SALTMED Model Applications Across the World

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SALTMED model Applications

SALTMED model can simulate up to twenty fields or treatments simultaneously. The model also simulates crop rotations. The model has been tested against a number of field experiments in different countries such as:

Tomato and potato under drip irrigation in Syria, Egypt, Crete, Serbia and Italy (Ragab et al., 2005b and 2015, Afzal et al., 2016), in Iran, sugar cane under sprinkler irrigation (Golabi et al., 2009), in Greece, cotton under drip irrigation (Kalfountzos et al., 2009), in Denmark, quinoa irrigated with saline water (Razzaghi et al., 2011), in Morocco, quinoa, sweetcorn and chickpea under drip irrigation (Hirich et al., 2012), in Brazil, vegetable crops (Montenegro et al., 2010), in Italy, quinoa and amaranth using saline water (Pulvento et al., 2013a &Pulvento et al., 2015b), in Portugal, rainfed and irrigated chickpea (Silva et al., 2013), in Morocco, quinoa under deficit drip irrigation (Fghire et al., 2015), in Turkey, sweet pepper in green houses using saline water (Rameshwaran et al., 2015, 2016b), in Syria, legumes (lentil, chickpea and faba bean) using saline water (Arslan et al., 2016, Rameshwaran et al., 2016a), in Turkey, quinoa using fresh and saline water (Kaya and Yazar, 2016) and in Egypt, potato using gated pipes furrow irrigation (El-Shafie et al., 2017).

In addition, the model was also able to derive an important relation commonly known as the salinity-yield response function for Syria and Turkey (Arslan, 2016; Rameshwaran et al., 2015, 2016a, 2016b). SALTMED was also used to study the possible impact of climate change on yield, dry matter, crop water requirements, harvest and sowing dates, and length of the growing season of amaranth and corn crops in Italy (Pulvento et al., 2015), Morocco, (Hirich et al., 2016) Pakistan (Chauhdary et al., 2024& 2025), Egypt;(Mehanna et al., 2024, Marwa et al., 2020), Greece (Ioannis et al., 2016).

The model has been intensively used in Egypt on a variety of field crops (Abdelraouf and Ragab 2017, 2018a,b,c, Abdelraouf et al., 2020 &2021, Dewedar et al., 2021, Marwa et al., 2020, El-Shafie et al., 2017), Malash et al., (2005, 2008 & 2011), Hamza et al., 2022, Somia et al., 2024, in Pakistan (Chauhdary et al., 2019, 2020, 2024), in Iran (Basiri et al. 2020, Dastranj et al., 2018, Emdad & Taftech 2020, Golabi et al., 2009, Razzaghi et al., 2011), in Portugal (Siva et al., 2013, 2017) and in Morocco (Hirich et al., 2012, 2014, 2016 and 2020, Filali et al., 2017, Fghire et al., 2015, 2017), Italy (Pulvento et al., 2013, Afzal et al., 2016), Greece (Maria Kokkora et al. 2019), Saudi Arabia (Ali, et al., 2015)

The model has also been used to derive some parameters that are not easy to measure (e.g. Leaf Area Index, LAI, Salinity tolerance index π_{50}, etc.) More details about the applications are published in a Special Issue of Journal of Irrigation and Drainage (Ragab 2020).

SALTMED Model: Irrigation with Fresh, Saline & WasteWater Applications

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Italy, Quinoa and Amaranth Experiments

Three irrigation levels were compared a control treatment with application of 100% of the water necessary to replenish to field capacity of the root zone and two deficit irrigation levels with application of 25% and 50% of the water volume used for the control treatment. For each irrigation level one treatment irrigated with saline (100S, 50S and 25S treatments) and one with fresh water (100, 50 and 25 treatments). For saline treatments water with an electrical conductivity (ECw) value of about 22 dS m-1 was used.

SALTMED MODEL TO SIMULATE YIELD AND DRY MATTER FOR QUINOA CROP AND SOIL MOISTURE CONTENT UNDER DIFFERENT IRRIGATION STRATEGIES IN SOUTH ITALY. C. PULVENTO1, M. RICCARDI1, A. LAVINI, R. D'ANDRIA AND R. RAGAB. IRRIGATION AND DRAINAGE. Irrig. and Drain. 62: 229–238 (2013). DOI: 10.1002/ird.1727

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Field trial

Biannual trial (2009-2010)

Complete randomized block design

Well water treatments

25% CWR

50 %CWR

100% CWR

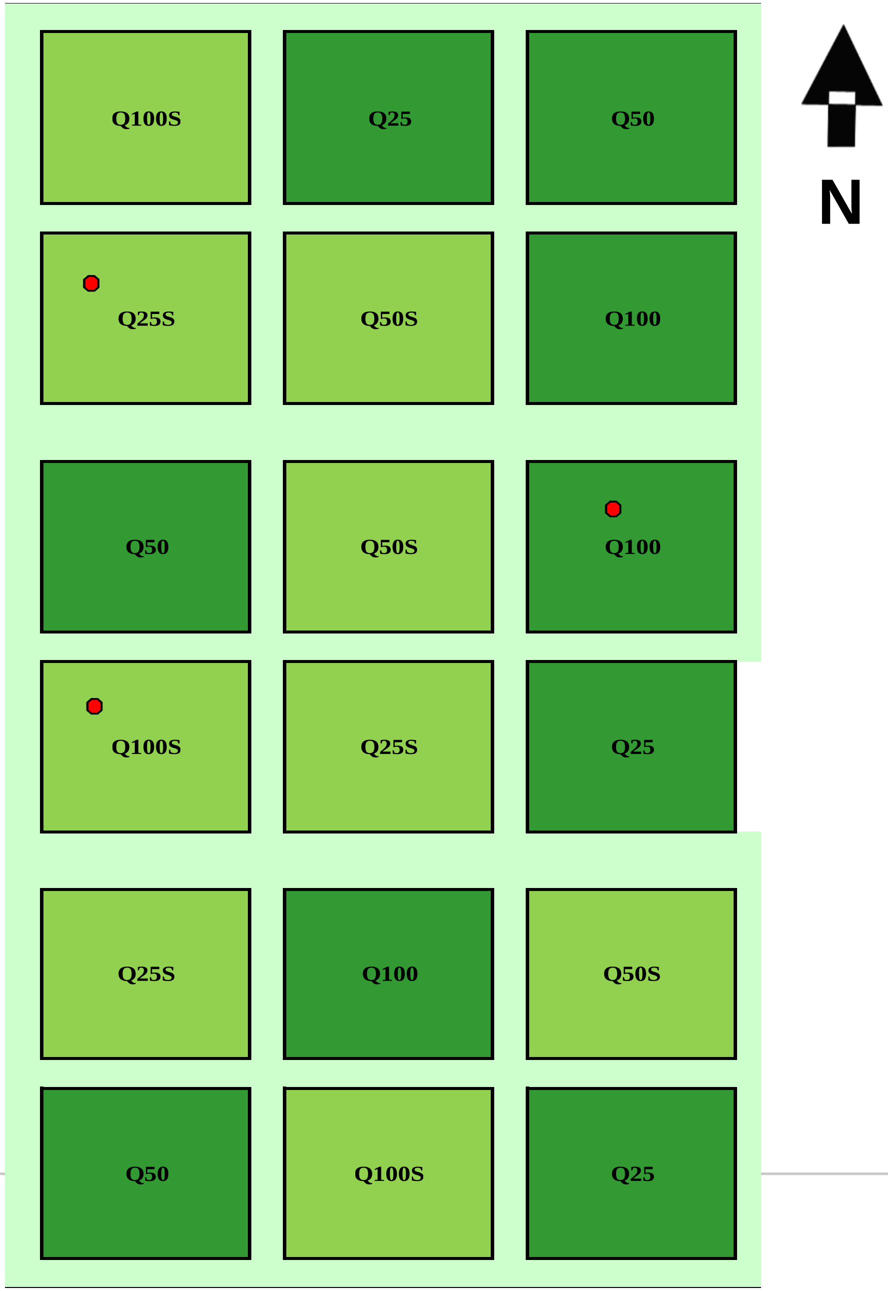
Saline water treatments

25% CWR S

50% CWR S

100% CWR S

S: $Ec_w \sim 20$ dS m^{-1}



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Saline treatments

	Well water
ECw *(dS m^{-1})*	0,643
CO_3^{2-} *(mg l^{-1})*	0
HCO_3^- *(mg l^{-1})*	391
Cl^- *(mg l^{-1})*	27,0
SO_4^{2-} *(mg l^{-1})*	15,2
Ca^{2+} *(mg l^{-1})*	76,8
Na^+ *(mg l^{-1})*	29,0
K^+ *(mg l^{-1})*	24,9
Mg^{2+} *(mg l^{-1})*	21,6
Total ions *(mg/l)*	585

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Added salts	
NaCl *(mg l^{-1})*	13380
$CaCl_2$ *(mg l^{-1})*	448
$MgCl_2$ *(mg l^{-1})*	1149
$MgSO_4$ *(mg l^{-1})*	1644
KCl *(mg l^{-1})*	339

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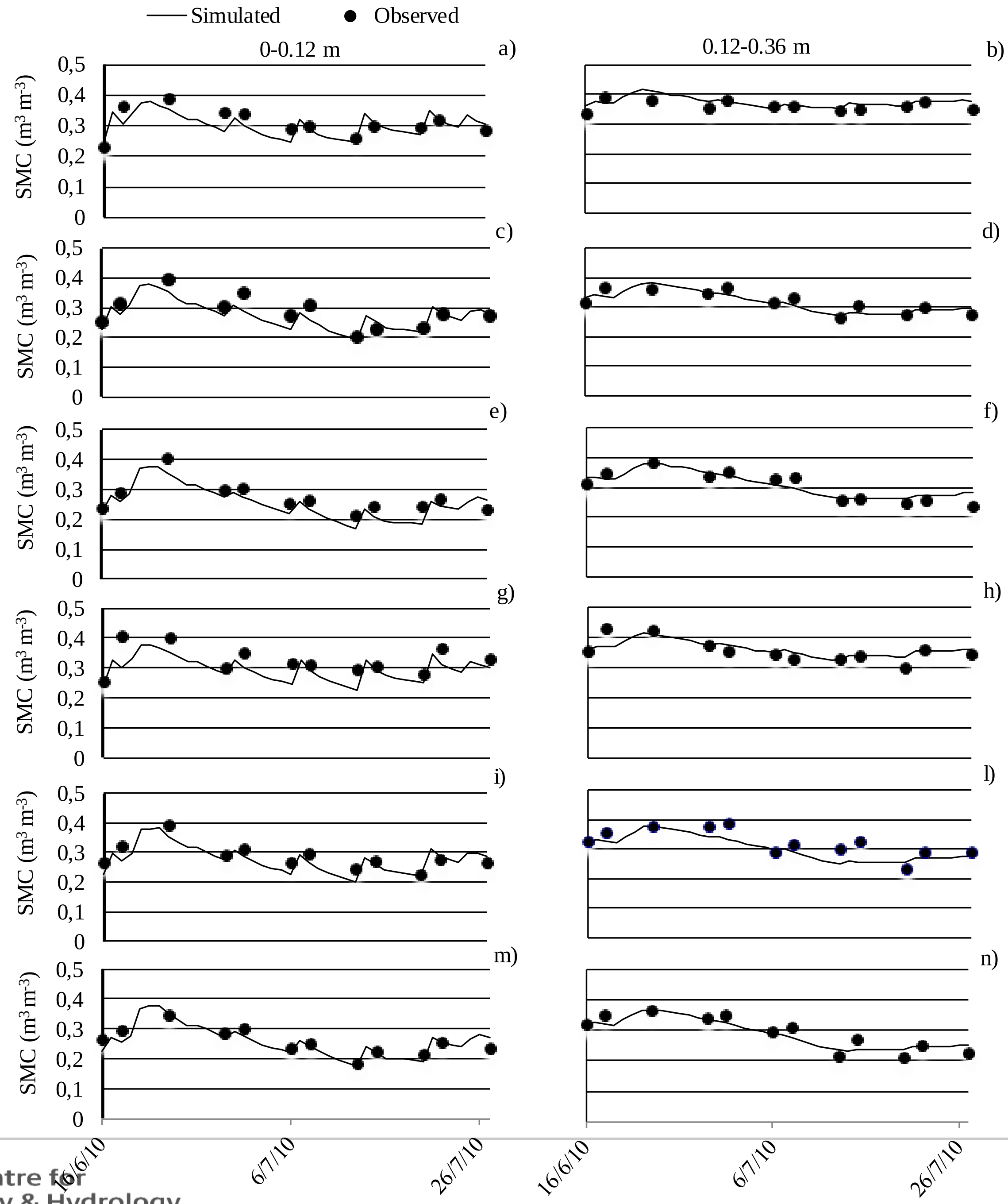
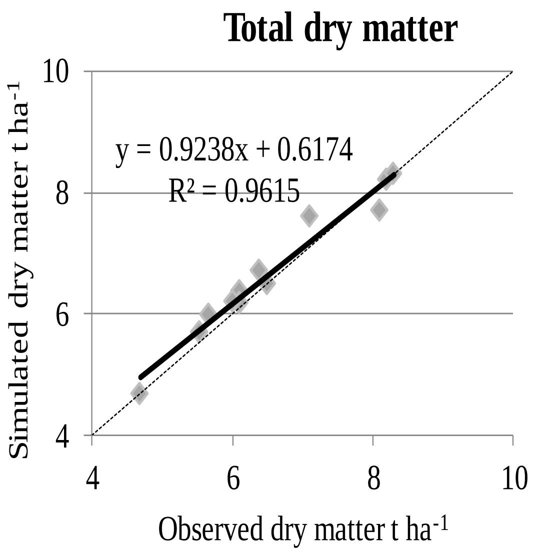
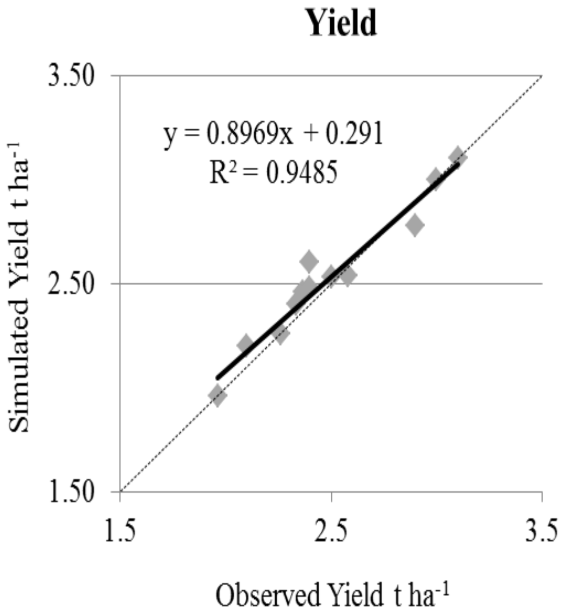
	Well + salt	Sea water
ECw *(dS m^{-1})*	22,5	40 ÷ 50
CO_3^{2-} *(mg l^{-1})*	0	71
HCO_3^- *(mg l^{-1})*	391	140
Cl^- *(mg l^{-1})*	9499	18971
SO_4^{2-} *(mg l^{-1})*	1327	2639
Ca^{2+} *(mg l^{-1})*	238	400
Na^+ *(mg l^{-1})*	5293	10556
K^+ *(mg l^{-1})*	202	380
Mg^{2+} *(mg l^{-1})*	647	1272
Total ions *(mg/l)*	17597	34429



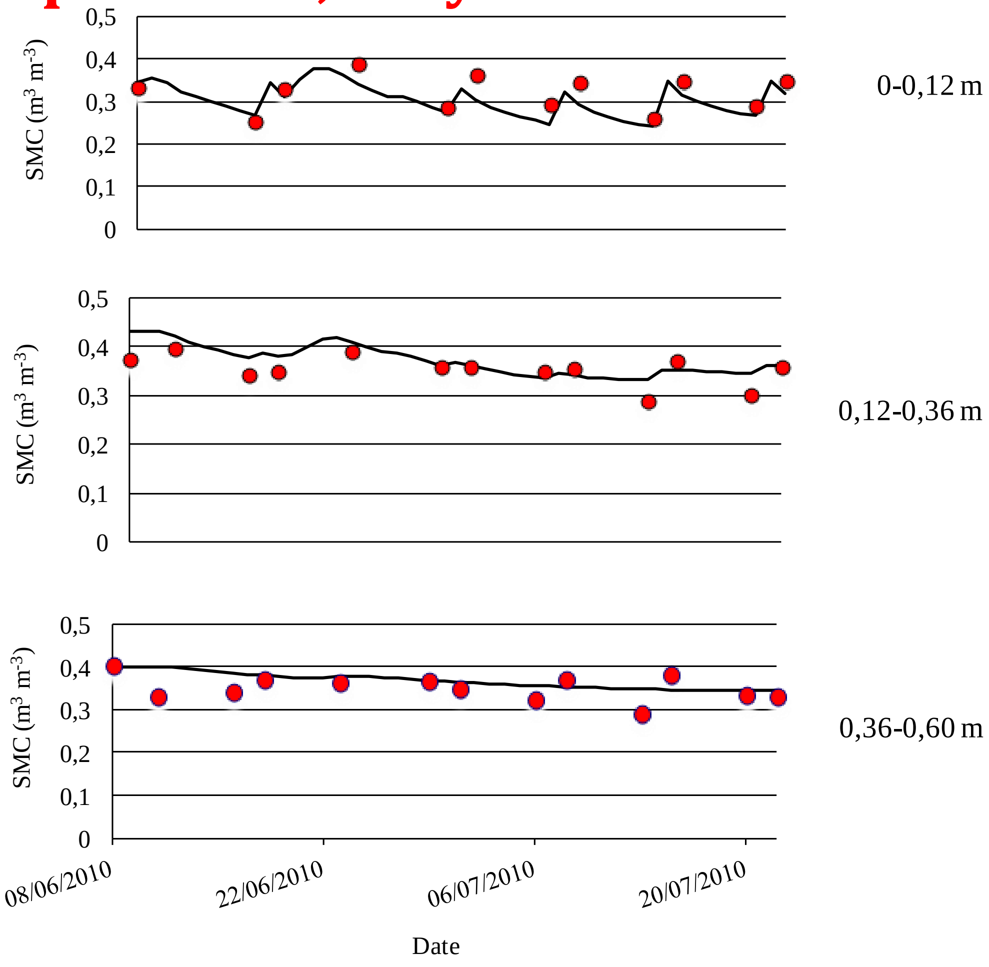

Quinoa experiment

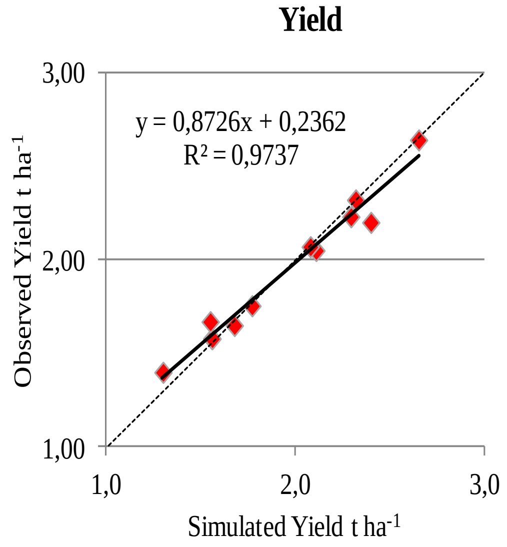


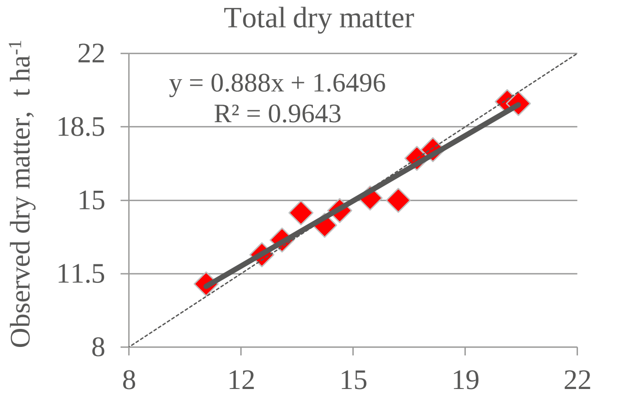




Amaranth experiment, Italy







Three irrigation levels were compared a control treatment with application of 100% of the water necessary to replenish to field capacity of the root zone and two deficit irrigation levels with application of 25% and 50% of the water volume used for the control treatment. For each irrigation level one treatment irrigated with saline (100S, 50S and 25S treatments) and one with fresh water (100, 50 and 25 treatments). For saline treatments water with an electrical conductivity (ECw) value of about 22 dS m^{-1} was used.

