Technological tool to address forecasting of agricultural production under different irrigation management

Ihab Jnad

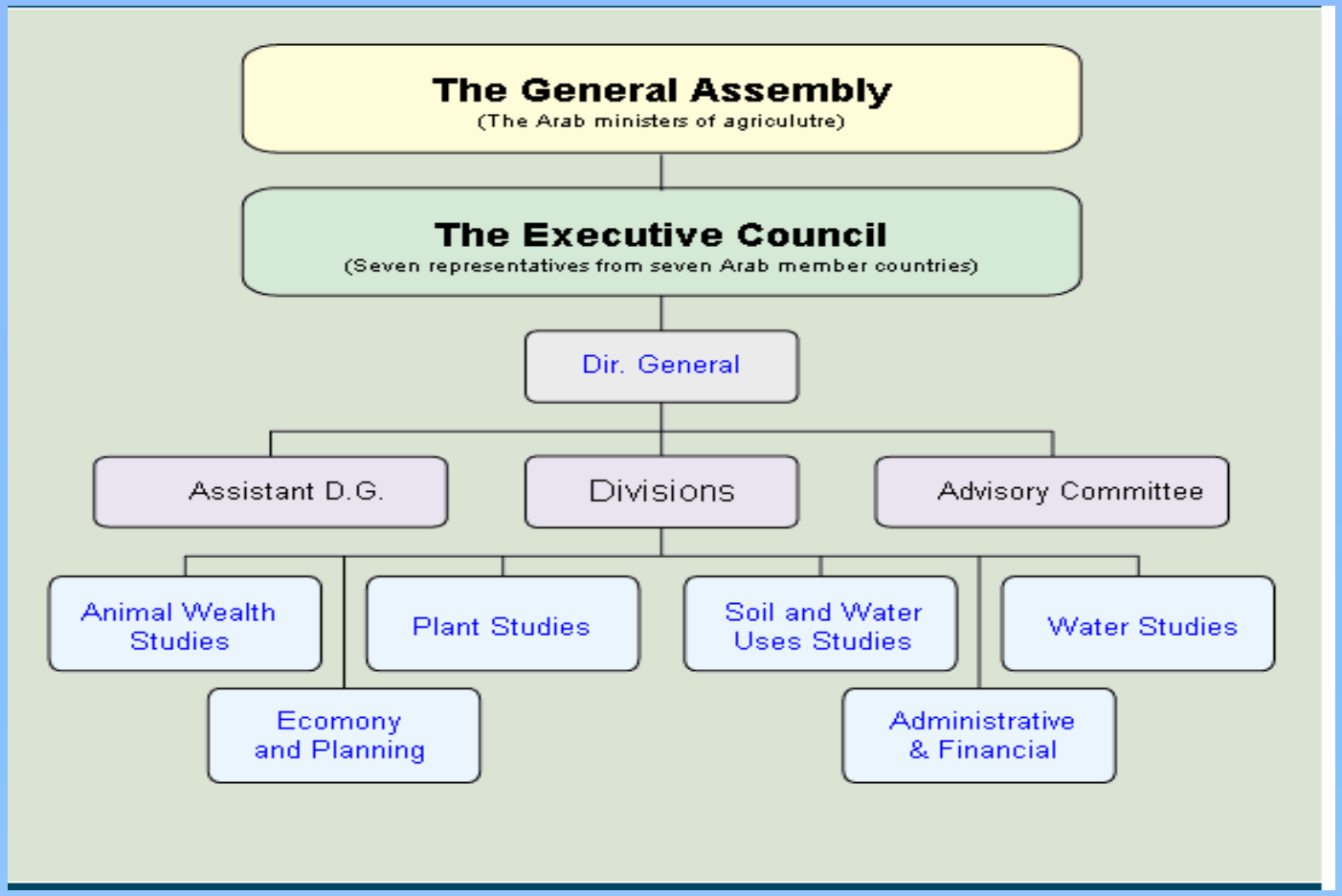
The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)

About ACSAD

The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) was established in Damascus, Syria in 1968. ACSAD is a specialized Arab organization working within the framework of the League of Arab States with the objective of unifying the Arab efforts which aim to develop the scientific agricultural research in the arid and semi-arid areas, help in the exchange of information and experiences and make use of the scientific progress and the modern agricultural techniques in order to increase the agricultural production.

ACSAD web site: *http://www.acsad.org*

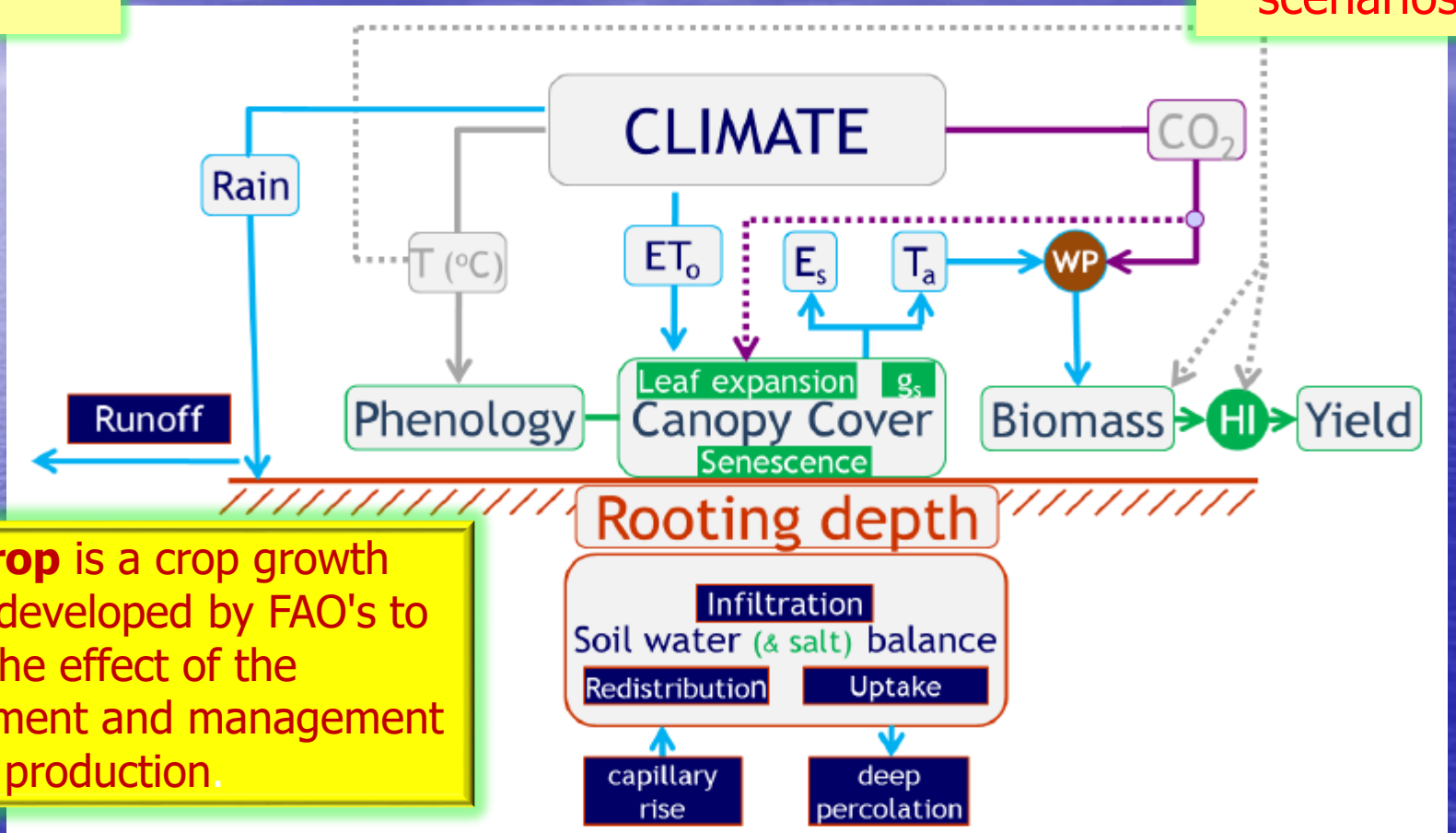
ACSAD Structure



AquaCrop model simulate yield response to water

AquaCrop model

AquaCrop predict yield under climate change scenarios



AquaCrop is a crop growth **model** developed by FAO's to assess the effect of the environment and management on crop production.

