	-1.81	0.10
Ln growing season length(β1)	40.74	19.47	2.09	0.06
Ln rainfall (β2)	4.50	2.83	1.59	0.10
Growing season length (α1)	-0.30	2.83	-2.02	0.07
Rainfall (α2)	-0.01	2.83	-1.85	0.10
time (year number) (β3)	-0.0009	0.04	-0.02	0.98
DW =1.99 GSL = 136 days R^2 =0.62				

Interpretations

$$\beta_1 \text{ and } \beta_2 \text{ are positive and significant}$$

$$\alpha_1 \text{ and } \alpha_2 \text{ are négative and significant}$$

$$R^2 \text{ is significant}$$

Our empirical results show that the two climate variables (growing season length and rainfall) have a significant impact on durum wheat yield.

Climate change scenarios and their impact on GSL

Temperature increase (C)	GSL(Beja)	GSL (Elkef)
0	105	136
1.5	83	125
2	79	72
2.5	74	84
3	71	80
3.5	68	76
Mean GSL	91	127

Growing season length for durum wheat is decreasing in Beja and Elkef districts under various climate change scenarios.

Climate change scenarios and their impact on yield of durum wheat

Temperature increase (C)	Yield of durum wheat(Kg/Ha) (Beja)	Yield of durum wheat(Kg/Ha) (Elkef)
0	1652	1197
1.5	1831	1507
2	1784	963
2.5	1722	625
3	1592	1237
3.5	1642	1125
Mean of yield	1959	1058

Different variation for two regions.

Conclusions

- We find that high temperatures correspond to a decrease in growing season length.
- Future increases in temperatures between 1.5 and 3.5° C may reduce the yield of durum wheat in the two districts.
- The choice of good varieties of wheat and delaying the date of plantation to December will be the best solution to ameliorate the yield.

THANKS FOR YOUR ATTENTION