Comparison of the observed and measured quinoa yield in the validation.

Quinoa grown in Italy was tolerant at salinity level of 22 dS m^{-1} with small reduction in yield even when using 25% of the crop water requirement.

Year	Irrigation Treatments	Observed Yield	Simulated Yield	Difference
		t ha^{-1}	*t ha*$^{-1}$	%
2009	25	2.50	2.53	-1.19
2009	50	2.90	2.78	4.32
2009	100	3.10	3.10	0.00
2009	25S	2.40	2.48	-3.23
2009	50S	2.40	2.60	-7.69
2009	100S	3.00	3.00	0.00
2010	25	1.96	1.96	0.13
2010	50	2.10	2.22	-5.41
2010	100	2.33	2.40	-2.81
2010	25S	2.26	2.26	0.00
2010	50S	2.58	2.70	-4.37
2010	100S	2.36	2.46	-3.90
RMSE		29.90	30.49	0.17
CRM				-0.02

Denmark Lysimeter experiment:

Five salinity levels (0, 10, 20, 30 and 40 dS m^{-1})

Crop: **Quinoa (cv. Titicaca)**

Soil type: **Jyndevad (sandy soil)**

Sowing	Flowering	SeedFilling	Recovery	Harvest
24.04.2009 →	26.06.2009 →	14.07.2009 →	10.08.2009 →	24.08.2009
Tap water	FI_0, FI_{10}, FI_{20}, FI_{30} and FI_{40}	Continued irrigation with tap water		

Measured Parameters:

Soil water content :
TDR installed at 0-20 cm, 0-40 and 0-60 cm to measure The volumetric water content

Soil water electrical conductivity:
Soil samples took from 0-60 cm at 10 cm interval to determine the gravimetric water content and soil water salinity.

Yield:
Measured at harvest time

SIMULATION OF QUINOA (CHENOPODIUM QUINOA WILLD.) RESPONSE TO SOIL SALINITY USING THE SALTMED MODEL. Fatemeh Razzaghi, Finn Plauborg, Seyed Hamid Ahmadi, Sven-Erik Jacobsen, Mathias N. Andersen, Ragab Ragab. Paper presented at ICID 21st international congress on irrigation and drainage, Tehran, Iran, October 2011

A field lysimeter experiment was carried out, at the Faculty of Agricultural Sciences, Aarhus University. Drip Full irrigation (FI; 95% of FC) combined with five salinity levels (0, 10, 20, 30 and 40 dS m^{-1}) of irrigation water were applied from 55 DAE (days after emergence).

Treatment	Quinoa Total dry matter			Seed yield		
	Observed (ton ha^{-1})	Simulated (ton ha^{-1})	Relative error (%)	Observed (ton ha^{-1})	Simulated (ton ha^{-1})	Relative error (%)
FI_{10}	5.88	5.90	-0.37	1.99	2.01	-0.84
FI_{20}	5.08	5.16	-1.57	1.47	1.50	-1.95
FI_{30}	5.87	5.84	0.47	1.77	1.75	0.97
FI_{40}	5.66	5.60	1.05	1.66	1.62	2.16

Observed, simulated and the % relative error of total dry matter and seed yield at harvest for different salinity levels.

Fresh water

Total dry matter-control			Seed yield - control		
Observed (ton ha^{-1})	Simulated (ton ha^{-1})	Relative error (%)	Observed (ton ha^{-1})	Simulated (ton ha^{-1})	Relative error (%)
6.06	6.07	-0.11	2.45	2.45	-0.04

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SALTMED model application using greenhouse experiment (Pepper), Turkey

THE EFFECT OF SALINE IRRIGATION WATER ON THE YIELD OF PEPPER: EXPERIMENTAL AND MODELLING STUDY. PONNAMBALAM RAMESHWARAN, AKIN TEPE, ATTILA YAZAR AND RAGAB RAGAB. IRRIGATION AND DRAINAGE, Irrig. and Drain. 64: 41–49 (2015). DOI: 10.1002/ird.1867

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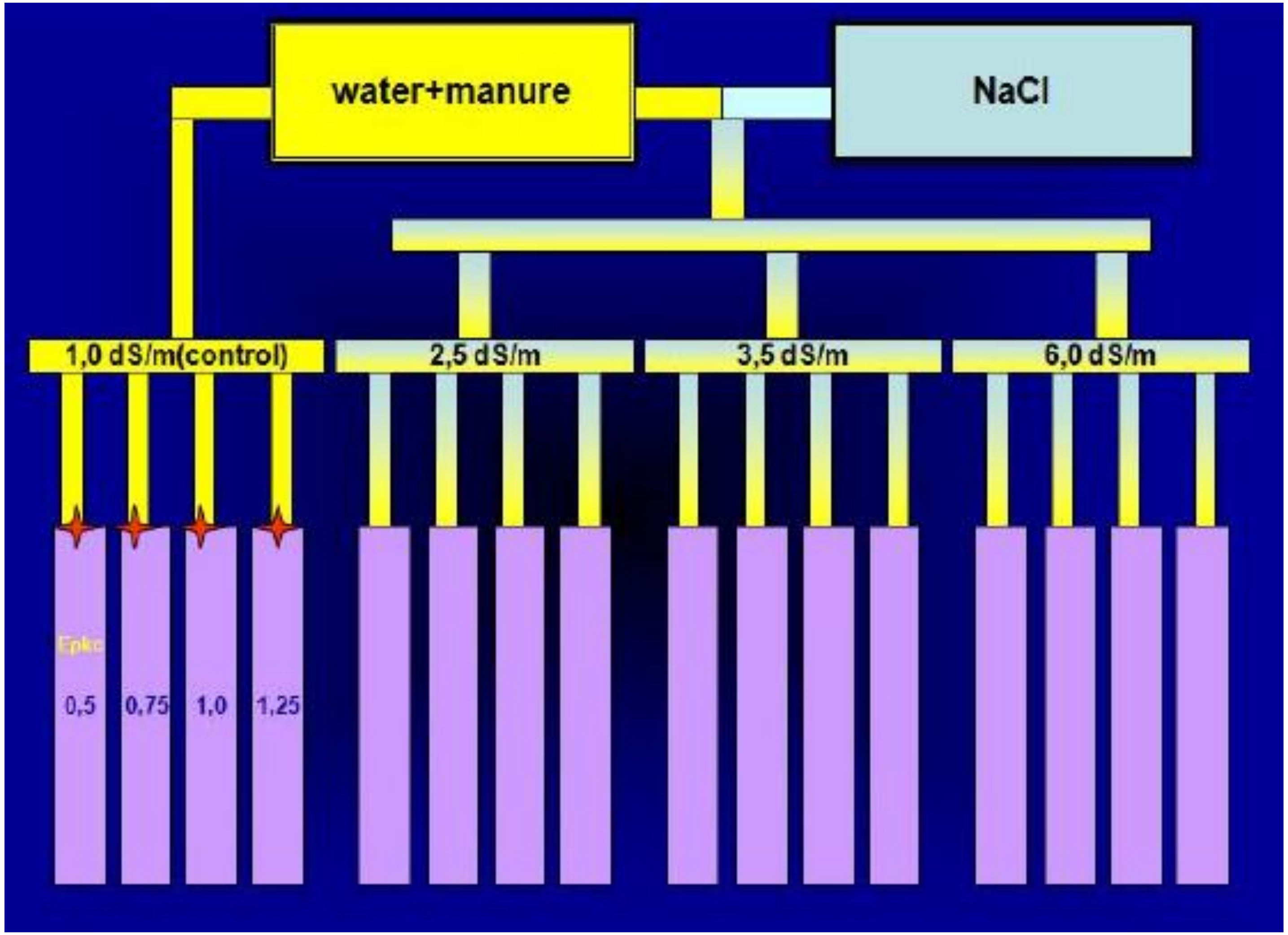
Greenhouse experimental setup

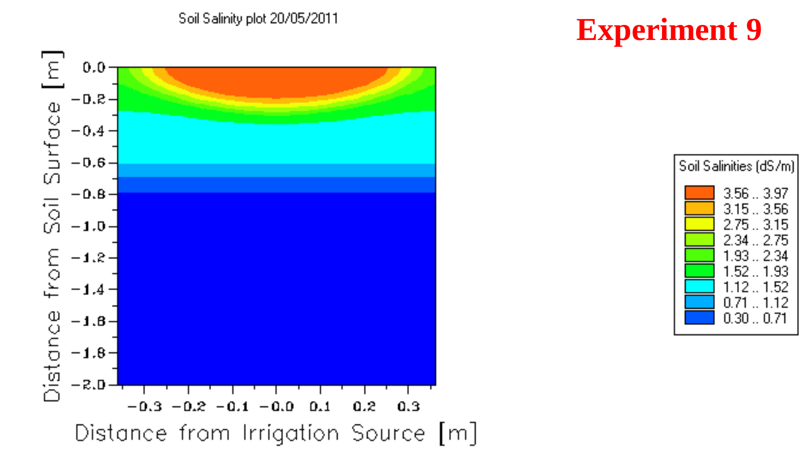
Salinity treatments
1.0, 2.5, 3.5 and 6.0 dS m $^{-1}$

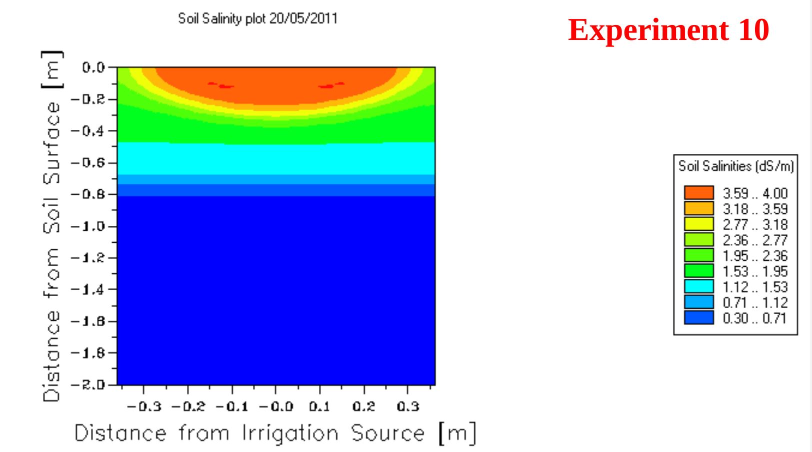
Irrigation treatments
Class A pan x Pan factor

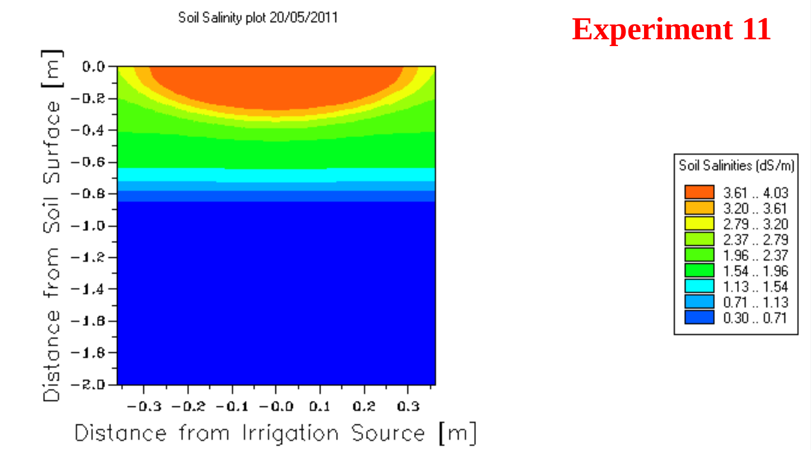


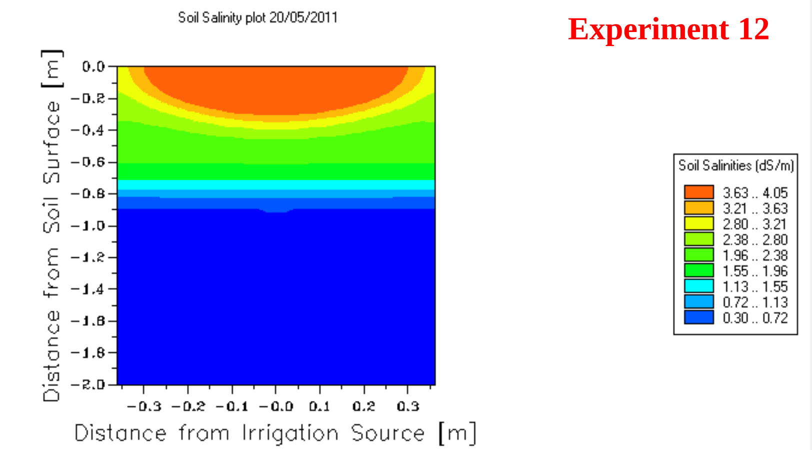
Class A pan evaporation data multiplied by pan coefficient (Epkc) of 0.50, 0.75, 1.00 and 1.25. In each irrigation treatment, plants were subjected to four salinity level treatments with electrical conductivities (ECw) of 1.0, 2.5, 3.5 and 6.0 dS m $^{-1}$

Predicted soil salinity (Day 55 of 110)







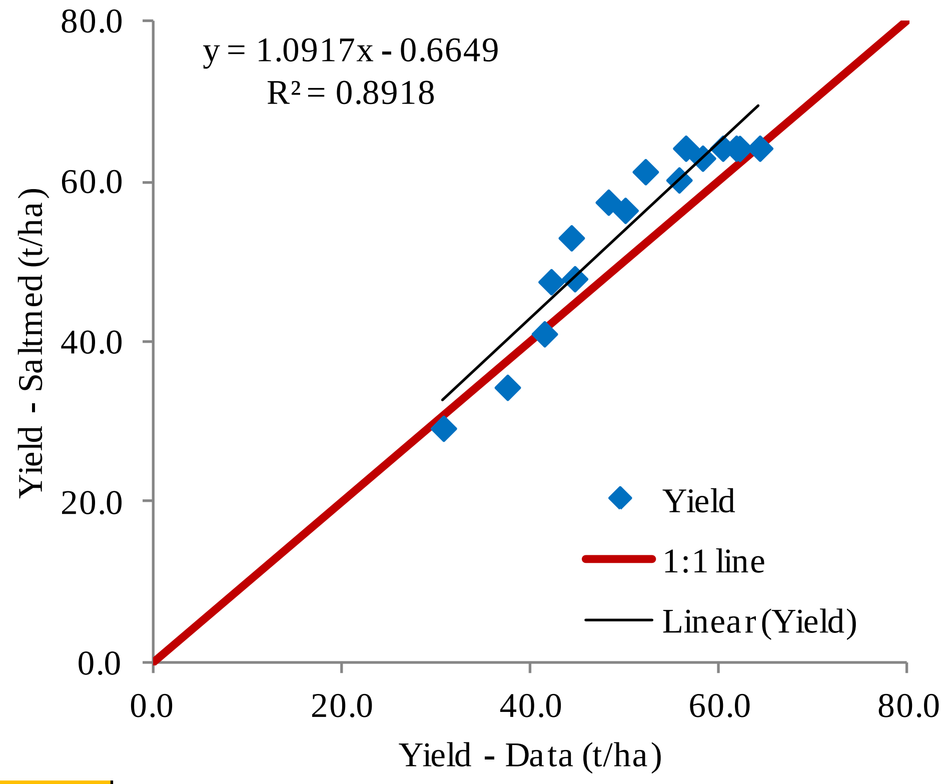


	Irrigation treatments (Ekpc)			
dS/m	0.5	0.75	1.00	1.25
1.0	Experiment 1	Experiment 2	Experiment 3	Experiment 4
2.5	Experiment 5	Experiment 6	Experiment 7	Experiment 8
3.5	**Experiment 9**	**Experiment 10**	**Experiment 11**	**Experiment 12**
6.0	Experiment 13	Experiment 14	Experiment 15	Experiment 16

Correlation between measured and predicted fresh yield

Measured data

ONUR F1 Fresh yield tonnes per hectar (t/ha)				
	Ekpc			
dS/m	0.50	0.75	1.00	1.25
1.0	64.29	61.79	60.36	56.43
2.5	62.14	58.21	55.71	50.00
3.5	52.14	48.21	44.29	42.14
6.0	44.64	41.43	37.50	30.71



	Irrigation treatments (Ekpc)			
dS/m	0.5	0.75	1.00	1.25
1.0	Experiment 1	Experiment 2	Experiment 3	Experiment 4
2.5	Experiment 5	Experiment 6	Experiment 7	Experiment 8
3.5	Experiment 9	Experiment 10	Experiment 11	Experiment 12
6.0	Experiment 13	Experiment 14	Experiment 15	Experiment 16