Developed by FAO

Dirk RAES, Pasquale STEDUTO, Theodore C. HSIAO, and Elias FERERES

AquaCrop model

AquaCrop is :

- Public domain
- Need a limited data requirements,
- a user-friendly interface enabling non-specialist to develop scenarios,
- focus on climate change, CO2, water and crop yields,
-

Required data

Climate data:

- Precipitation
- Temperature
- ET
- Concentration of CO2

soil data:

- Soil water content (θ) at saturation, field capacity, and permanent wilting point;Ksat; Depth of layer restricting root deepening

Field management data:

- Cover and type of soil mulches;
- Height of soil bunds;
- Surface runoff: ON/OFF

irrigation data:

- Irrigation method;
- Application depth and time of irrigation events;
- Salinity of the irrigation water.

crop data:

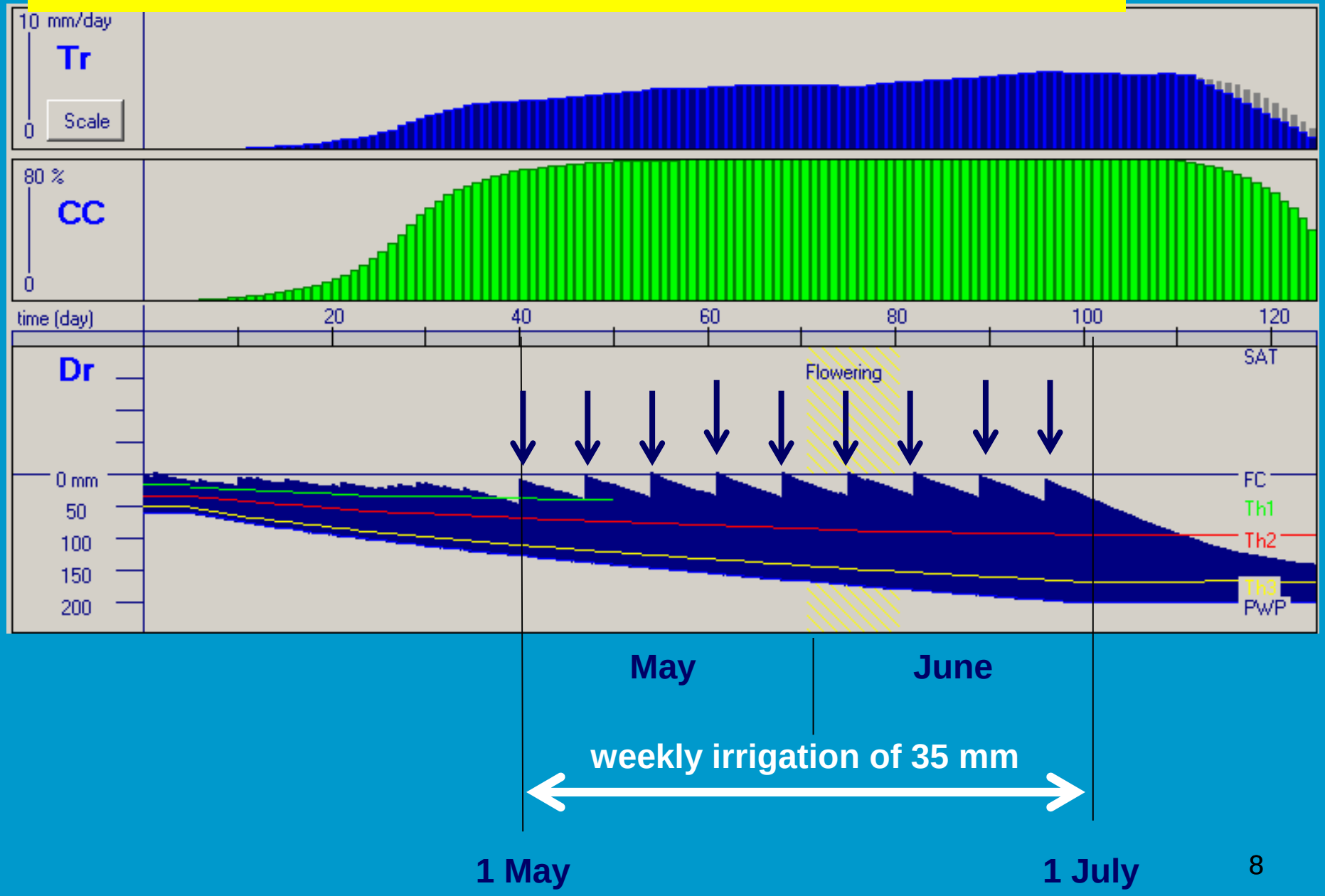
- Planting date; Plant density;
- Maximum canopy cover (CCx);Time to crop emergence, flowering, start of canopy senescence and to maturity (length of crop cycle);
- Maximum effective rooting depth (Zx) and time to reach

Initial condition:

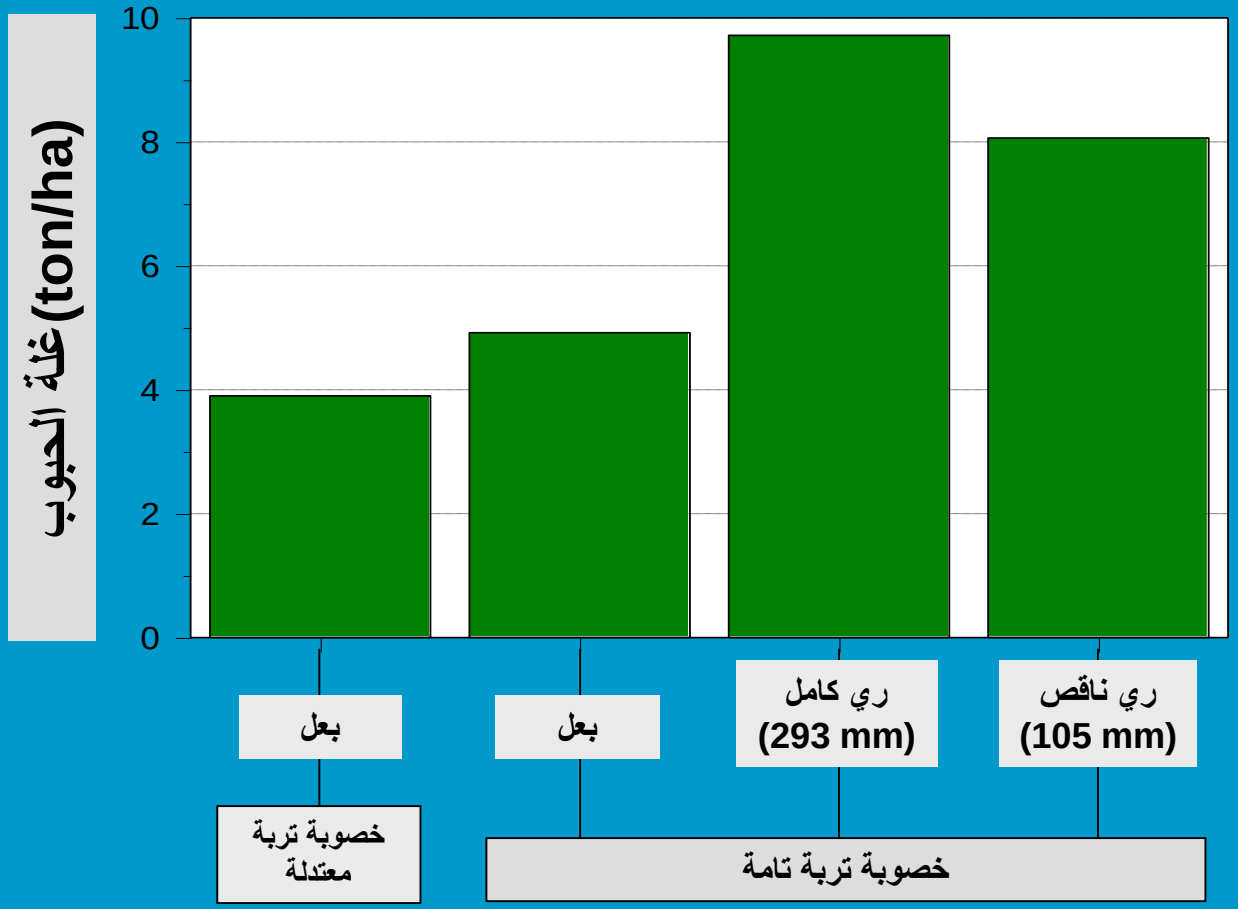
- Initial soil water content and soil salinity at various depths in the soil profile