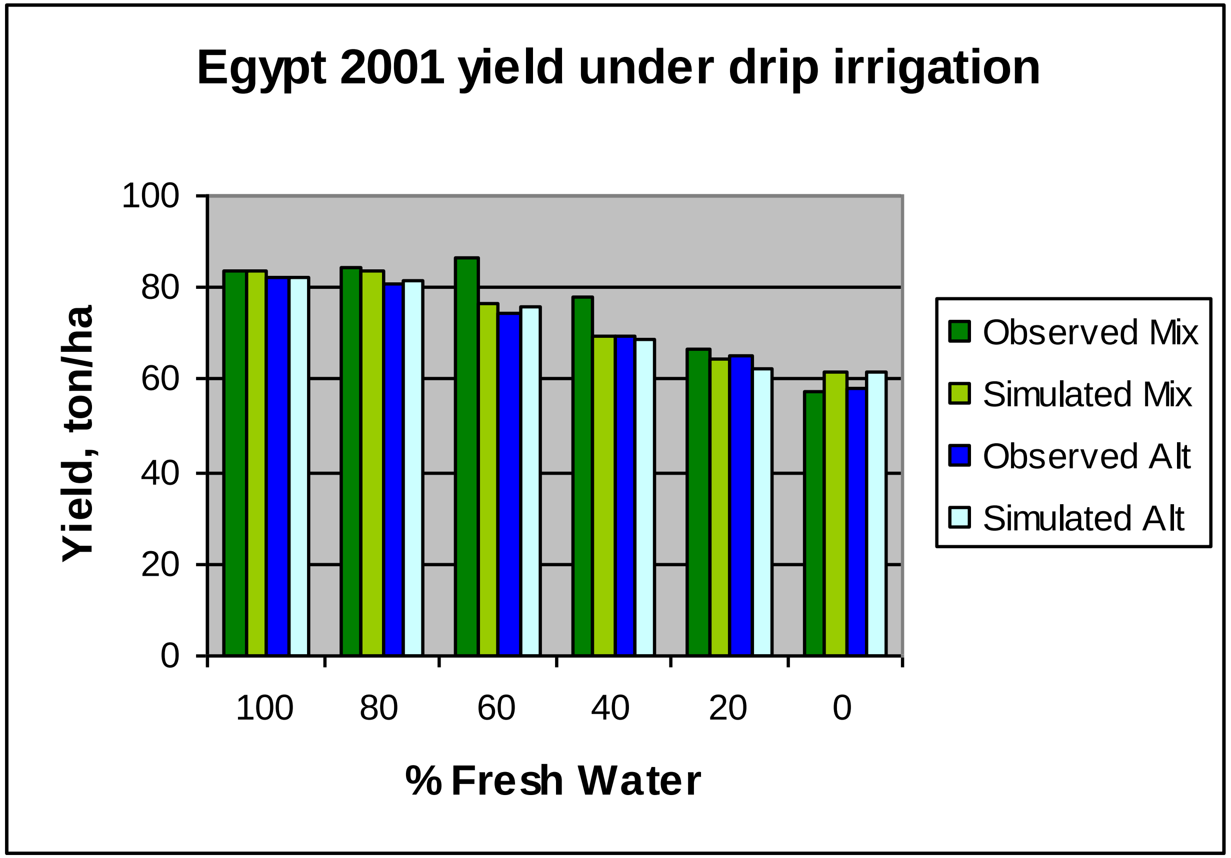
Conclusion: Sweet pepper varieties ONUR F1 and ADA F1 are moderately sensitive to salinity with a threshold value of 1.43 dS m^{-1}

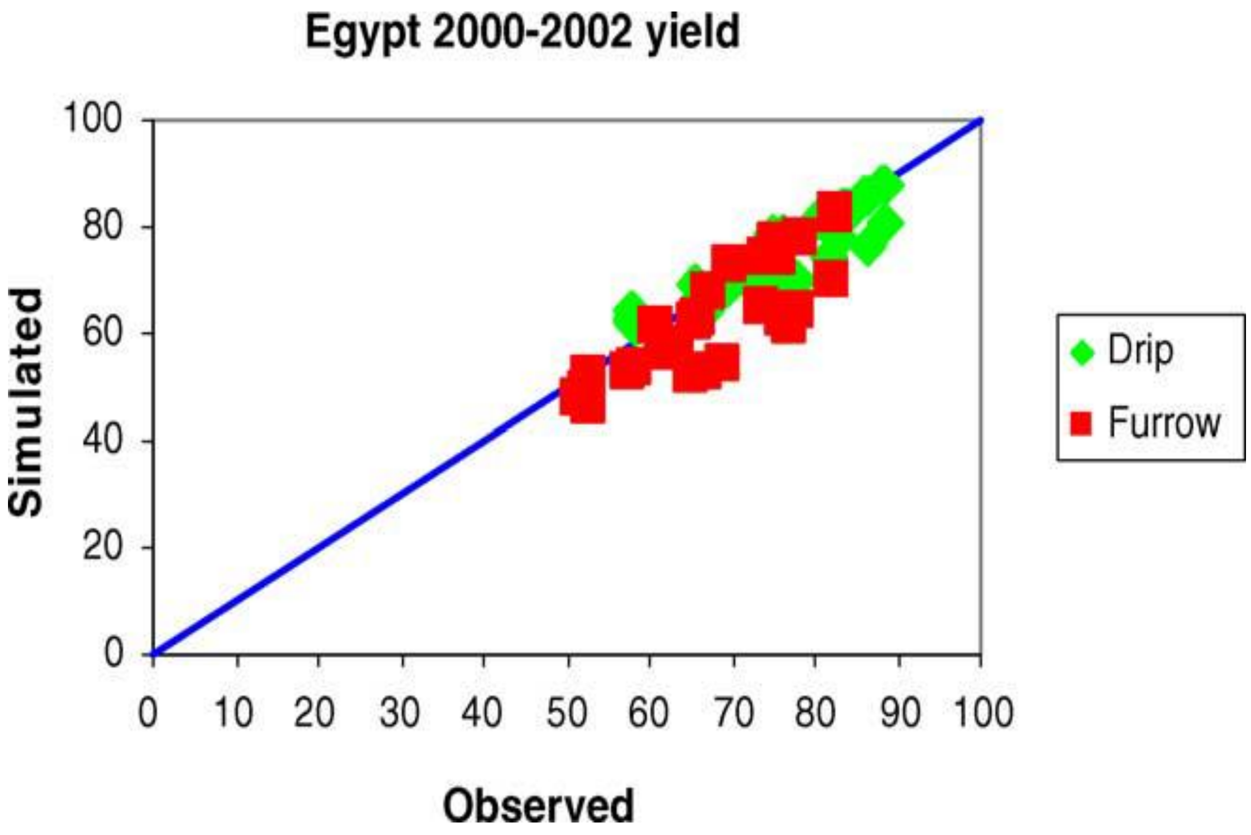
Egypt: Use of saline water resources on Tomato

Alternate and mixed supply of fresh [canal water (0.55 dS/m)] and saline [drainage water (4.2–4.8 dS/m)] water in six ratios applied through drip and furrow method on tomato (cv. Floradade) yield and growth, and salt concentration in the root zone were investigated in the Nile Delta, Egypt.

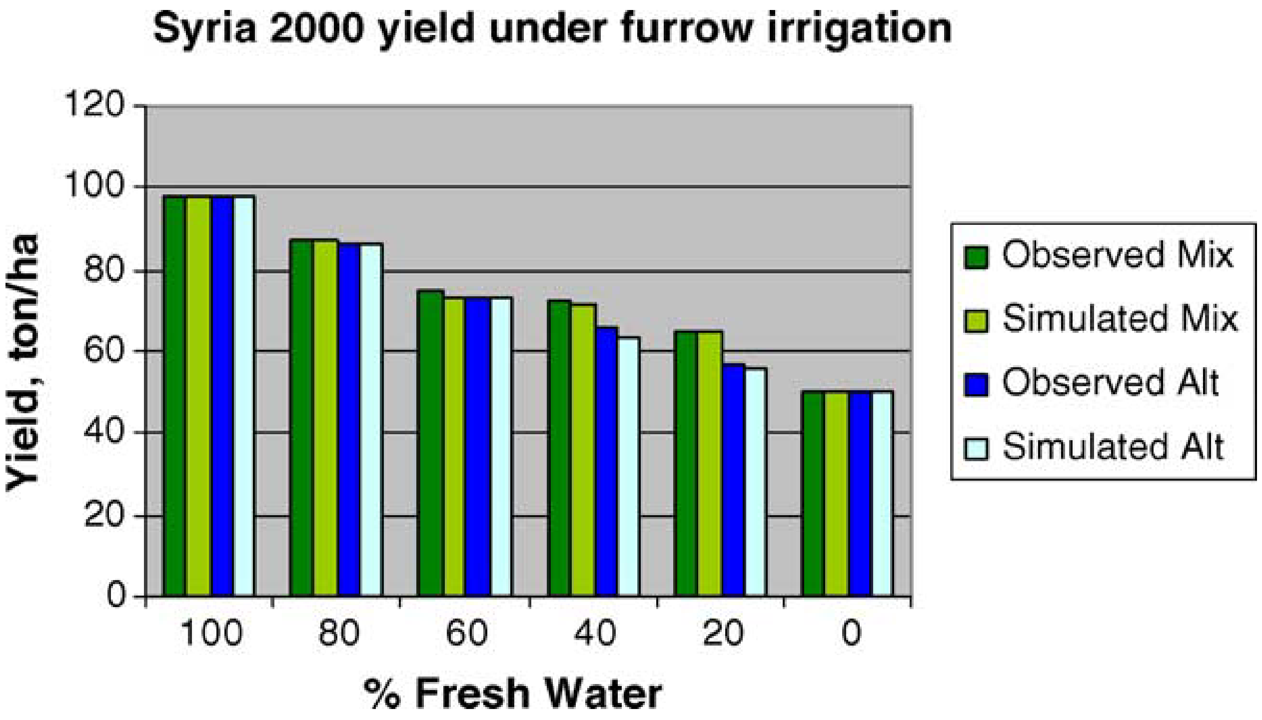
Tomatoes of high quality with high sugar content were obtained when using saline water for irrigation in field experiment in Egypt.

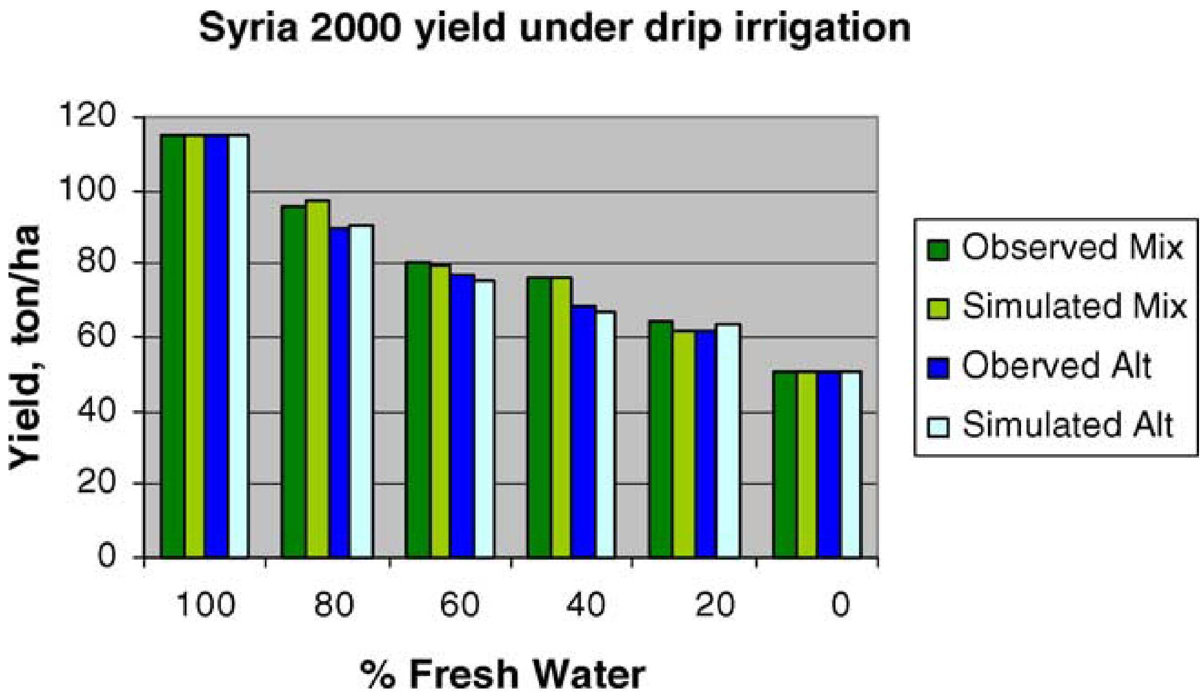
Egypt& Syria: SALTMED Field applications



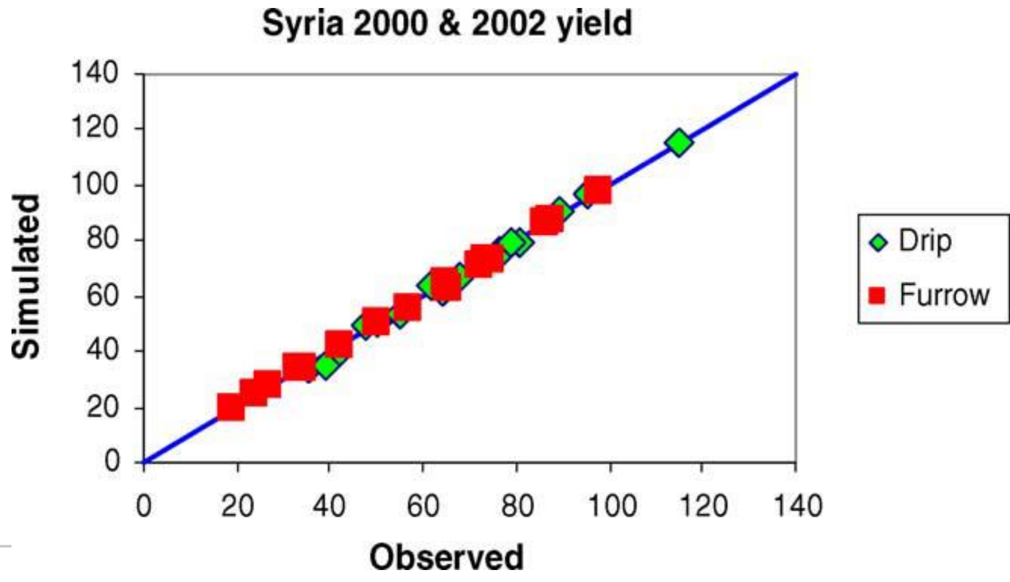


Effect of irrigation systems and water management practices using saline and non-saline water on tomato production N. Malash, T.J. Flowers , R. Ragab. Agricultural Water Management 78 (2005). Agricultural Water Management 78 (2005) 25–38 doi:10.1016/j.agwat.2005.04.016. & Effect of irrigation methods, management and salinity of irrigation water on tomato yield, soil moisture and salinity distribution, N. M. Malash · T. J. Flowers · R. Ragab. Irrig Sci (2008) 26:313–323 DOI 10.1007/s00271-007-0095-7. 25–38





The results indicated that the Floradade variety of tomato is salt tolerant and suitable to grow in the Mediterranean region. The results indicated that a 7 dS/m irrigation water reduced the yield by 50%. The results indicated that the relation between both yield and water uptake as a function of irrigation water salinity is non-linear and is better described by a polynomial function. the yield also decreased with increasing the salinity level of irrigation water and the yield under cyclic irrigation was slightly less than for the mixed treatment due to the nutrients present in the drainage water.



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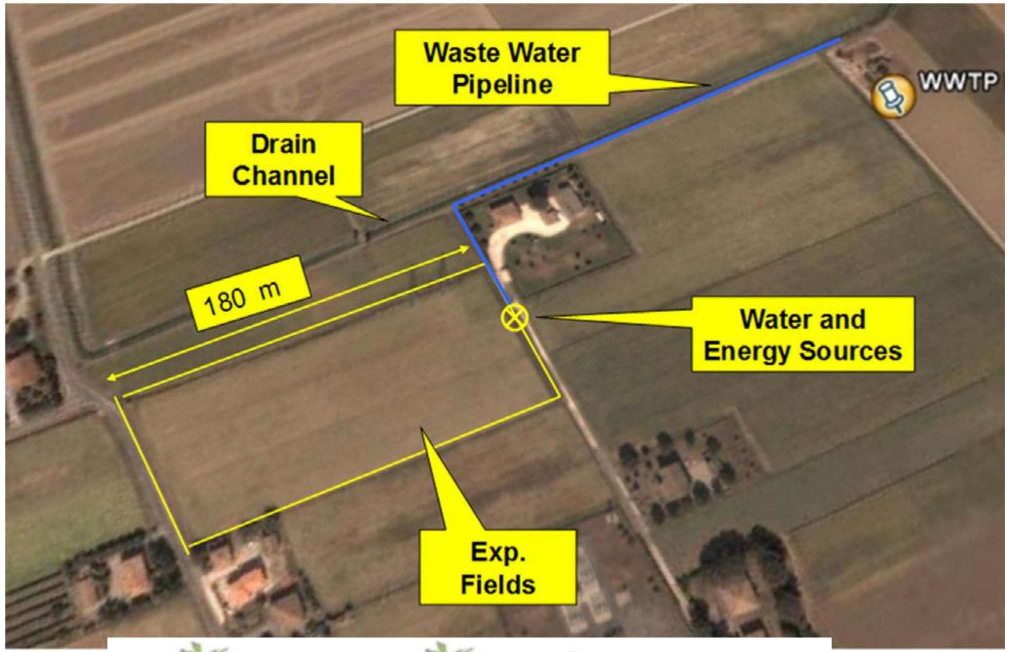
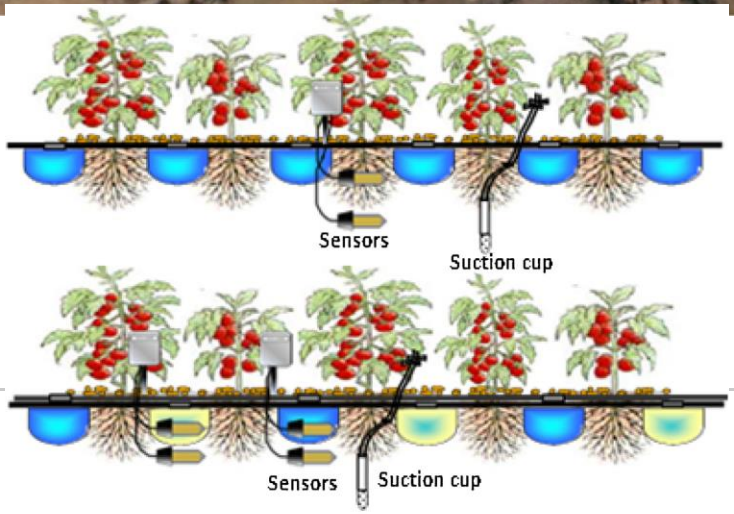
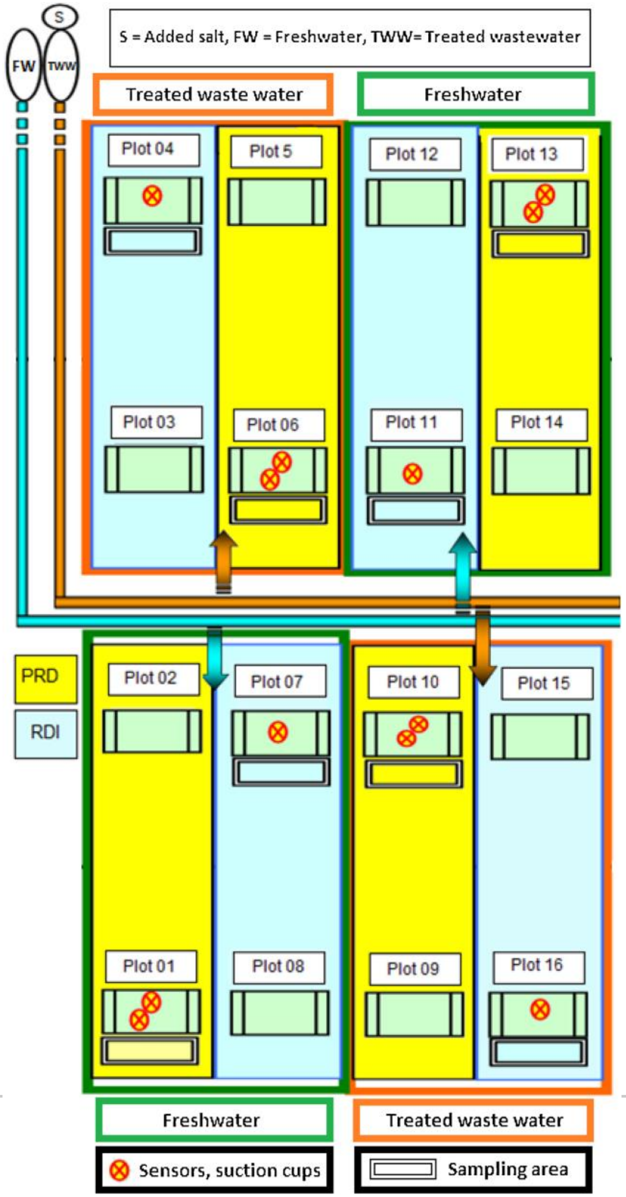
Italy, Improving water resources management using different irrigation strategies and water qualities: Field and modelling study. M. Afzal,, A. Battilani, D. Solimando, R. Ragab. Agricultural Water Management 176 (2016) 40–54. http://dx.doi.org/10.1016/j.agwat.2016.05.005