Using AquaCrop model for irrigation management

Generation of irrigation schedule



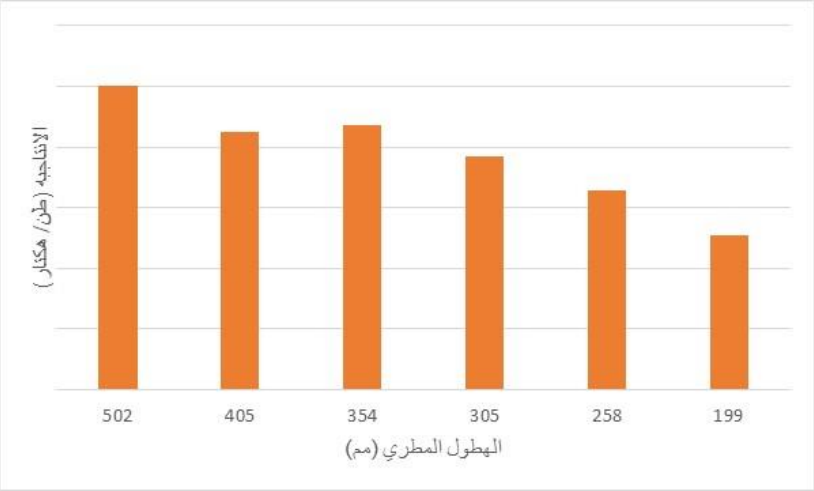
Using AquaCrop model for deficit irrigation scheduling



جدولة الري الناقص لمحصول البطاطا في جنين - فلسطين

تأثير الري الناقص على إنتاجية محصول البطاطا وعلى الإنتاجية المائية

المعاملة	كمية مياه الري mm	نسبة التوفير بمياه الري %	Yield T/Ha	نسبة انخفاض الإنتاجية %	Wpet kg/m3
Full IRR	502		10.01		1.85
Dif Irr 80%	405	20	9.48	5	1.85
Dif Irr70%	354	30	8.74	13	1.85
Dif Irr 60%	305	40	7.68	23	1.78
Dif Irr 50%	258	50	6.59	34	1.7
Dif Irr 40%	199	60	5.07	49	1.51



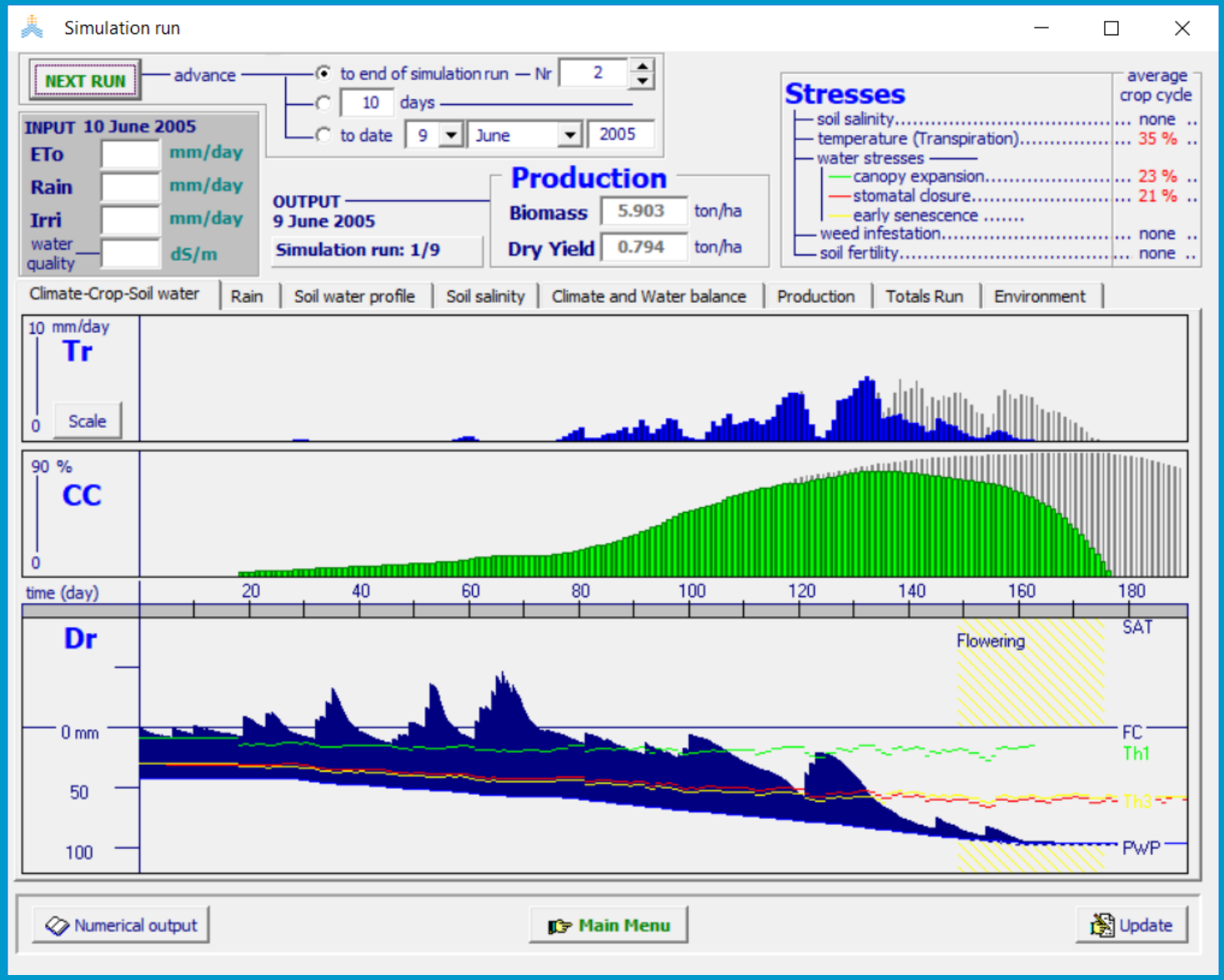
جدولة الري الناقص لمحصول البندوره في الدفيانه الأردن

تأثير الري الناقص على إنتاجية محصول البندورة وعلى الإنتاجية المائية

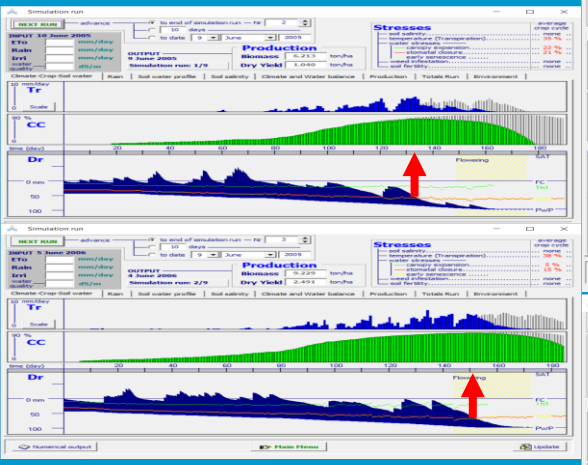
المعاملة	كمية مياه الري mm	نسبة التوفير بمياه الري %	Yield T/Ha	نسبة انخفاض الإنتاجية %	Wpet kg/m3
Full IRR	954		10.52		1.06
Dif Irr 80%	770	20	9.11	13	1.06
Dif Irr70%	672	30	8.31	21	1.09
Dif Irr 60%	579	40	7.62	28	1.13
Dif Irr 50%	496	50	6.66	37	1.11
Dif Irr 40%	380	60	5.00	52	1.03

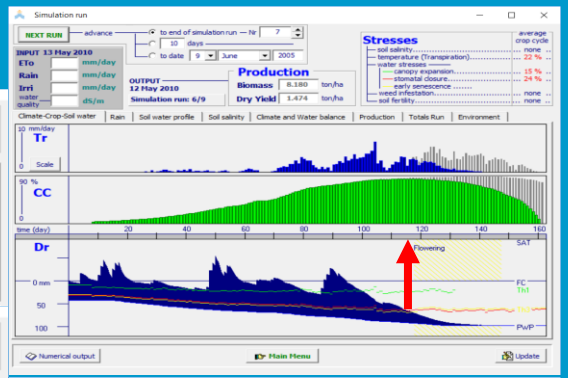
Using AquaCrop model for supplementary irrigation scheduling