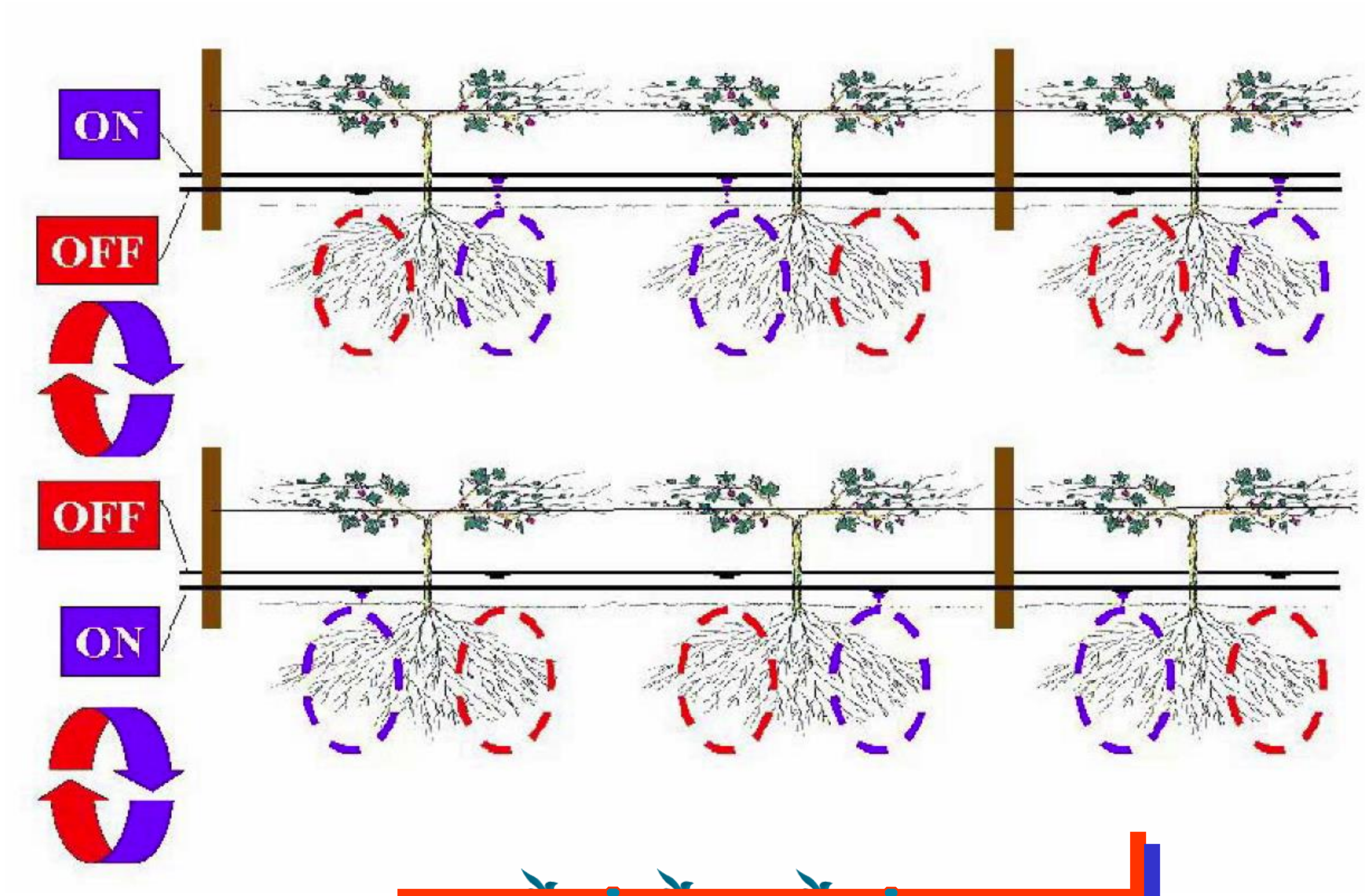


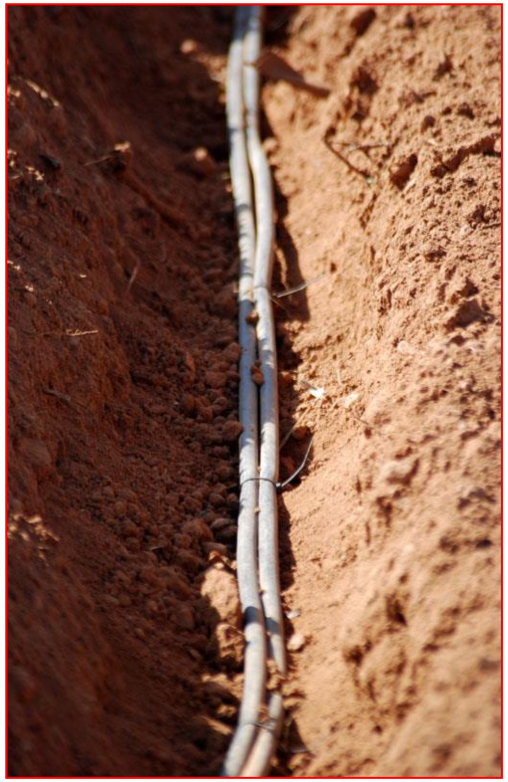
Subsurface drip irrigation in potatoes

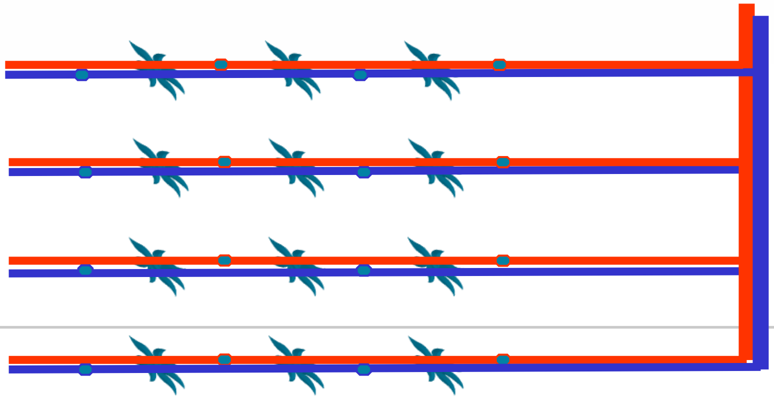
Subsurface drip

Investigate the effects of two different irrigation strategies, regulated deficit irrigation, RDI and partial root drying, PRD using surface freshwater (SW) and treated wastewater (TWW) spiked with salts (sodium chloride) to increase its salinity (up to 4 dS m^{-1}) maize and potato crops.

Saving water by irrigating half of the root zone, the PRD method







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Potato Yield

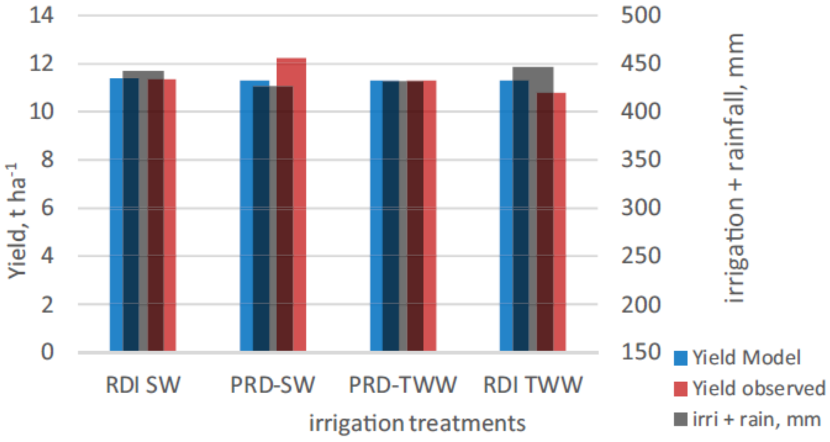


Fig. 12. Observed and simulated potato yield and water supply under different irrigation treatments in Bologna, Italy for the year 2013.

Maize Yield

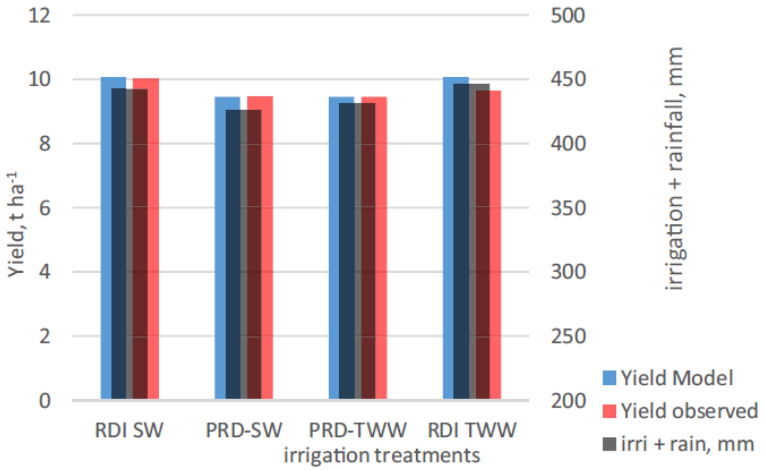


Fig. 13. Observed and simulated maize total yield and water supply under different irrigation treatments in Italy for the year 2014.

Soil moisture

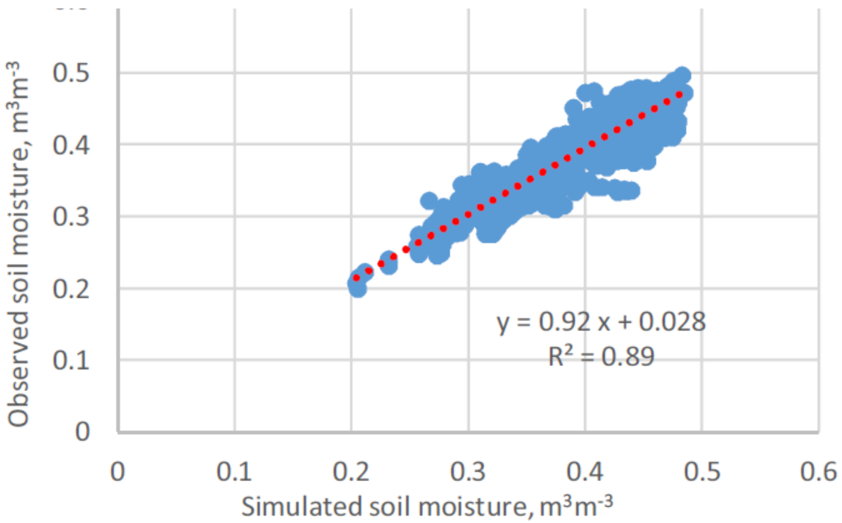


Fig. 8. The correlation between the observed and simulated soil moisture for all types of treatments.

Soil Salinity

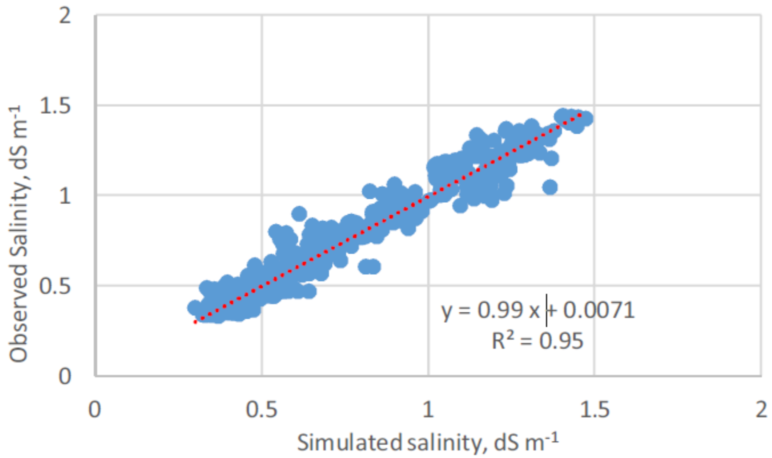


Fig. 11. The relationship between observed and simulated salinity over a depth of (25–35 cm) and (55 cm–65 cm) for all potato and maize treatments for the years 2013 and 2014.

Conclusions: Despite the fact that PRD used between 15–17% less water than RDI (excluding the rainfall contribution), the water productivity was slightly higher for the PRD in comparison with the RDI irrigation strategy. Given that the two strategies received the same amount of rainfall the results favour the PRD over RDI.

Egypt

The Benefit of Using Drainage Water of Fish Farms for Irrigation: Field and Modelling Study Using the SALTMED Model. R.E. Abdelraouf, R. Ragab. Volume66, Issue5. December 2017 Pages 758-772

https://doi.org/10.1002/ird.2180

Best paper Award, ICID 2018.

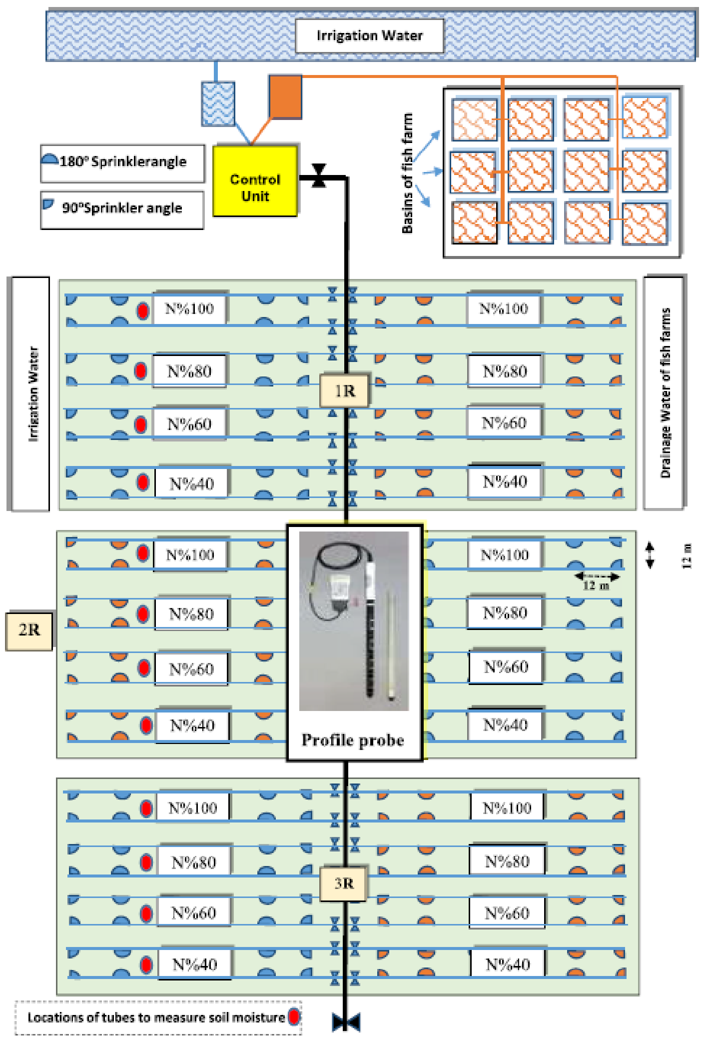
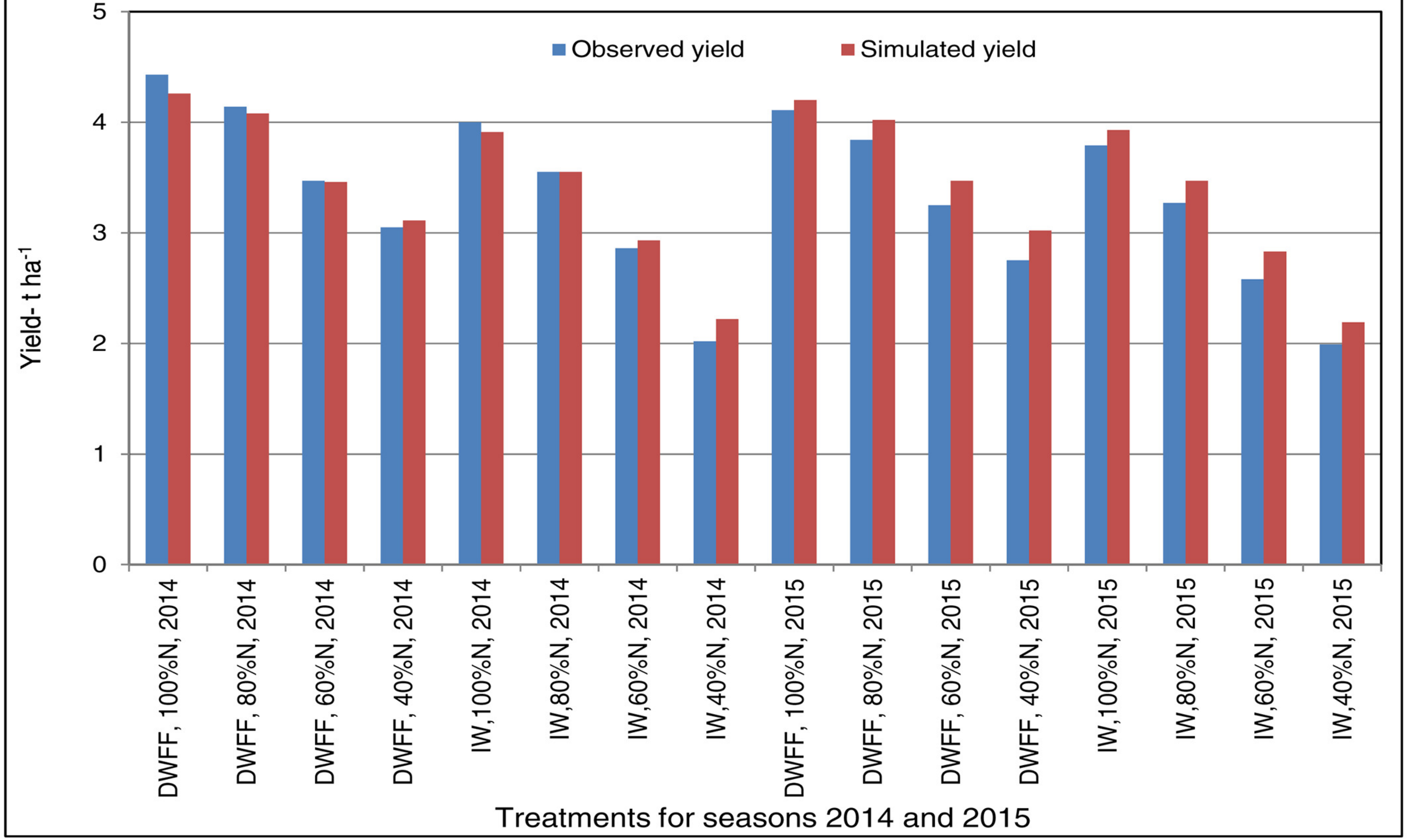


Figure 2. Layout of the experimental design.

This study investigated the suitability and benefits of using drainage water of fish farms (DWFF), instead of canal fresh water (IW), for wheat irrigation. Two water qualities, DWFF and IW, and four levels of N-fertigation rates [100% N (192 kg N ha−1 season−1), 80% N, 60% N and 40% N]

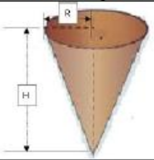
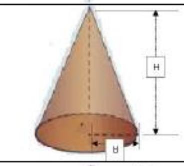
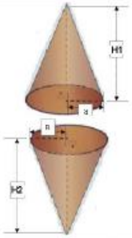
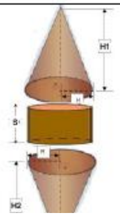


Wheat

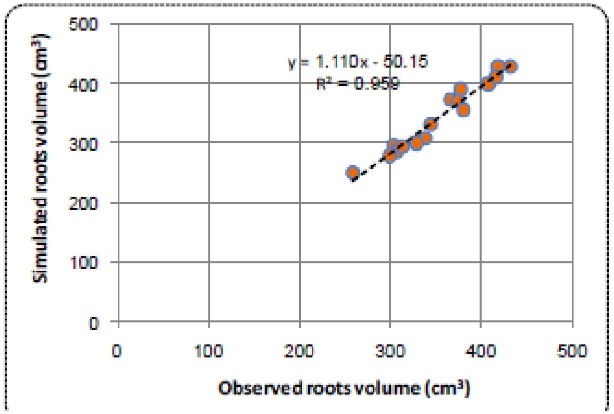
Conclusions: The wheat yield under DWFF was higher than the yield under the IW treatment by between 11 and 51% in 2014 and between 8 and 38% in 2015. This is due to the additional amount of dissolved biological nitrogen and other nutrients inherent in DWFF.

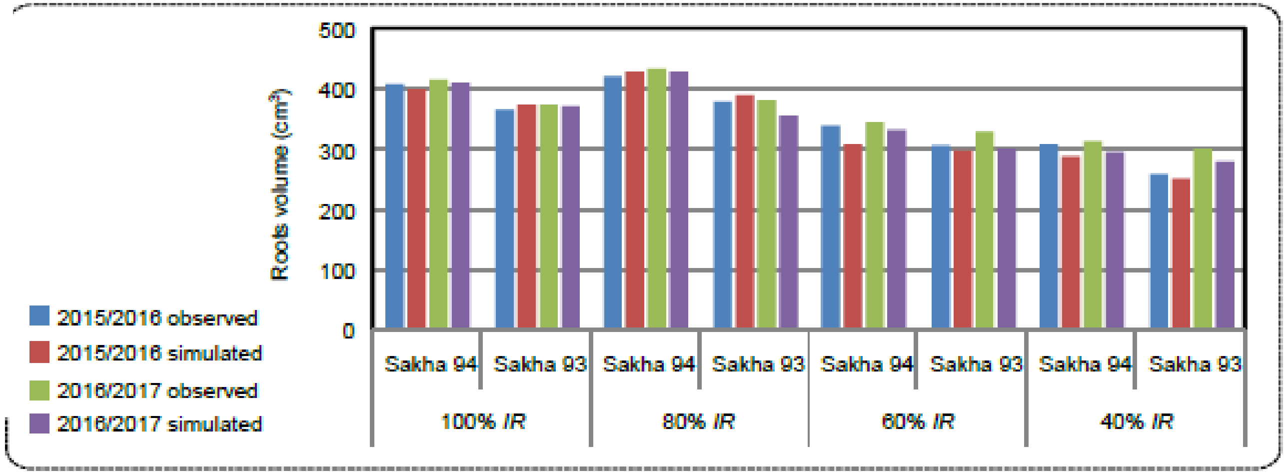
Egypt, Field and modelling study for deficit irrigation strategy on roots volume and water productivity of wheat Article in Journal of Water and Land Development · JOURNAL OF WATER AND LAND DEVELOPMENT. 2021, No. 49 (IV–VI): 129–138; https://doi.org/10.24425/jwld.2021.137105. Ramadan E. ABDELRAOUF, Mohamed A. EL-SHAWADFY, Osama M. DEWEDAR, Mahmoud HOZAYN

Table 4. Observed and simulated root volume (*RV*)

Case number	Root shape in the soil	3D shape of the true volume of the wheat plant roots	Observed root volume equation
1			$RV = (3.14R^2 \cdot H)/3$ (1)
2			$RV = (3.14R^2 \cdot H)/3$ (2)
3			$RV = (3.14R^2 \cdot H_1)/3 + (3.14R^2 \cdot H_2)/3$ (3)
4			$RV = (3.14R^2 \cdot H_1)/3 + (3.14R^2 \cdot H_2)/3 + 3.14R^2 \cdot S$ (4)

Effect of deficit irrigation strategy and varieties on roots volume of wheat at 50 days from plant age and compared to simulated roots volume for all treatments.





Observed versus simulated roots volume of wheat plant for all treatments for seasons 2015/2016

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SALTMED Simulated Root System Geometry