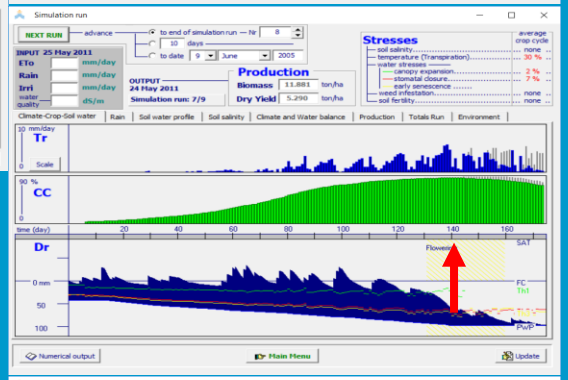
Rainfed wheat

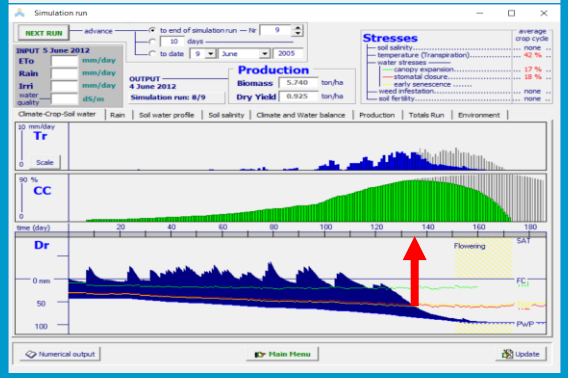


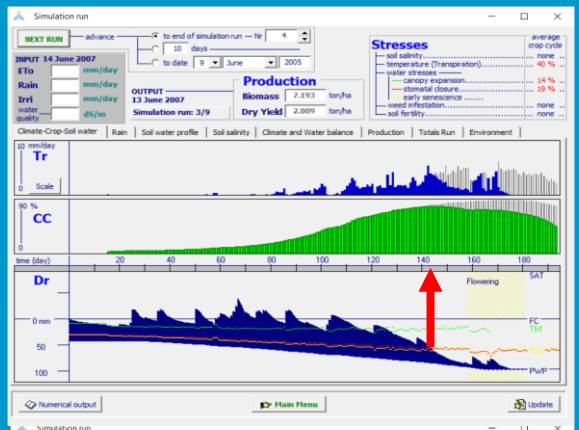
Rainfed wheat

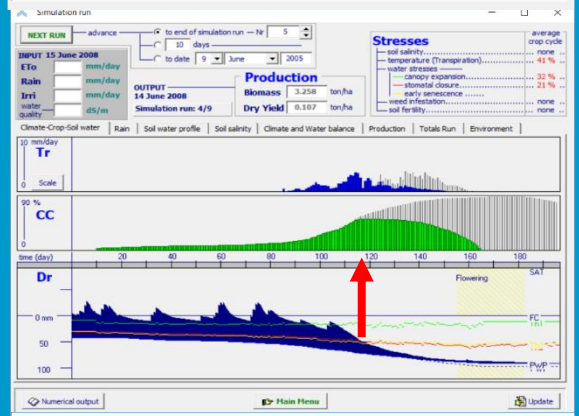


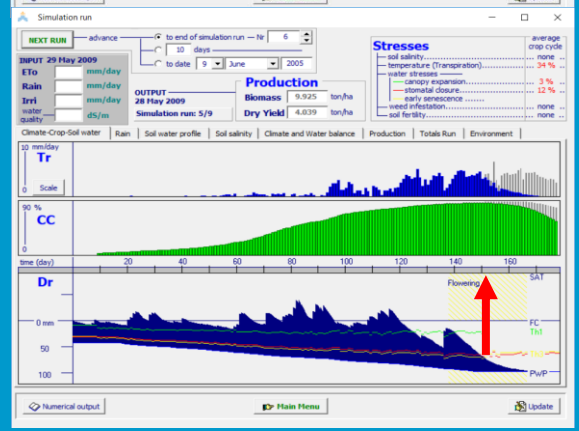






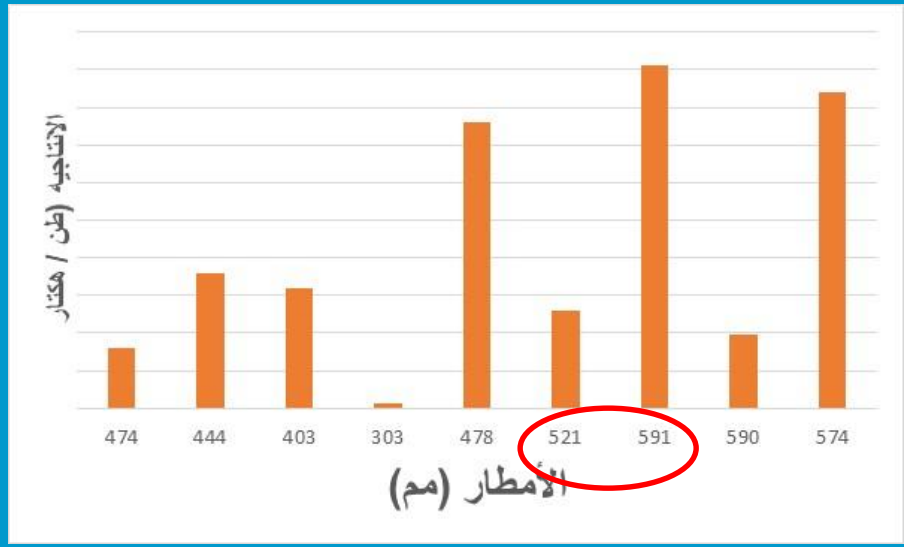






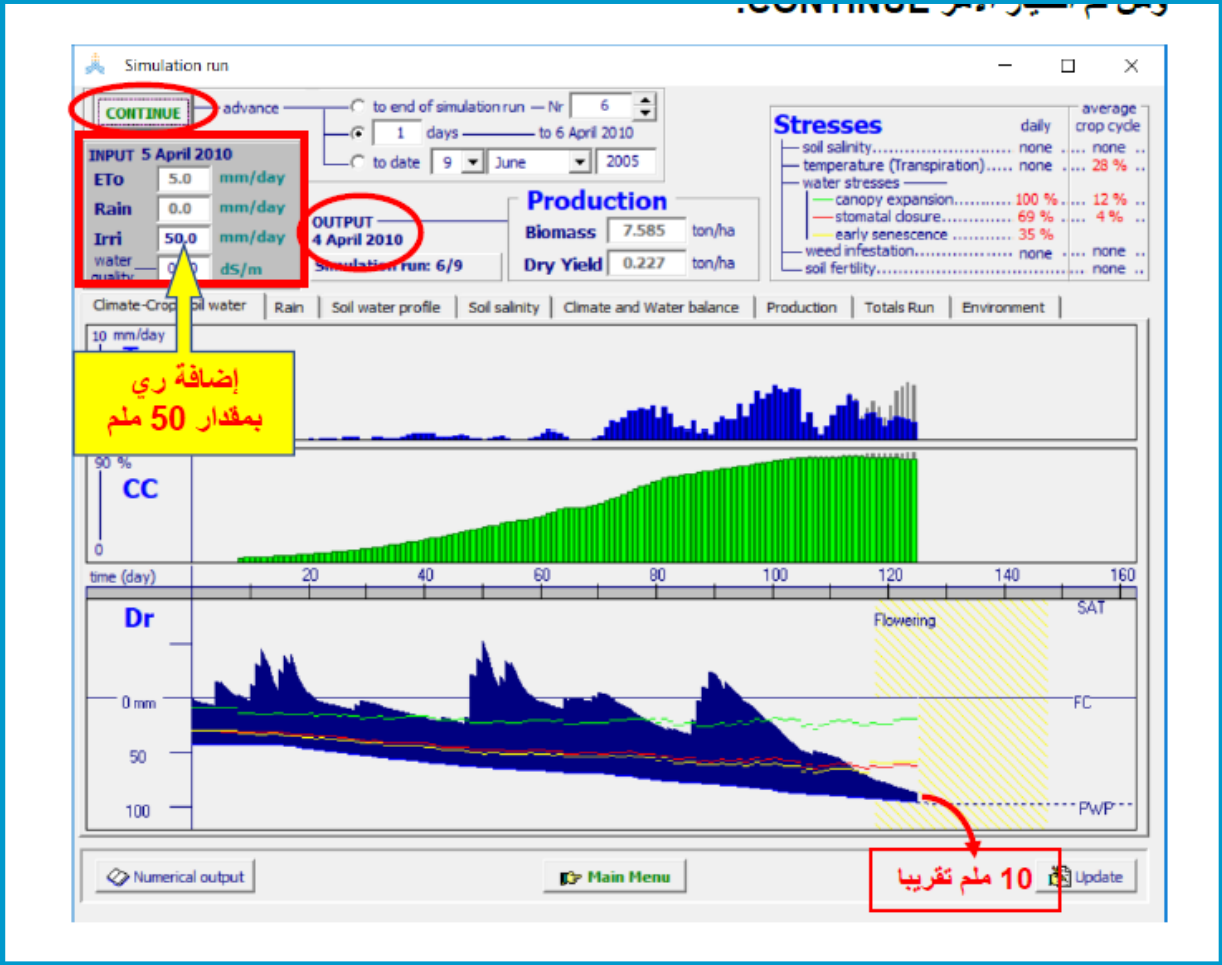
إنتاجية القمح في حالة الزراعه المطريه في تل عماره – البقاع لبنان