RootProfile02.dat - Notepad

File Edit Format View Help

```
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Current Date: 08/05/1999
Root Zone Depth = 0.600000	Root Zone Width =0.300000
0	0	0	0	0	0	0	1	1	2	2	2	2	2	2	2	2	2	2
0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2
0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2
0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2
0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2
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0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2
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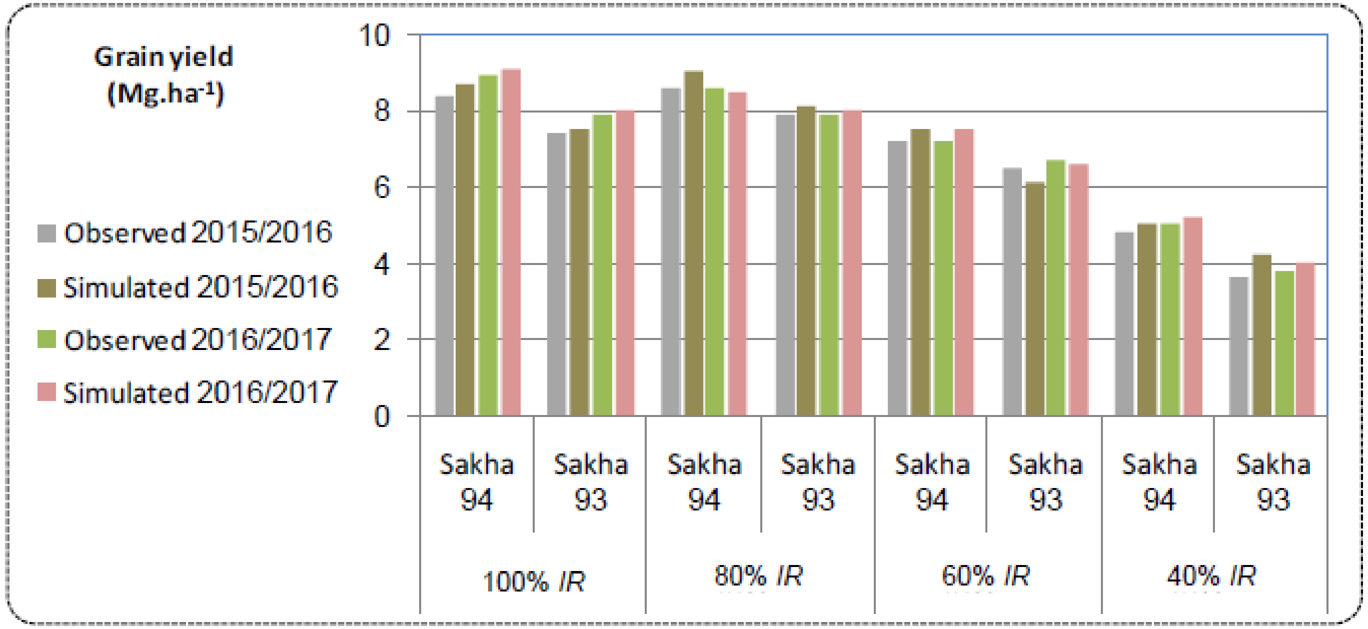
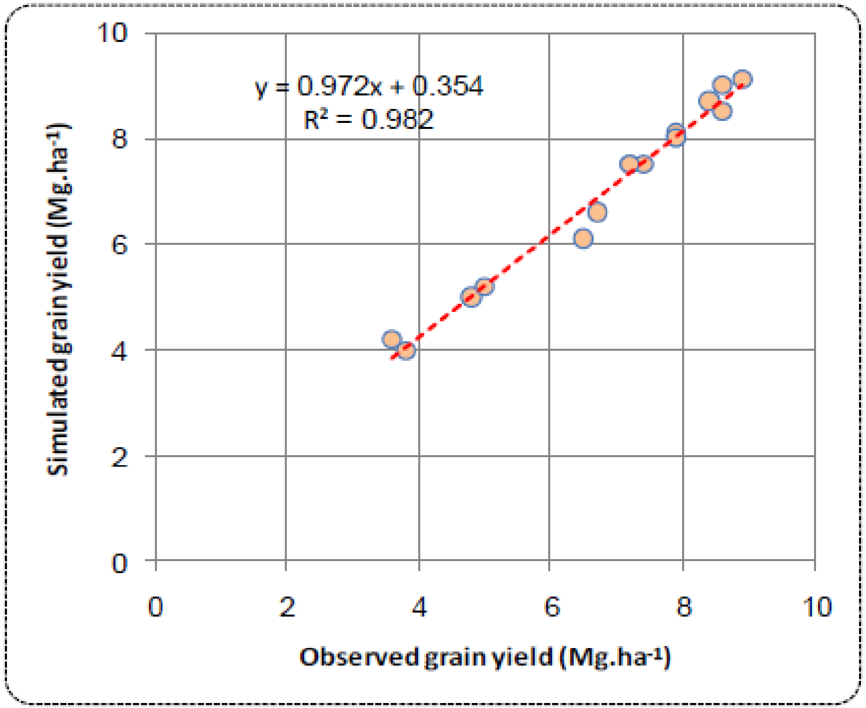


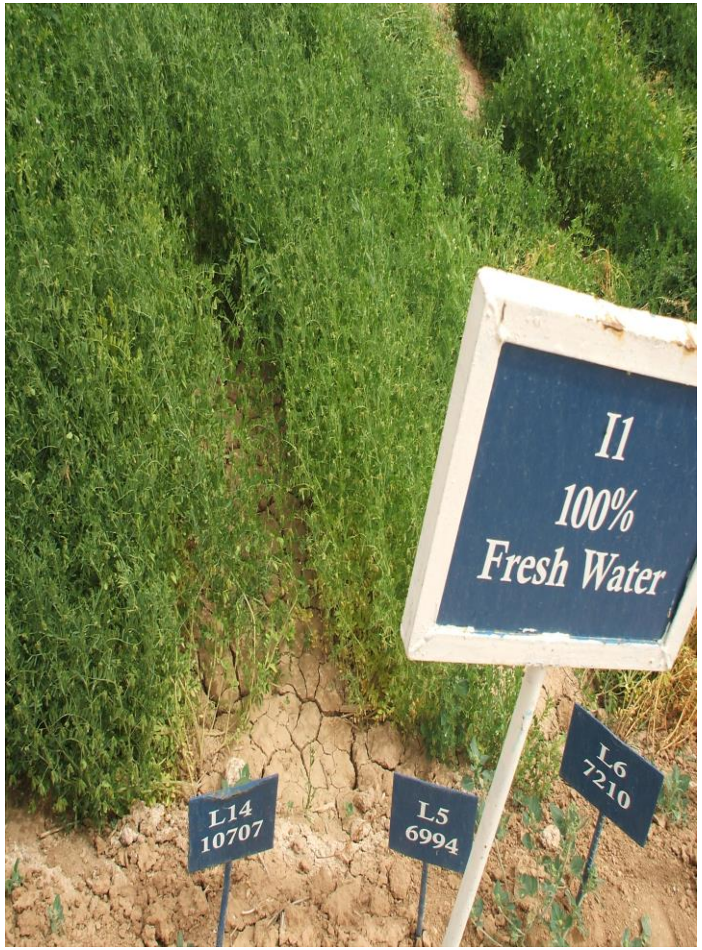
Effect of deficit irrigation strategy and varieties on grain yield for all treatments.



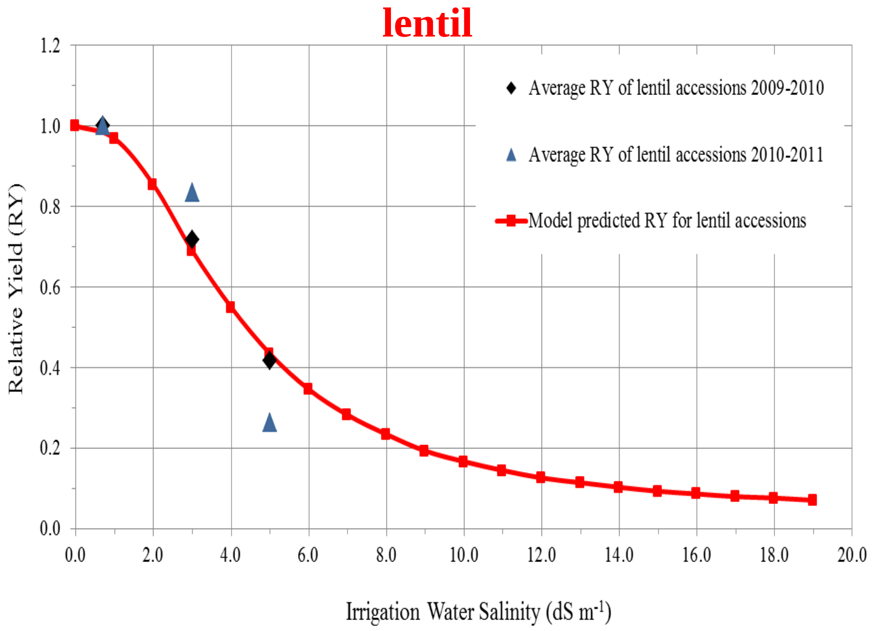
Observed versus simulated grain yield for all treatments for seasons 2015/2016 and 2016/2017

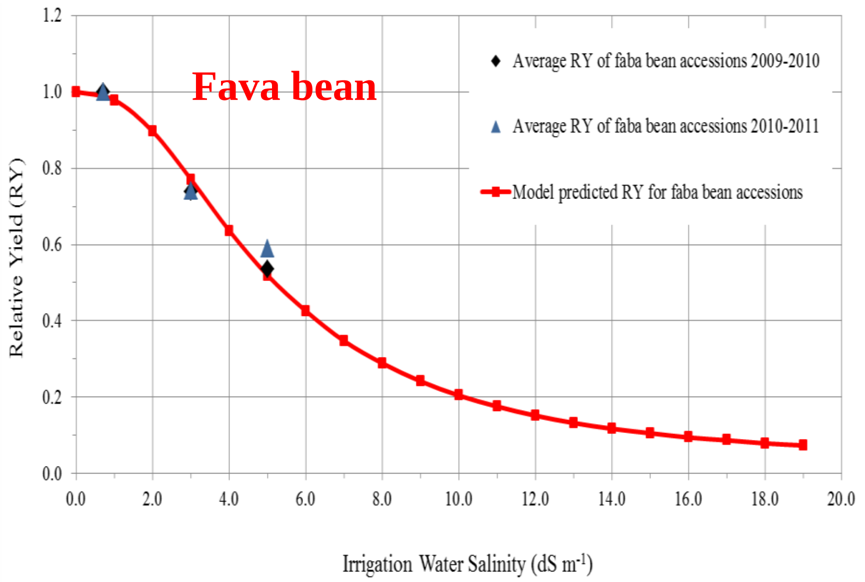
Conclusions: There were no significant differences between the yield values at 100% and 80% of irrigation Requirement, IR, so we recommend irrigating wheat at 80% of IR and which will save 20% IR.

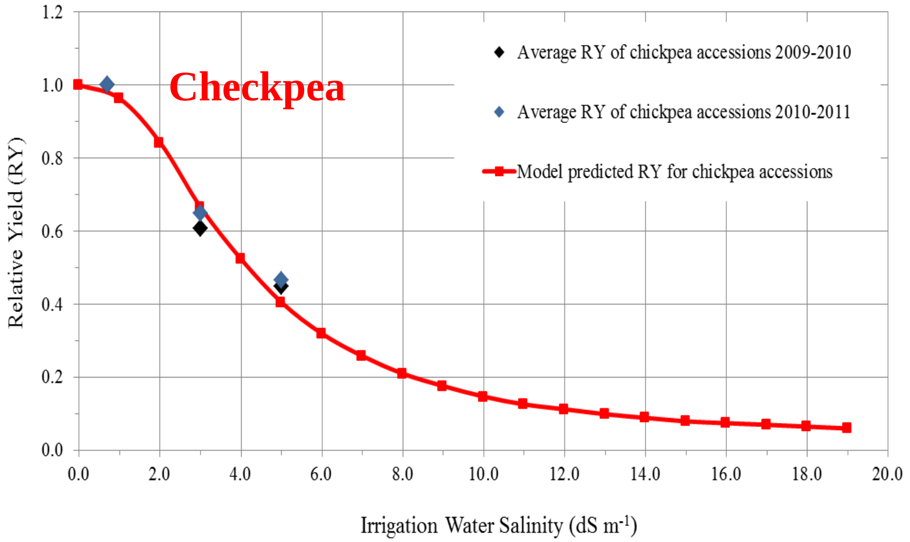
Syria, Use of saline water on conventional crops Chickpea, lentil and faba bean



Legumes : Lentil, chickpea and faba bean yield-salinity curves , Syria







50% yield reduction (π_{50} value) in chickpea, lentil, and faba bean occurred at salinity levels of 4.2 dS m^{-1}, 4.4 dS m^{-1}, and 5.2 dS m^{-1}, respectively. These results suggest that faba bean can withstand relatively high levels of irrigation water salinity, followed by lentil and chickpea.

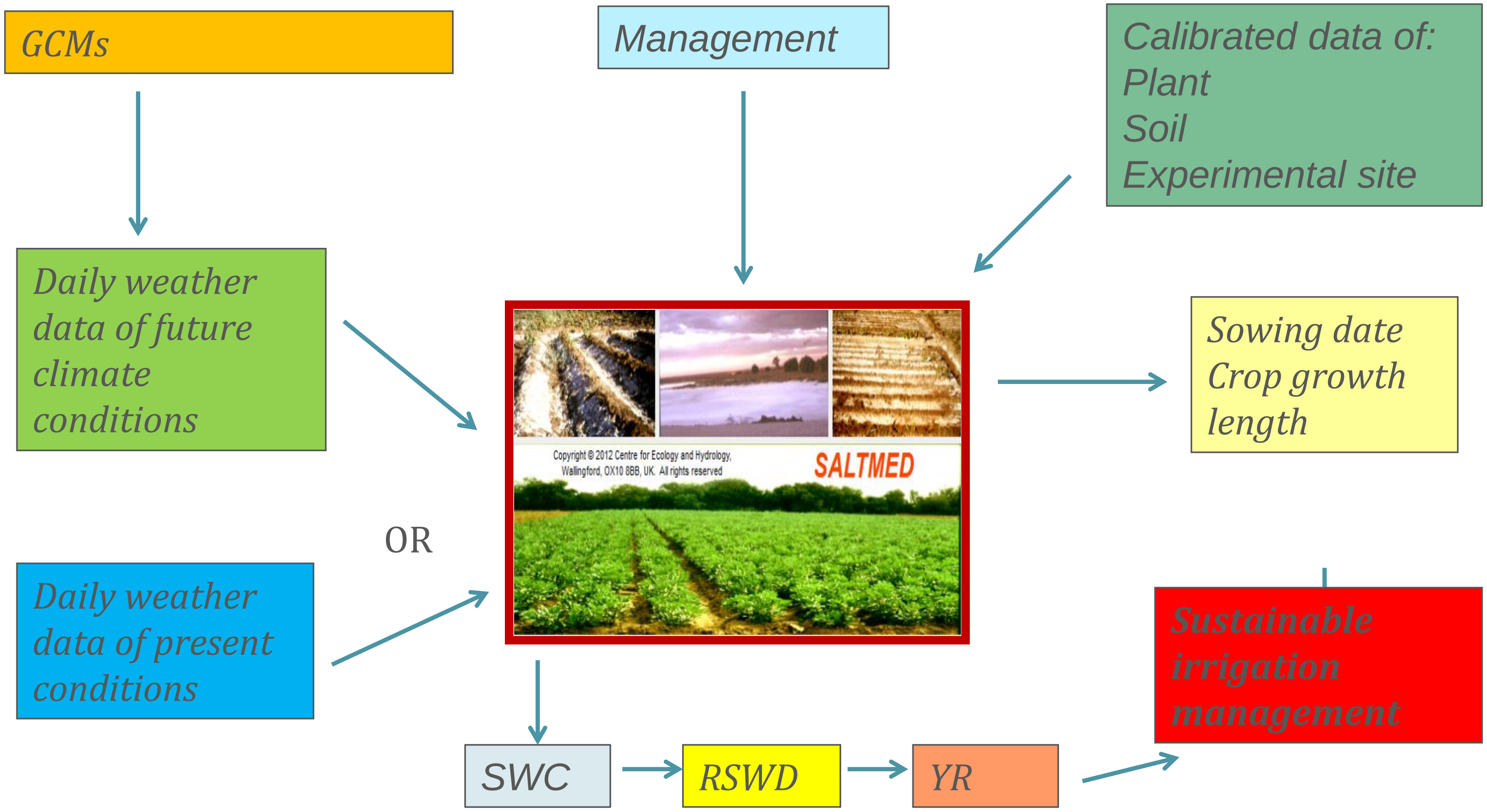
UK Centre for Ecology & Hydrology

EVALUATING THE PRODUCTIVITY POTENTIAL OF CHICKPEA, LENTIL AND FABA BEAN UNDER SALINE WATER IRRIGATION SYSTEMS. A. ARSLAN, G. A. MAJID, K. ABDALLAH, P. RAMESHWARAN, R. RAGAB, M. SINGH3 AND M. QADIR. IRRIGATION AND DRAINAGE. Irrig. and Drain. 65: 19–28 (2016). DOI: 10.1002/ird.1912

SALTMED model as a tool for investigating the climate change impact :

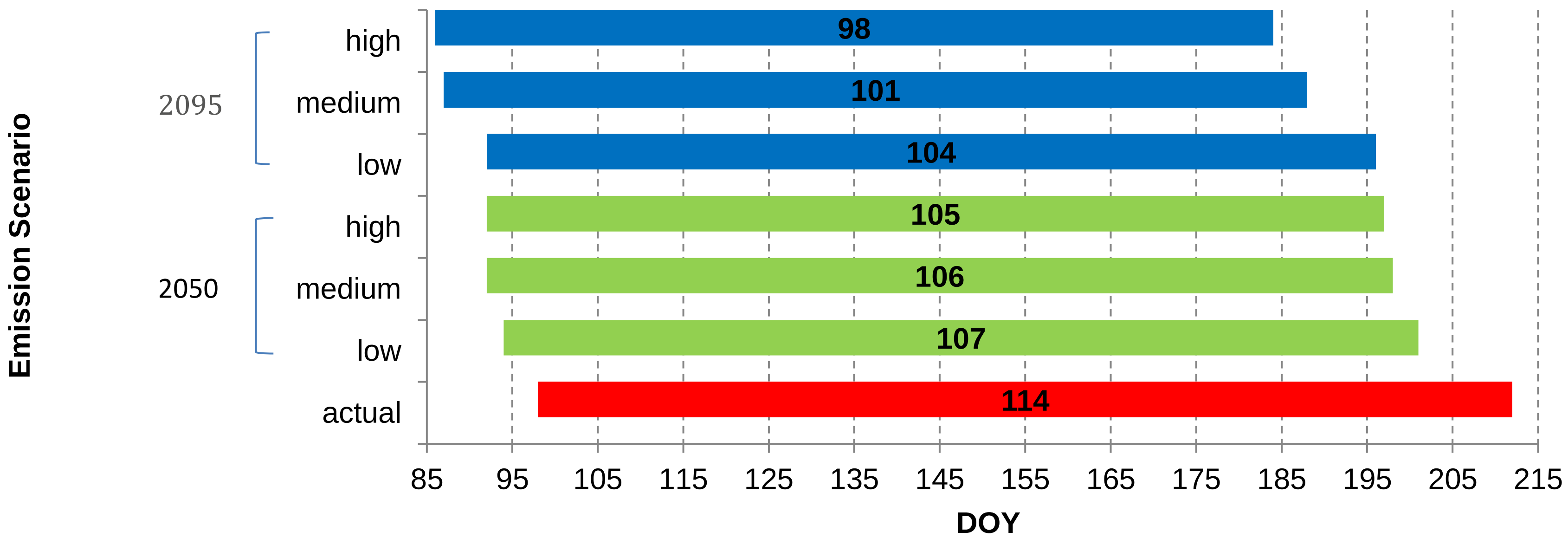
UK Centre for
Ecology & Hydrology

Impact of Climate Change on Crop Growth, growth period, yield and Crop water requirement using SALTMED model



ASSESSING AMARANTH ADAPTABILITY IN A MEDITERRANEAN AREA OF SOUTH ITALY UNDER DIFFERENT CLIMATIC SCENARIOS. C. PULVENTO, A. LAVINI, M. RICCARDI, R. D'ANDRIA1 AND R. RAGAB. Irrig. and Drain. (2015). Volume64, Issue1. Pages 50-58. DOI: 10.1002/ird.1906

Scenarios	2050 C°	2095 C°
high emissions	1.65	3.13
medium emissions	1.75	2.65
low emissions	1.29	1.79



Amaranth growing season

Pakistan: Climate Change Impacts on Future Wheat (Triticum aestivum) Yield, Growth Periods and Irrigation Requirements: A SALTMED Model Simulations Analysis Junaid Nawaz Chauhdary , Hong Li , Ragab Ragab , Md Rakibuzzaman , Azeem Iqbal Khan, Jing Zhao and Nadeem Akbar . Agronomy 2024, 14, 1484. https://doi.org/10.3390/ agronomy14071484

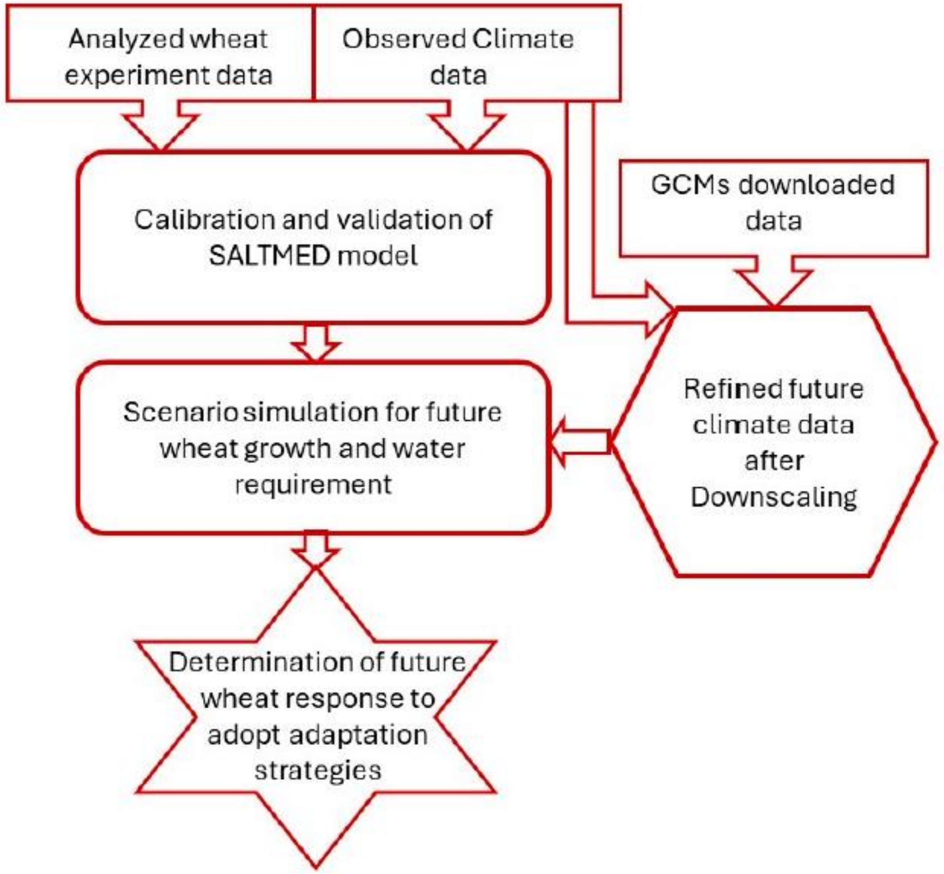


Figure 1. Flowchart depicting the application of the SALTMED model for predicting future climate change on wheat response.

Wheat yield, dry matter and height

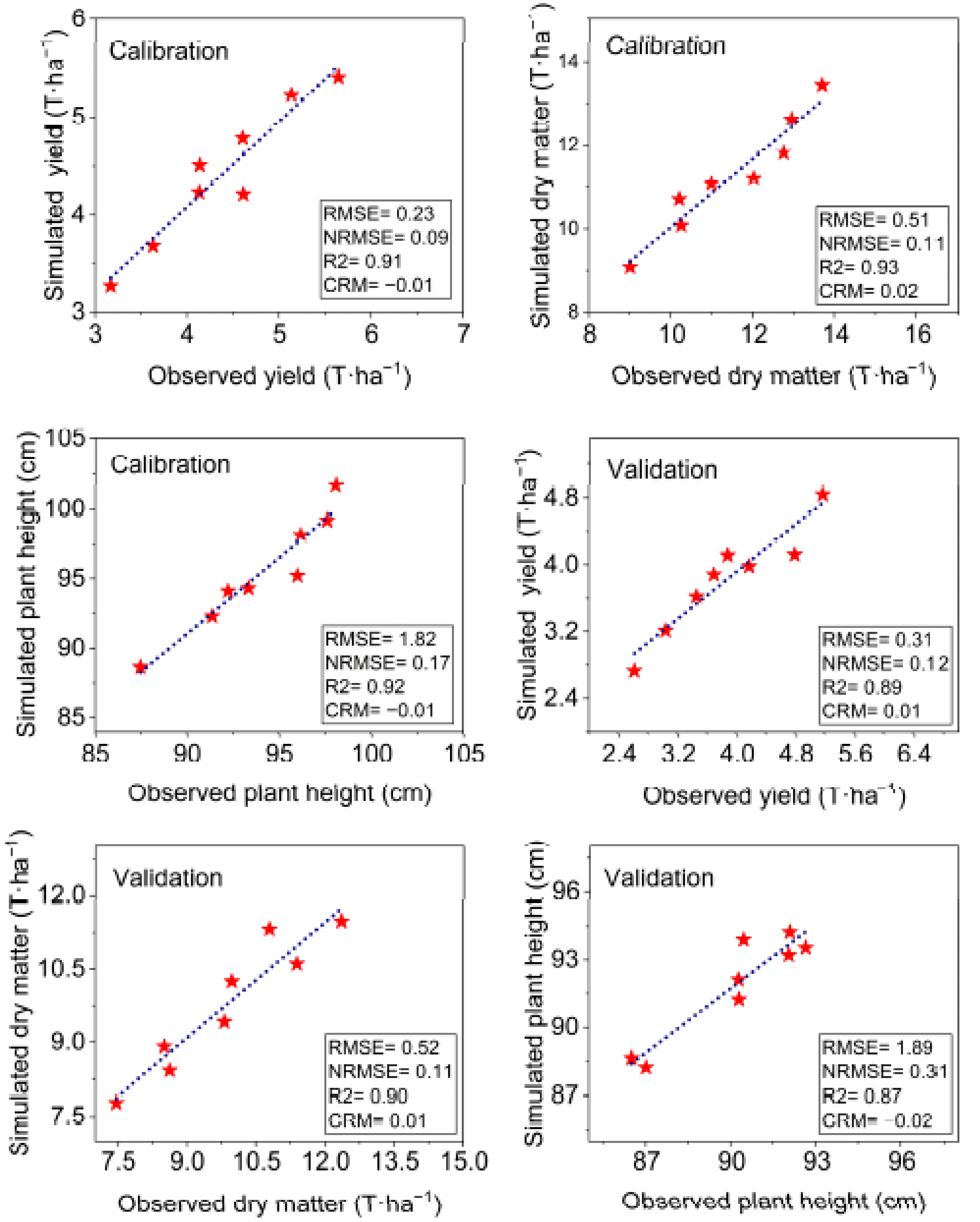


Figure 5. Comparison between observed and simulated values of crop parameters during calibration and validation of SALTMED.

Table 5. The simulated wheat yield, dry matter, irrigation requirements and water productivity under different scenarios of future climate change.

	Wheat Season	Wheat Yield ($T \cdot ha^{-1}$)				Dry Matter ($T \cdot ha^{-1}$)			
Baseline data	2021–2022	5.18				12.36			
		RCP4.5	% Decrease	RCP8.5	% Decrease	RCP4.5	% Decrease	RCP8.5	% Decrease
Future simulations	2039–2040	5.05	2.4	4.85	6.3	11.80	4.6	11.61	6.1
	2054–2055	4.92	5.1	4.66	10.0	11.43	7.5	11.26	8.9
	2069–2070	4.81	7.1	4.52	12.8	11.30	8.6	10.63	14.0
	2084–2085	4.62	10.9	4.25	18.0	10.85	12.2	9.84	20.4
	2099–2100	4.44	14.2	4.09	21.0	10.52	14.9	9.49	23.3
	Wheat season	Irrigation requirement (mm)				Water productivity ($kg \cdot m^{-3}$)			
Baseline data	2021–2022	365				1.42			
		RCP4.5	% Increase	RCP8.5	% Increase	RCP4.5	% Decrease	RCP8.5	% Decrease
Future simulations	2039–2040	376	3.0	385	5.5	1.34	5.3	1.26	11.2
	2054–2055	383	5.0	391	7.0	1.28	9.6	1.19	15.9
	2069–2070	395	8.1	405	11.1	1.22	14.1	1.11	21.5
	2084–2085	406	11.2	417	14.2	1.14	19.9	1.02	28.2
	2099–2100	419	14.9	431	18.0	1.06	25.3	0.95	33.0

Wheat yield Prediction under Climate Change

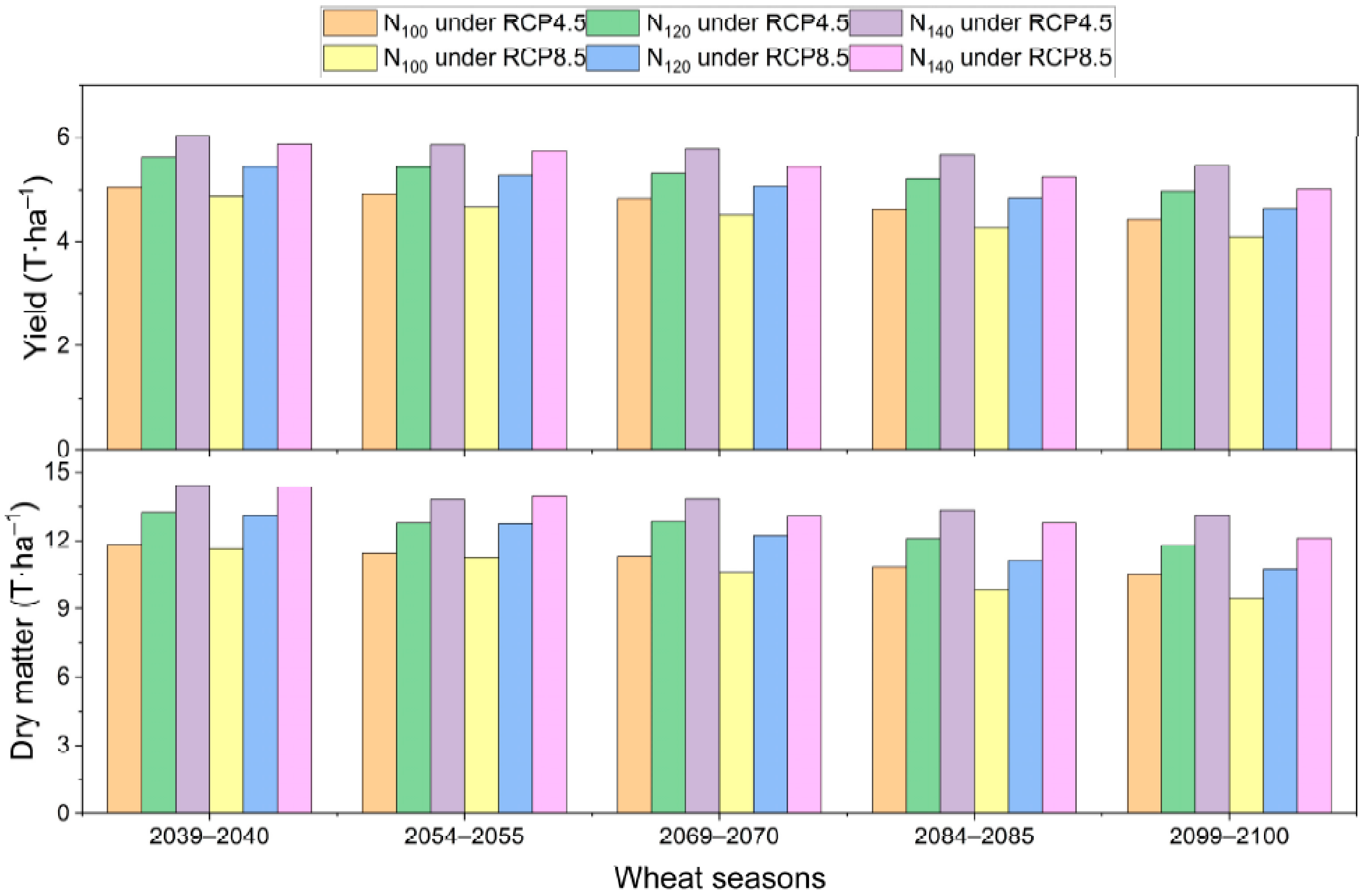


Figure 9. Simulation of wheat grain yield and dry matter under various hypothetical nitrogen application scenarios in the context of future climate change.

UK Centre for Ecology & Hydrology

Conclusions

The projections for future climate scenarios indicated significant shifts in wheat phenology by the end of the century. The sowing dates advanced by nine days under RCP4.5 and eleven days under RCP8.5, while the harvesting dates shifted earlier by twenty-four days under RCP4.5 and twenty-eight days under RCP8.5. Consequently, the overall crop Agronomy 2024, 14, 1484 21 of 23
period was shortened by fifteen days under RCP4.5 and eighteen days under RCP8.5.

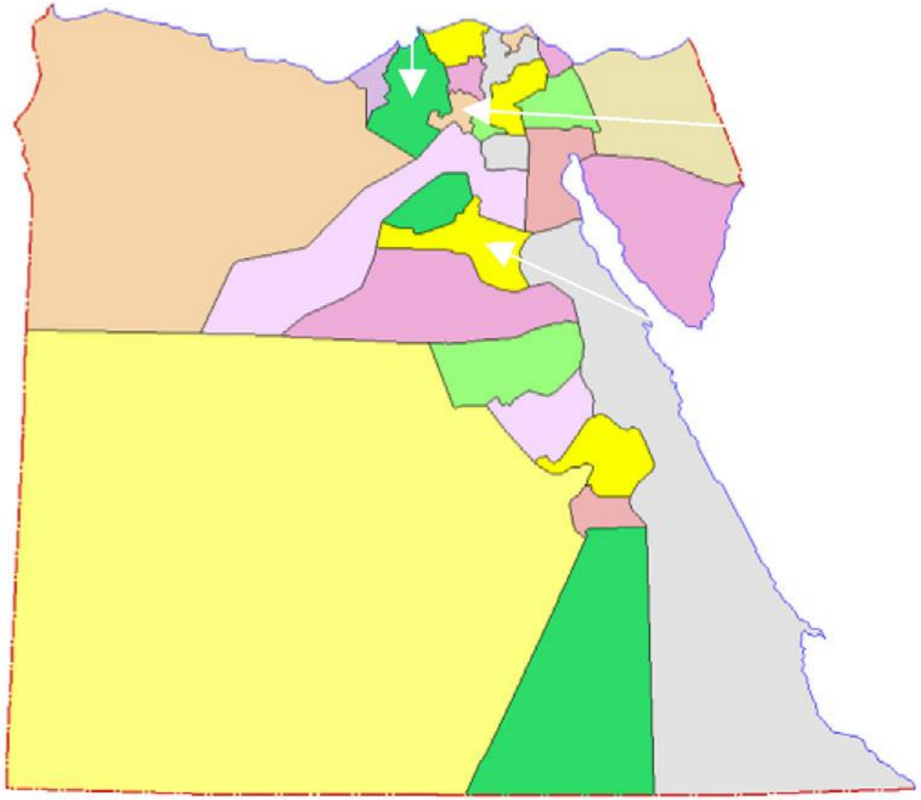
Further simulations revealed substantial reductions in the wheat yield and dry matter, with yields decreasing by 14.2% under RCP4.5 and 21.0% under RCP8.5 and dry matter reducing by 14.9% under RCP4.5 and 23.3% under RCP8.5.

Additionally, the irrigation requirement increased by 14.9% under RCP4.5 and 18.0% under RCP8.5, leading to a significant decline in water productivity, which decreased by 25.3% under RCP4.5 and 33.0% under RCP8.5

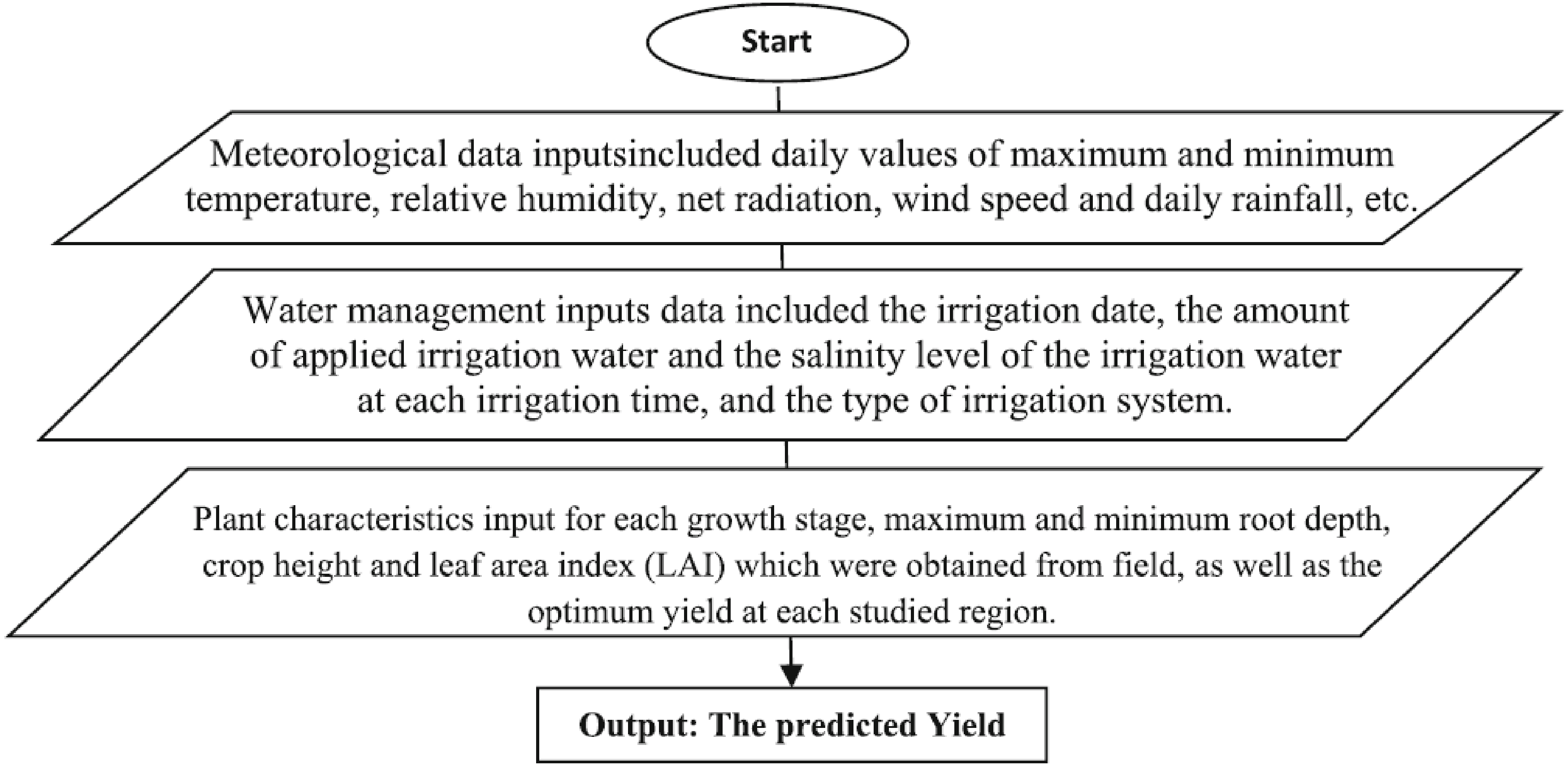
By the end of the century. Hypothetical scenarios suggested that increasing nitrogen applications by 20–40% could mitigate some of the negative impacts of climate change. These adjustments could enhance wheat yield by 11.4–20.8% and dry matter by 12.1–26.6% under RCP4.5 and by 12.8–22.1% and 13.5–25.5% under RCP8.5.

Egypt

Estimating yield stability and predicting the response of sesame genotypes to climate change using the SALTMED model. Hani Mehanna Ayman Saber Ghada Samaha | Mahmod Abd El-Aziz and Ragab Ragab. 2024. Irrig. and Drain. 2024;73:1483–1495. DOI: 10.1002/ird.2970



The three governorates studied in Egypt.



Inputs and outputs of SALTMED model for simulating the climate change effect (of increasing air temperature and the crop water requirement) on the productivity of sesame lines.

TABLE 8 The effect of climate change (raising the air temperature from +1°C to +5°C for each scenario) on the total crop irrigation water requirement.

	Predicted irrigation water requirements (m^3 ha^{-1} $season^{-1}$) (% increment from the current water requirements)					
Location	**Current**	**+1°C**	**+2°C**	**+3°C**	**+4°C**	**+5°C**
Beni Suwef	5255	5385 (2.5%)	5519 (5.1%)	5607 (6.7%)	5744 (9.4%)	5847 (11.3%)
El-Beheira	3780	3865 (1.6%)	3964 (3.5%)	4064 (5.4%)	4209 (8.2%)	4264 (9.3%)
El-Menoufia	3765	3858 (1.8%)	3970 (3.9%)	4072 (5.9%)	4178 (7.9%)	4281 (9.9%)

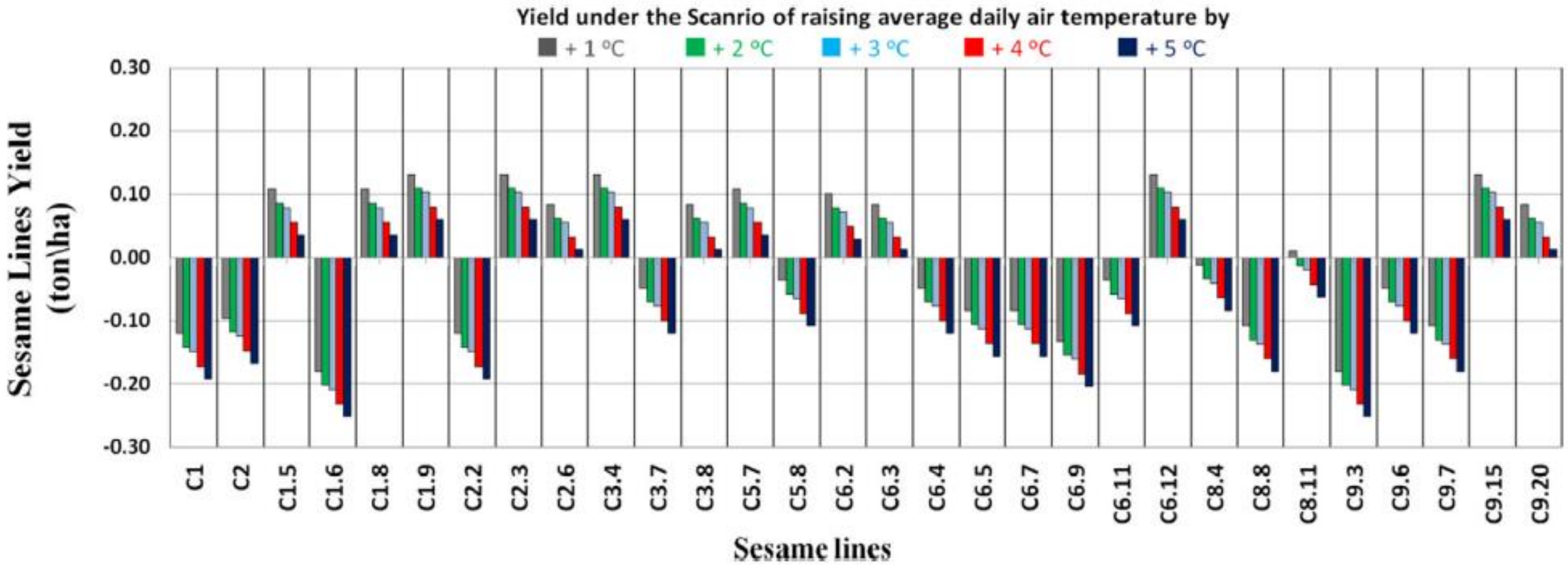


FIGURE 3 The impact of raising the air temperature as a factor of the climate change from +1°C to +5°C on the 30 sesame lines studied in the El-Beheria region.

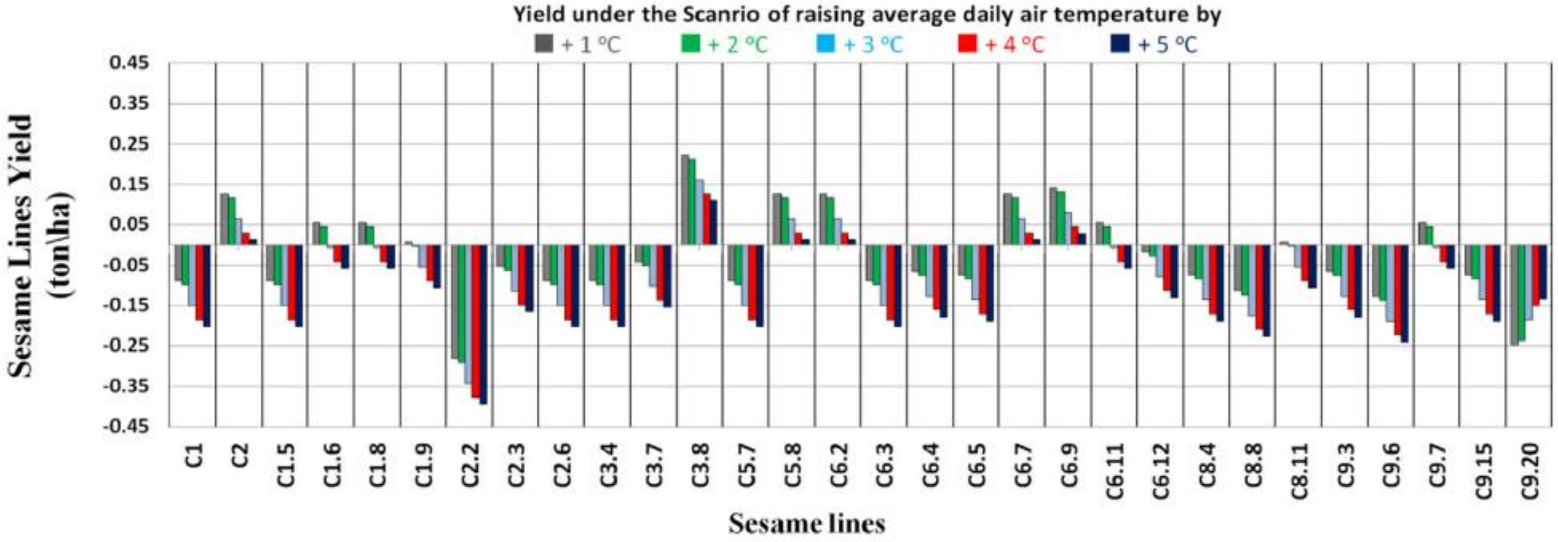


FIGURE 4 The impact of raising the air temperature as a factor of the climate change from +1°C to +5°C on the 30 sesame genotypes studied in El-Menoufia governorate.

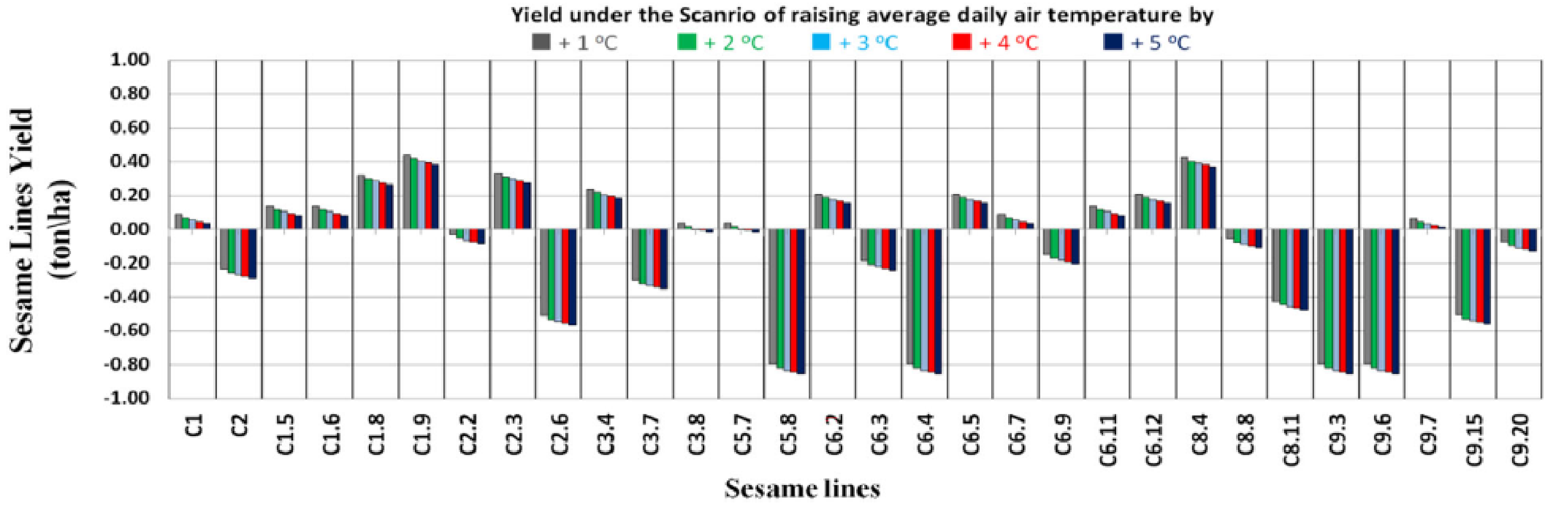


FIGURE 5 The impact of raising the air temperature as a factor of the climate change from +1°C to +5°C on the 30 sesame lines studied in the Beni Suwef governorate.

Conclusions

The use of the SALTMED model helped to predict the response of new and current crop genotypes to the expected scenarios of increasing daily air temperature.

The C3.8 and C6.2 lines under the three locations studied and the C1.8, C2.3 and C6.12 lines under the Beni Suwef and El-Beheira governorates showed possible increases in yield with increasing air temperature, while the C9.6, C8.11, C8.8, C2.3 and C2.2 lines showed possible decreases in yield with increasing temperature.