Rainfed wheat

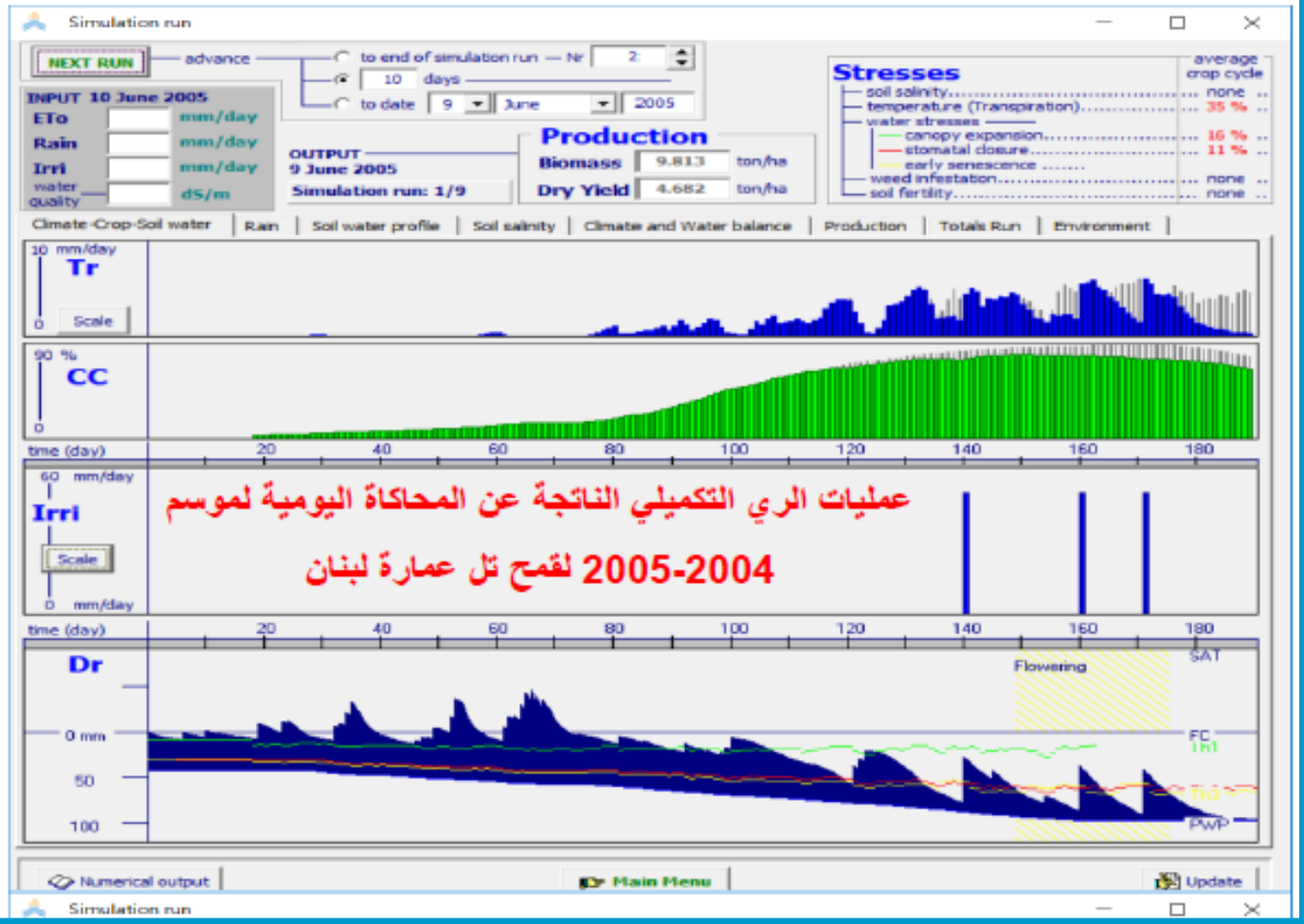


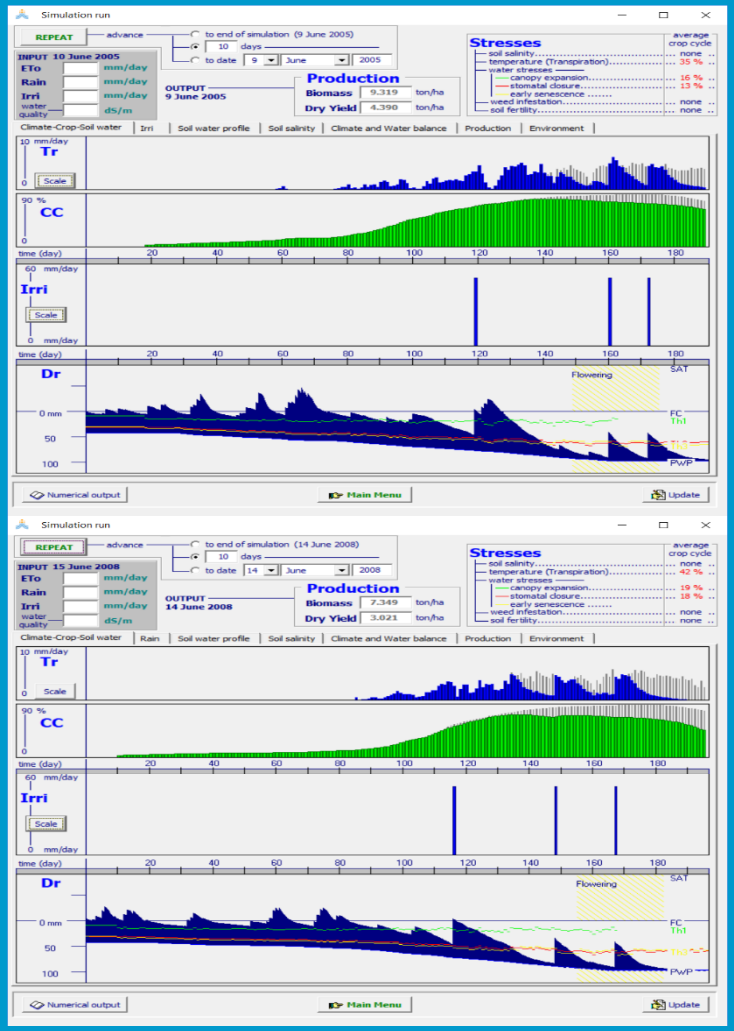
Year	Rain mm	Yield ton/ha	WPet kg/m3
2005	474	0.794	0.26
2006	444	1.801	0.56
2007	403	1.611	0.5
2008	303	0.072	0.03
2009	478	3.798	1.18
2010	521	1.291	0.53
2011	**591**	**4.569**	1.4
2012	**590**	**0.975**	0.38
2013	574	4.188	1.48
Average	**486**	**2.12**	**0.7**

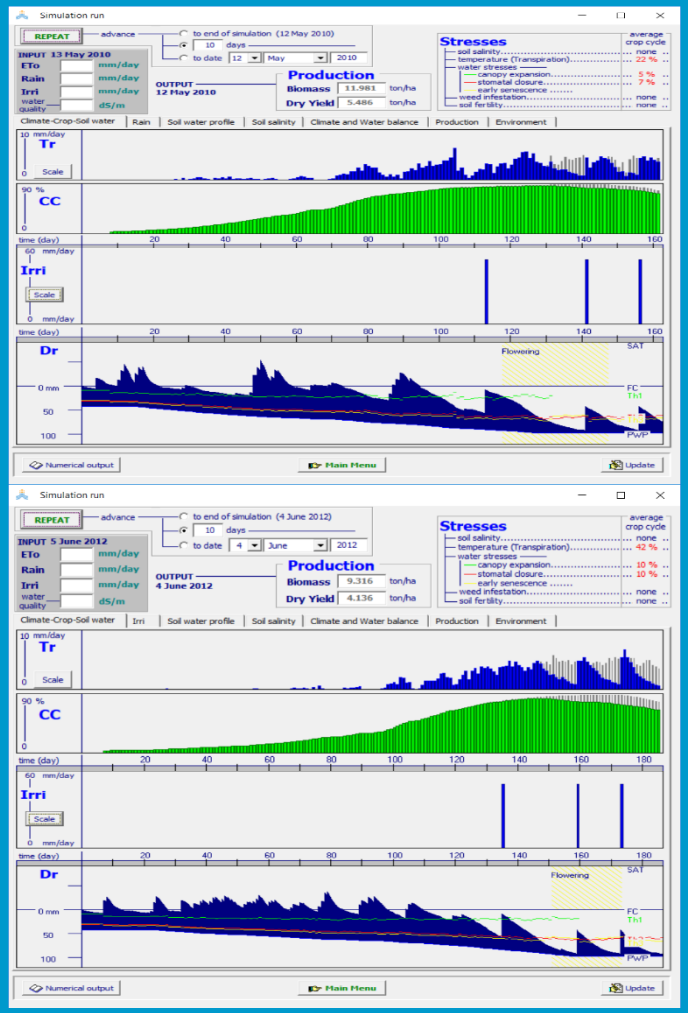
Criteria for supplementary irrigation



supplementary irrigation scheduling




Simulation run
REPEAT
advance
to end of simulation (9 June 2005)
10 days
to date 9 June 2005
INPUT 10 June 2005
ETo mm/day
Rain mm/day
Irri mm/day
water quality dS/m
OUTPUT 9 June 2005
Production
Biomass 9.319 ton/ha
Dry Yield 4.390 ton/ha
Stresses
average crop cycle
soil salinity none
temperature (Transpiration) 35 %
water stresses
canopy expansion 16 %
stomatal closure 13 %
early senescence
weed infestation none
soil fertility none
Climate-Crop-Soil water | Irri | Soil water profile | Soil salinity | Climate and Water balance | Production | Environment
Tr
CC
Irri
Dr
Flowering
SAT
FC
Thl
PWP
Numerical output
Main Menu
Update
Simulation run
REPEAT
advance
to end of simulation (14 June 2008)
10 days
to date 14 June 2008
INPUT 15 June 2008
OUTPUT 14 June 2008
Production
Biomass 7.349 ton/ha
Dry Yield 3.021 ton/ha
Stresses
temperature (Transpiration) 42 %
canopy expansion 19 %
stomatal closure 18 %
Climate-Crop-Soil water | Rain | Soil water profile | Soil salinity | Climate and Water balance | Production | Environment
Tr
CC
Irri
Dr
Flowering
SAT
FC
Thl
PWP
Numerical output
Main Menu
Update

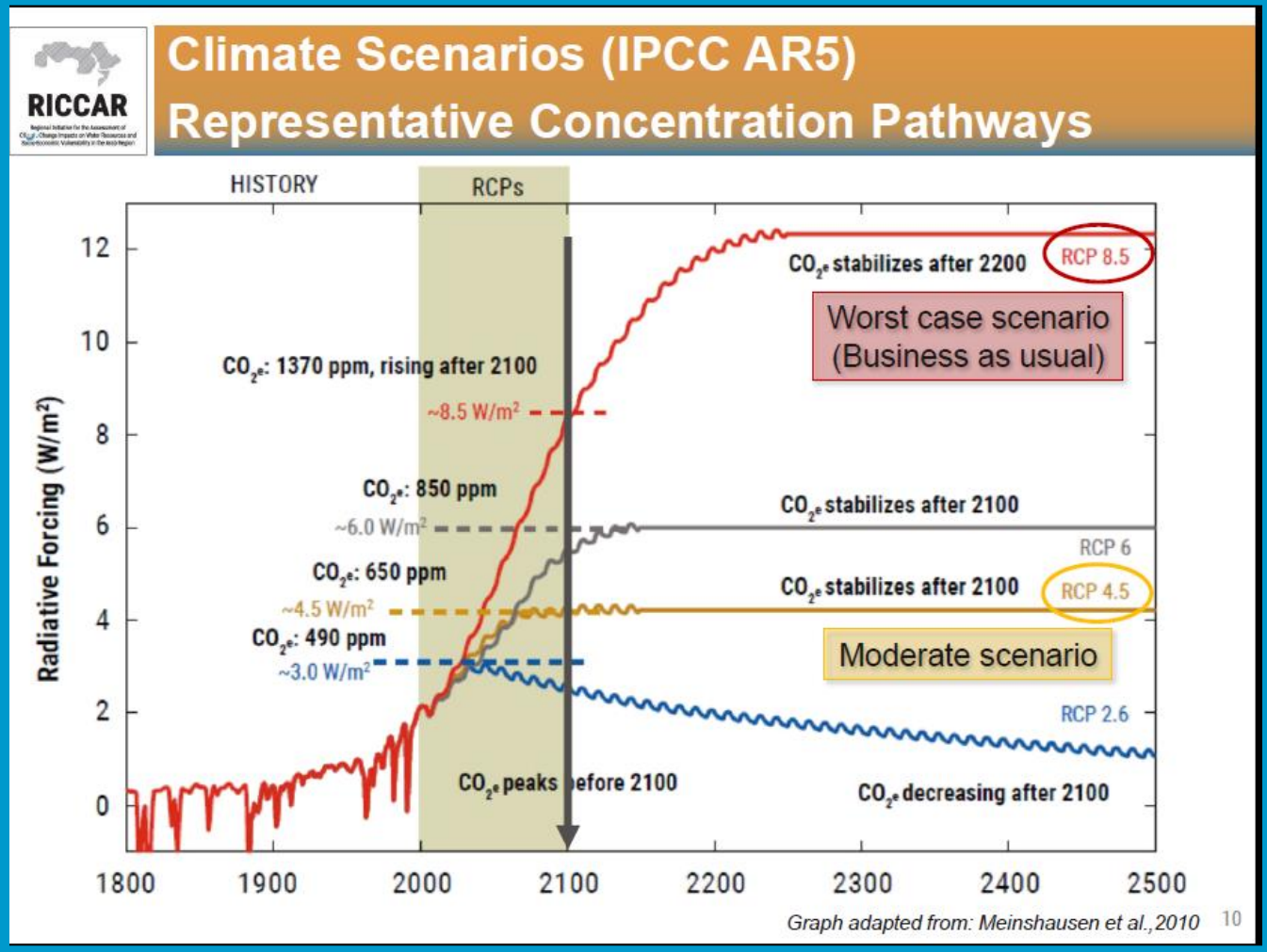

Simulation run
REPEAT
advance
to end of simulation (12 May 2010)
10 days
to date 12 May 2010
INPUT 13 May 2010
OUTPUT 12 May 2010
Production
Biomass 11.981 ton/ha
Dry Yield 5.486 ton/ha
Stresses
average crop cycle
soil salinity none
temperature (Transpiration) 22 %
water stresses
canopy expansion 5 %
stomatal closure 7 %
early senescence
weed infestation none
soil fertility none
Climate-Crop-Soil water | Rain | Soil water profile | Soil salinity | Climate and Water balance | Production | Environment
Tr
CC
Irri
Dr
Flowering
SAT
FC
Thl
PWP
Numerical output
Main Menu
Update
Simulation run
REPEAT
advance
to end of simulation (4 June 2012)
10 days
to date 4 June 2012
INPUT 5 June 2012
OUTPUT 4 June 2012
Production
Biomass 9.316 ton/ha
Dry Yield 4.136 ton/ha
Stresses
temperature (Transpiration) 42 %
canopy expansion 10 %
stomatal closure 10 %
Climate-Crop-Soil water | Irri | Soil water profile | Soil salinity | Climate and Water balance | Production | Environment
Tr
CC
Irri
Dr
Flowering
SAT
FC
Thl
PWP
Numerical output
Main Menu
Update

مقارنة الإنتاجية لمحصول القمح في تل عمارة - لبنان لحالة الري التكميلي مع حالتي الري الكامل والري المطري(الزراعة البعلية)

Year	Rain fed		Full Irr (80 % RAW)			Sup Irr		
	Yield	WPet	Irri	Yield	WPet	Irri	Yield	WPet
	ton/ha	kg/m3	mm	ton/ha	kg/m3	mm	ton/ha	kg/m3
2005	**0.794**	0.26	348	**6.2**	1.12	150	**4.682**	1.03
2006	**1.801**	0.56	308	**5.791**	1.15	100	**4.415**	1.07
2007	**1.611**	0.5	304	**5.839**	1.07	150	**4.744**	1.03
2008	**0.072**	0.03	485	**6.079**	0.96	200	**3.405**	0.77
2009	**3.798**	1.18	212	**6.068**	1.4	100	**5.413**	1.36
2010	**1.291**	0.53	261	**6.383**	1.48	150	**5.407**	1.46
2011	**4.569**	1.4	161	**6.414**	1.54	50	**5.463**	1.49
2012	**0.975**	0.38	299	**5.674**	1.17	150	**4.41**	1.1
2013	**4.188**	1.48	207	**6.458**	1.57	100	**5.851**	1.59
Average	**2.12**	**0.70**	**287**	**6.10**	**1.27**	**128**	**4.87**	**1.21**

Using AquaCrop model to assess impact of CC on crop yield and water requirement

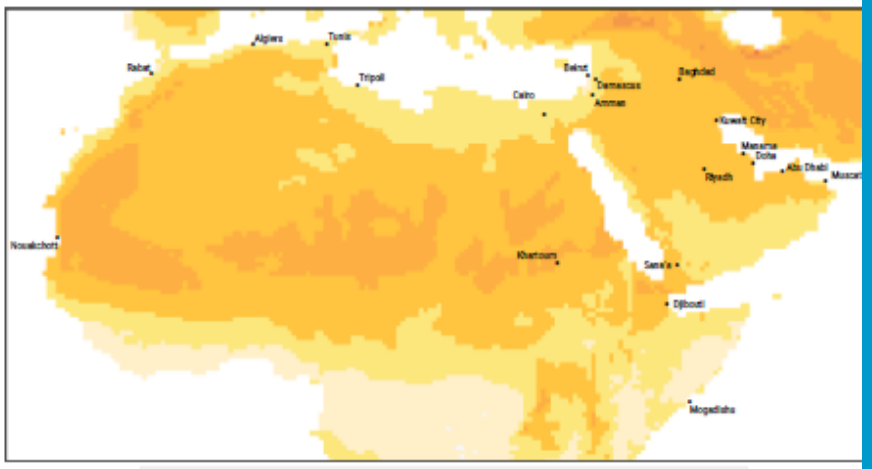
atmospheric CO_2 concentration ($[CO_2]$):



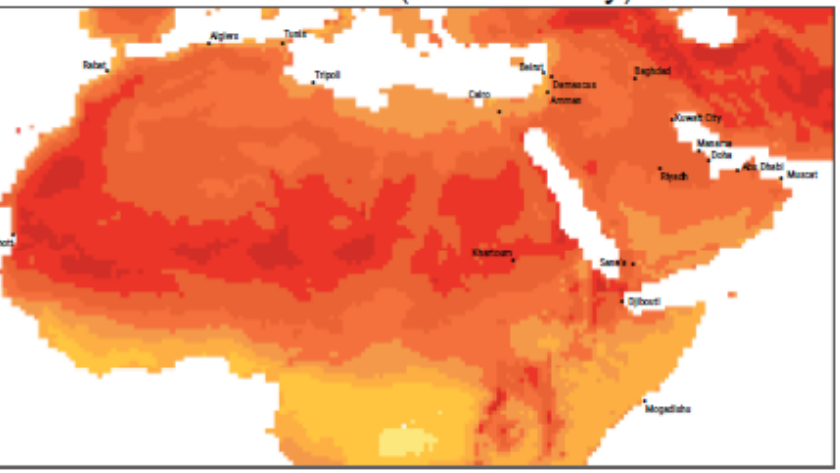
Change in temperature (RCP8.5)

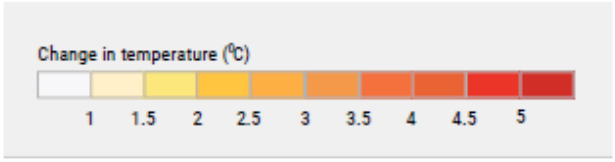
2016 – 2035 (Near-century)

2046 – 2065 (Mid-century)



2081 – 2100 (End-century)

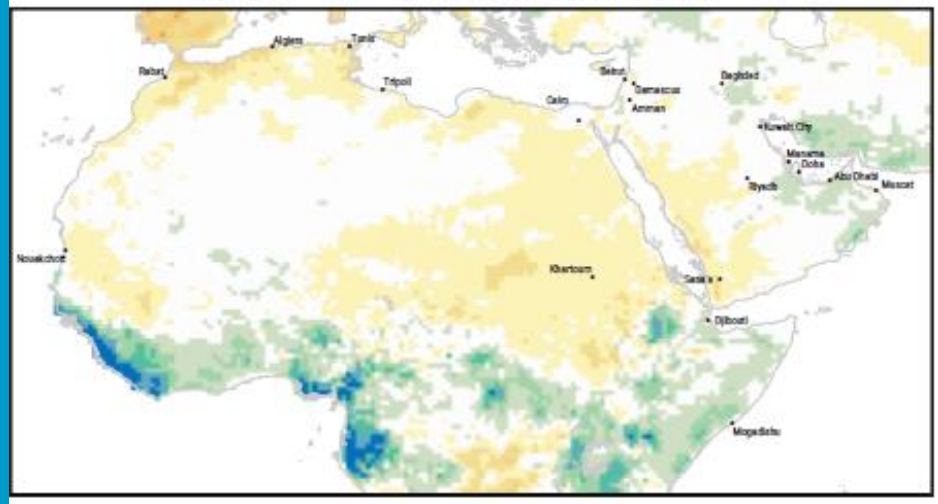




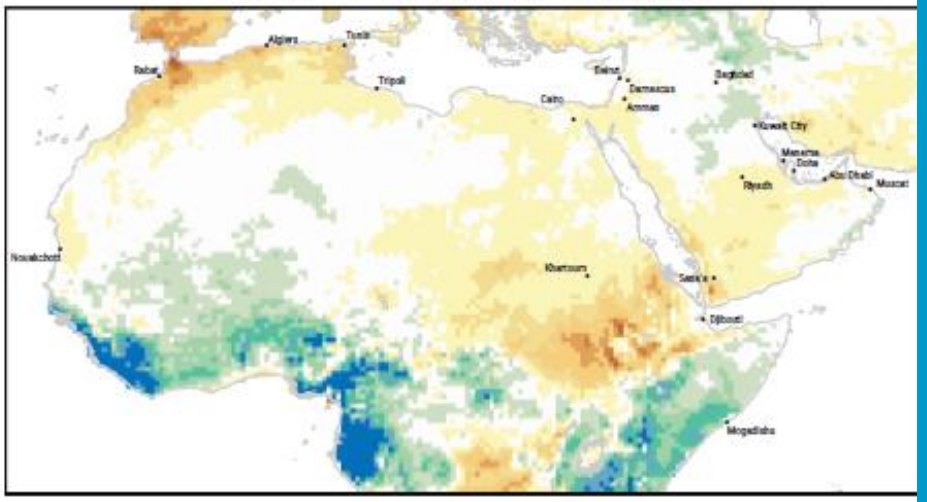
Annual Mean Temperature (°C) – Tunisia			
1986 – 2005	2016 – 2035	2046 – 2065	2081 – 2100
20.2	+0.8	+2.0	+3.7

Change in precipitation (RCP4.5)

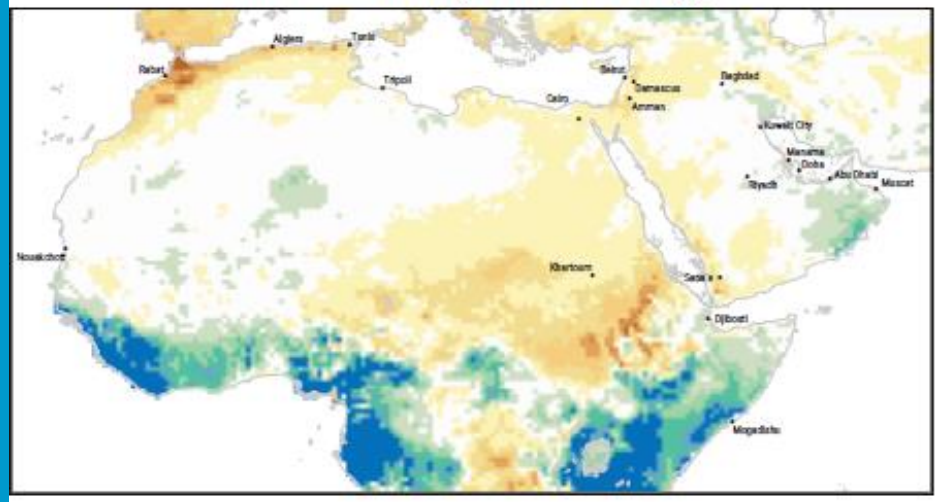
2016 – 2035 (Near-century)



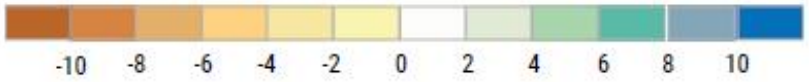
2046 – 2065 (Mid-century)



2081 – 2100 (End-century)



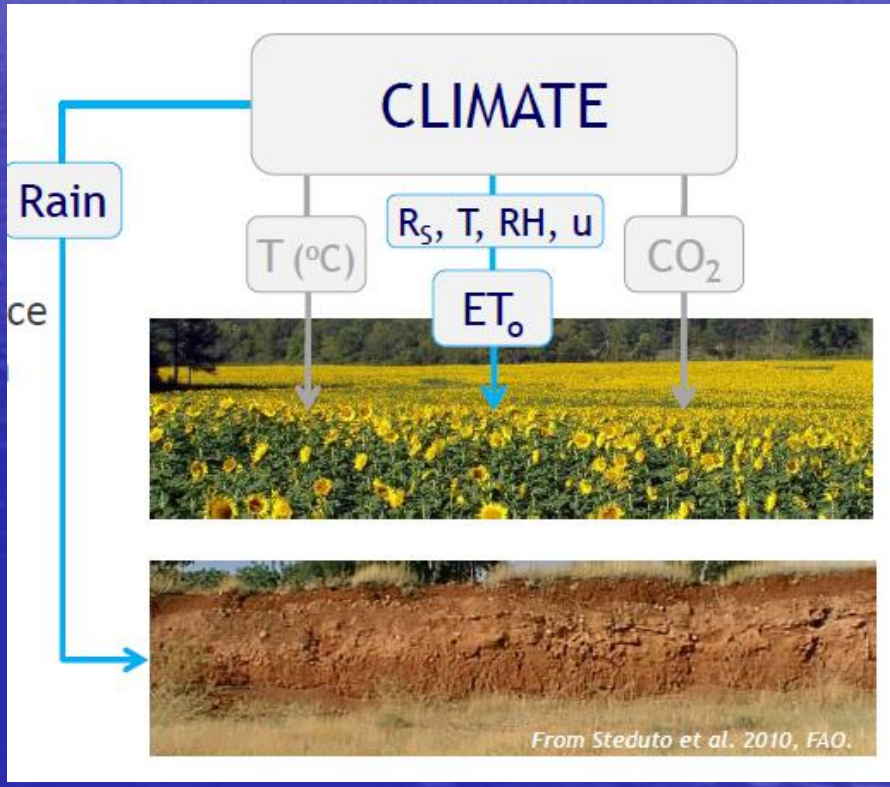
Change in precipitation (mm/month)



Annual Mean Precipitation (mm/month) – Tunisia			
1986 – 2005	2016 – 2035	2046 – 2065	2081 – 2100
20.8	-1.2	-2.3	-0.9

The impact of climate change can be included in AquaCrop by three factors:

- adjusting the precipitation data file,
- adjusting the temperature data file,
- impact of enhanced CO2 levels.



تأثير التغيرات المناخيه على محصول القمح البعل في منطقة مرشوش المغرب

الانتاجيه

الجدول 20. متوسط إنتاجية القمح في مرشوش والتغير المتوقع في الانتاجيه من اجل السيناريو RCP8.5 لحالة ثبات تركيز غاز ثاني أكسيد الكربون

	متوسط التغير خلال الفترة (2020-2030)	متوسط التغير خلال الفترة (2040-2050)
الإنتاج في سنة الأساس (طن/هكتار)	4.01	
التغير المطلق (طن/هكتار)	-0.36	-1.03
التغير النسبي (%)	-9 %	-26 %

طول موسم النمو

الجدول 21. متوسط طول موسم النمو خلال فترة الأساس 1986-2005 وخلال الفترات 2020-2030 و2040-2050 من اجل السيناريو RCP8.5 لحالة ثبات تركيز غاز ثاني أكسيد الكربون

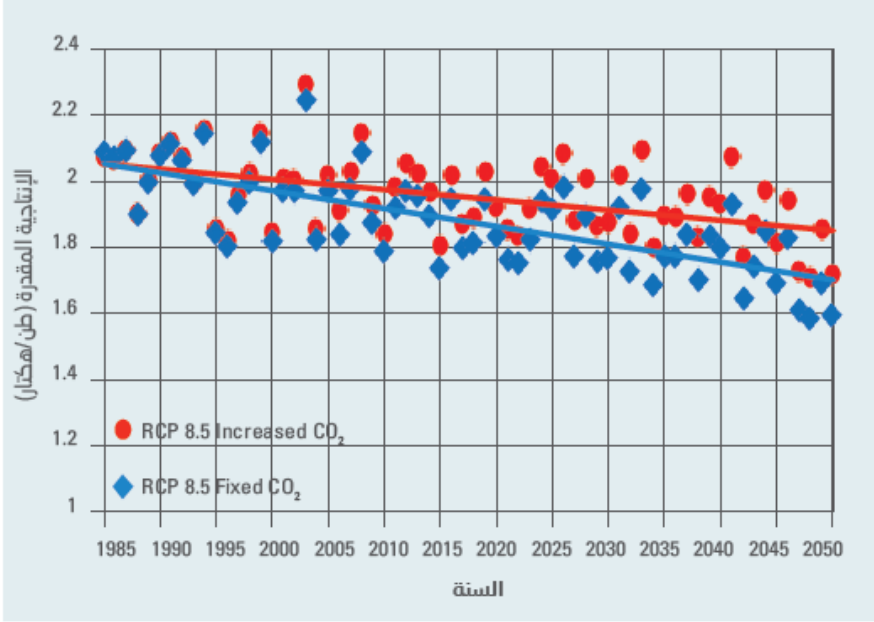
	خلال فترة الأساس 2005-1986	خلال الفترة 2030-2020	خلال الفترة 2050-2040
طول موسم النمو(يوم)	150	142	131

الاستهلاك المائي

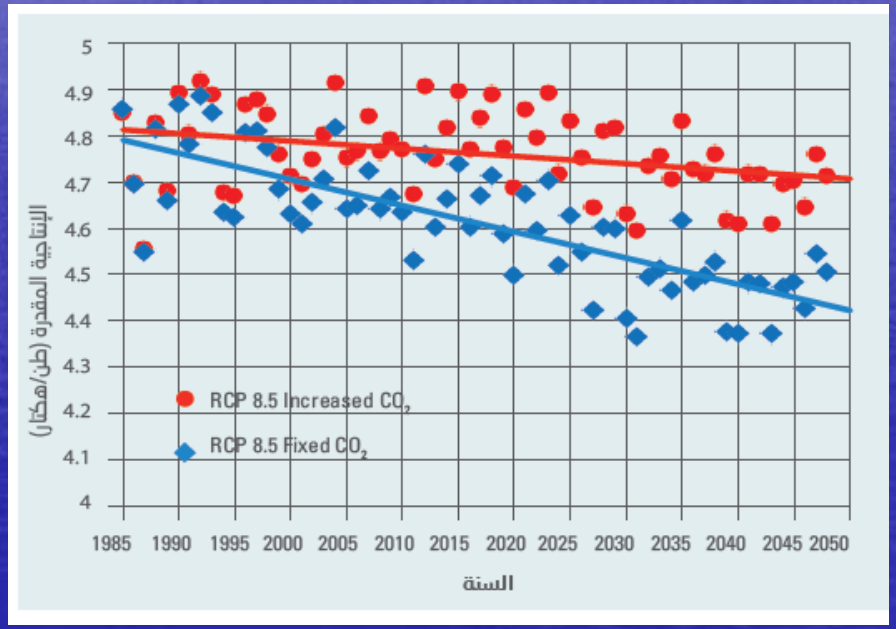
الجدول 22. التبخر-النتح المرجعي والفعلي خلال فترة الأساس 1986-2005 وخلال الفترات 2020-2030 و2040-2050 من اجل السيناريو RCP8.5 لحالة ثبات تركيز غاز ثاني أكسيد الكربون

	خلال فترة الأساس 2005-1986	خلال الفترة 2030-2020	خلال الفترة 2050-2040
التبخر النتح المرجعي (مم)	322	312	310
التبخر نتح الفعلي (مم)	238	223	195

تأثير التغيرات المناخيه على محصول الذرة الرفيعه البطيه في صتعاء اليمن



تأثير التغيرات المناخيه على محصول الذرة الشاميه في ابين اليمن



Thanks