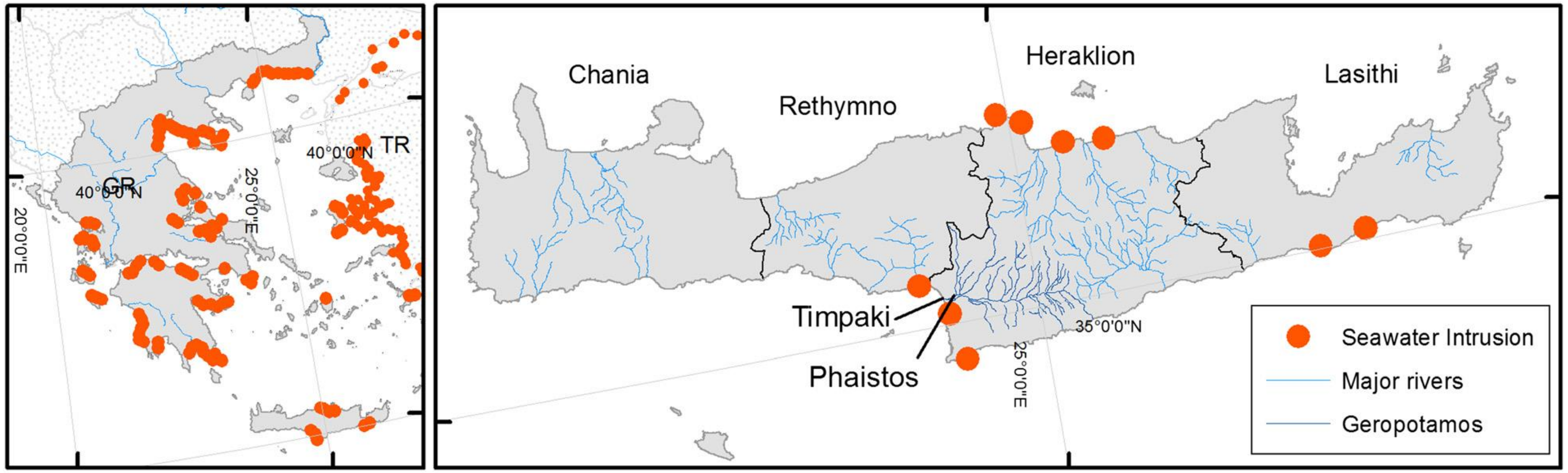
The results of the present study confirmed that the SALTMED model is a good tool for mapping the sesame genotypes studied under expected future CC and could be widely applied to other crops across the whole of Egypt.

These results are useful for helping decision makers and agricultural authorities identify the best location and best agronomic settings (irrigation system, soil type, fertilizer application, weather conditions) for growing high-yield crop varieties under future possible Climate Change.

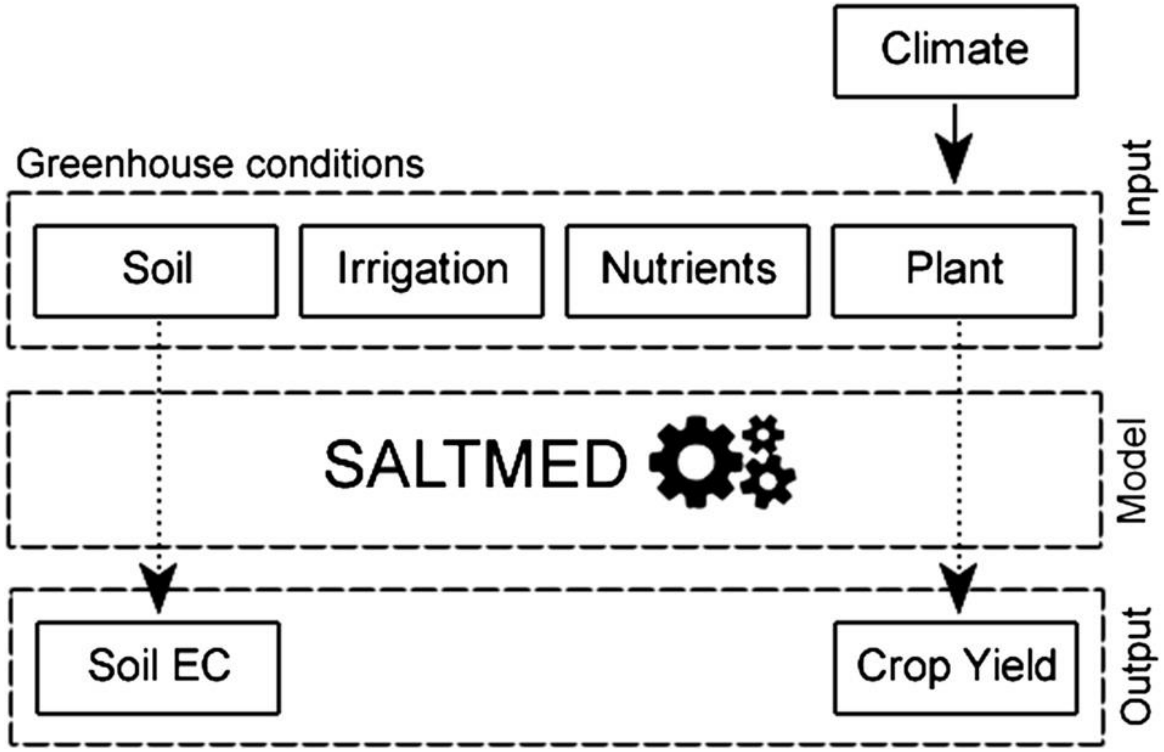
Greece

Modeling Soil Salinity in Greenhouse Cultivations Under a Changing Climate With SALTMED: Model Modification and Application in Timpaki, Crete Ioannis N. Daliakopoulos, Polixeni Pappa, Manolis G. Grillakis, Emmanouil A. Varouchakis, and Ioannis K. Tsanis. ISSN: 0038-075X DOI: 10.1097/SS.0000000000000161. Soil Science • 2016.

Study on S. lycopersicum (tomato), S. melongena (eggplant), C. annuum (pepper)

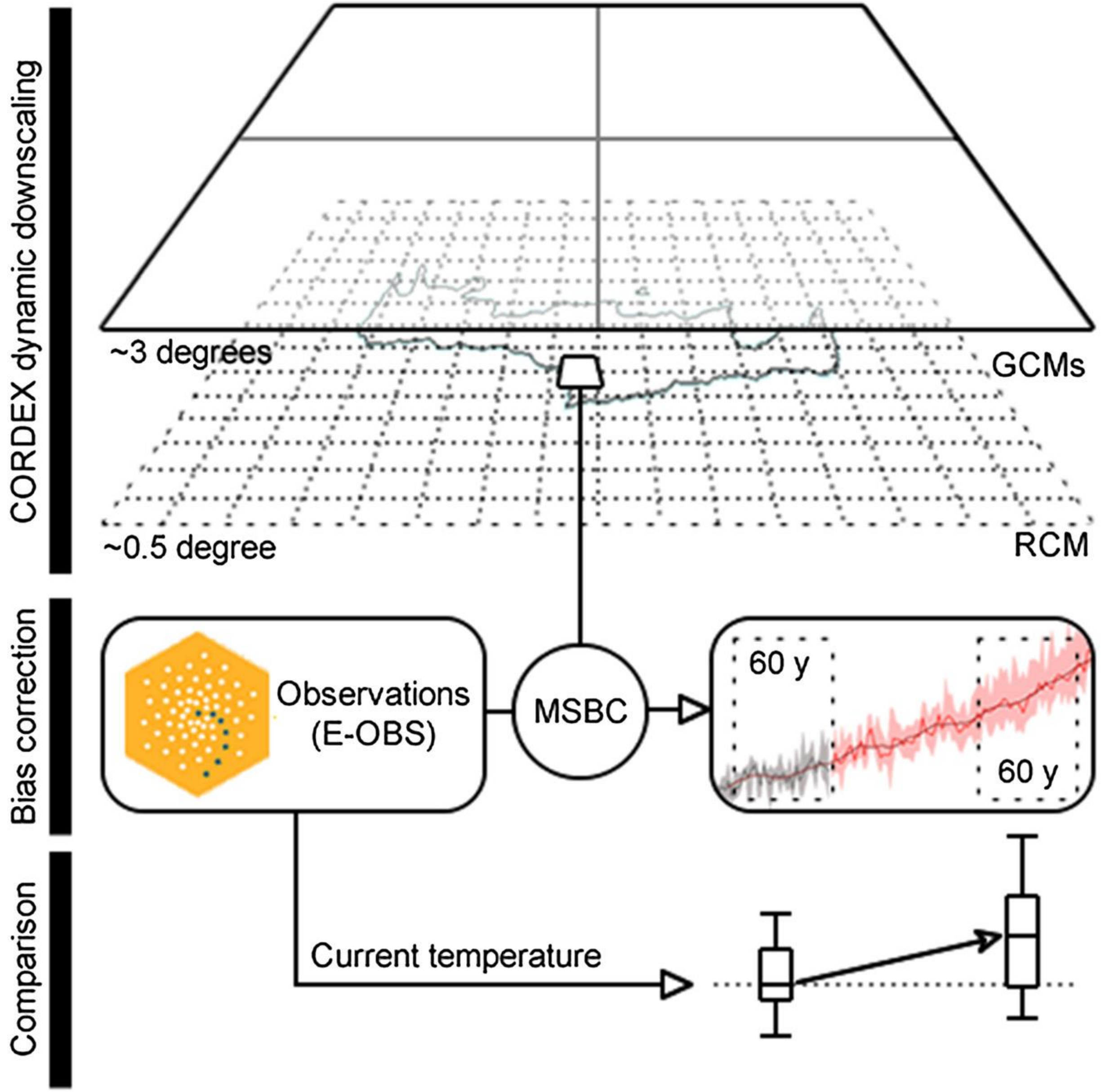


Areas of seawater intrusion in coastal Greece (GR) and Turkey (TR) (left) and specifically in Crete (right) after Panagea et al. (2016).

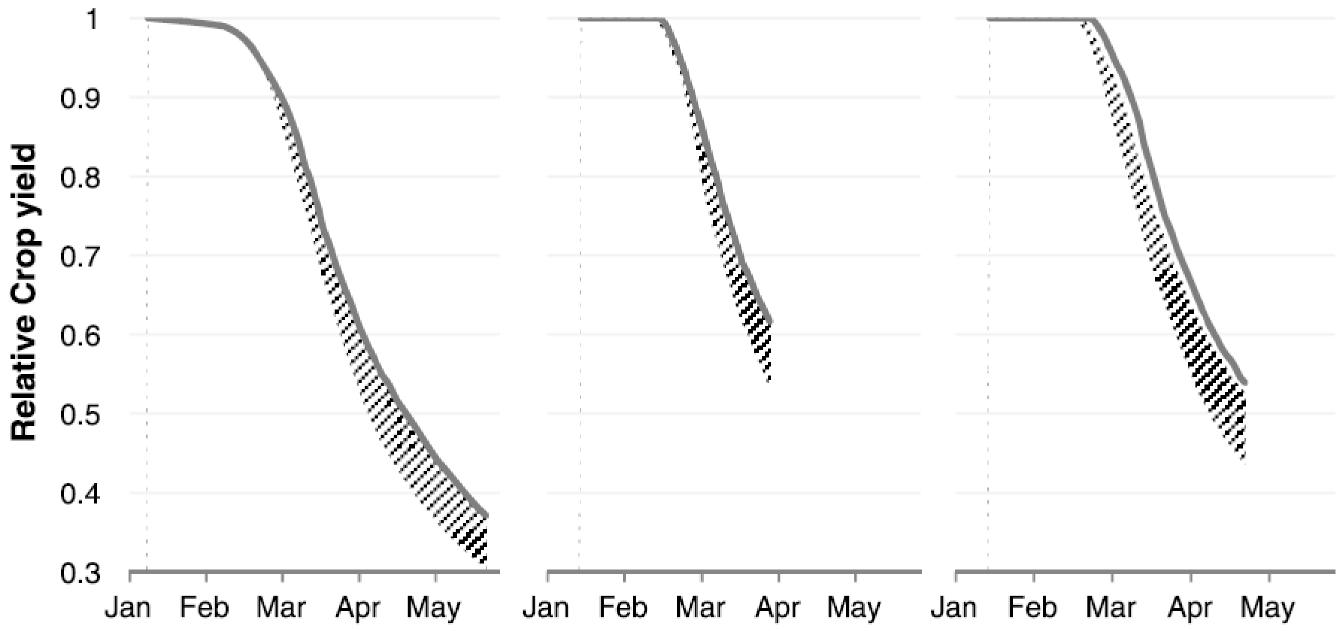


Conceptual approach of the SALTMED model modified for greenhouse conditions.

Horticultural crops are drip irrigated almost exclusively from groundwater extraction, mainly comprises of S. lycopersicum (tomato), S. melongena (eggplant), C. annuum (pepper)



Conceptual approach of climate data processing in this study, starting with the RCM output provided by CORDEX dynamic downscaling, their bias correction against the E-OBS data sets with MSBC, and the comparison of current and future climate

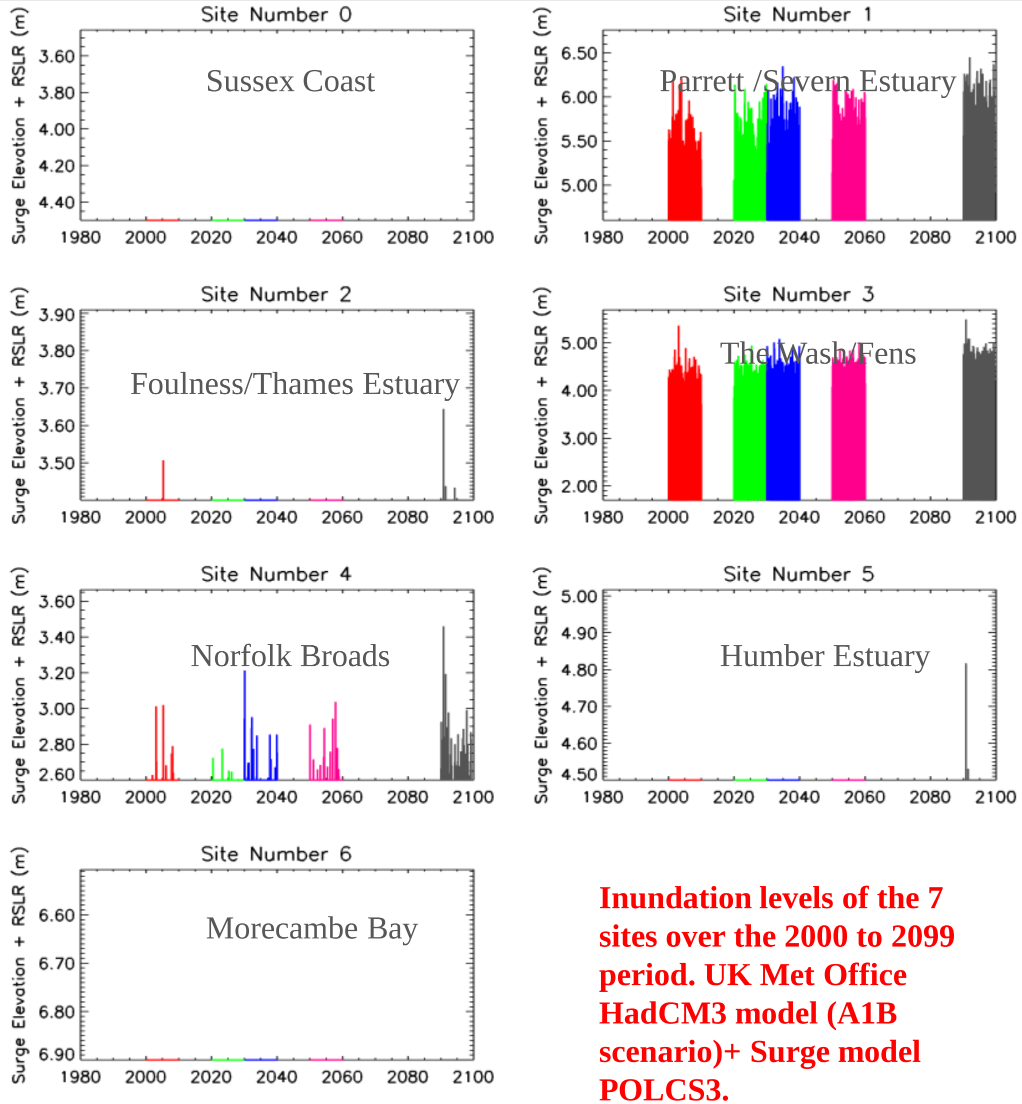


Comparison of crop yield for Tomato (left), Eggplant(centre), Pepper (right) for current (line) and future (shaded area) conditions. The shaded area represents the uncertainty caused by the range of climate model projections

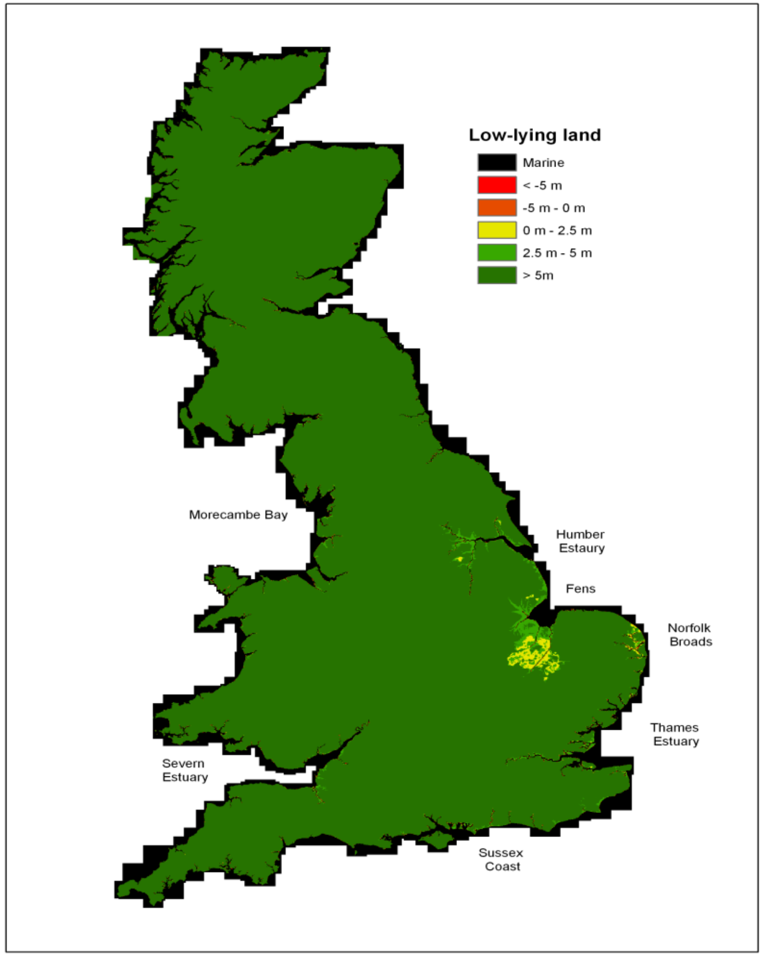
Conclusions: According to the results obtained by SALTMED for the three crops, for the current climate, Tomato enhances soil salinization the most (3.60 ± 0.4 dS m^{-1}) and suffers the highest yield losses (60%). The same crop is also the most vulnerable under the projected climate in Crete, with soil salinization and yield losses increasing by an additional 10%. Among the three crops, Eggplant has the highest potential for adaptation to saline soils and saline irrigation at the current and future climate.

Impact of climate Change on Seawater level & inundation of lowland coastal vegetation using SALTMED model

DEFRA Project SP0571. Use of 'UKCIP08 Scenarios' to determine the potential impact of climate change on the pressures/threats to soils in England and Wales Work Package 3-5. DEFRA - Department for Environment Food and Rural Affairs. Report SP0571_9948_FRA.pdf, David Cooper, Richard Gooday, Paul Hallett, Brian Irvine, Katrina Morrow, Ragab Ragab, Barry Rawlins, Mark Richards, Pete Smith, Andy Tye & report, Appendix D SALTMED Model results for sites 2, 4, and 5 (Parrett, Wash, Norfolk Broads) for 2020-2029, 2030-2039, 2050-2059 and 2090-2099, R. Ragab.



Inundation levels of the 7 sites over the 2000 to 2099 period. UK Met Office HadCM3 model (A1B scenario)+ Surge model POLCS3.



Name	easting	northing	Elevation, m
Sussex coast (0)	482500	102500	4.5
Parrett estuary (1)	327500	142500	4.6
Foulness (2)	597500	192500	3.4
The wash (3)	557500	307500	1.7
Norfolk Broads (4)	642500	322500	2.6
Humber estuary (5)	522500	422500	4.5
Morecambe Bay (6)	337500	447500	6.9

Salinity threat to some UK lowland coastal sites (soils) due to possible seawater inundation under future climate change, (DEFRA-2010). Salt tolerant crops and fodder/grass will have to be introduced at Parrett estuary, The wash and Norfolk Broads for UK food security.

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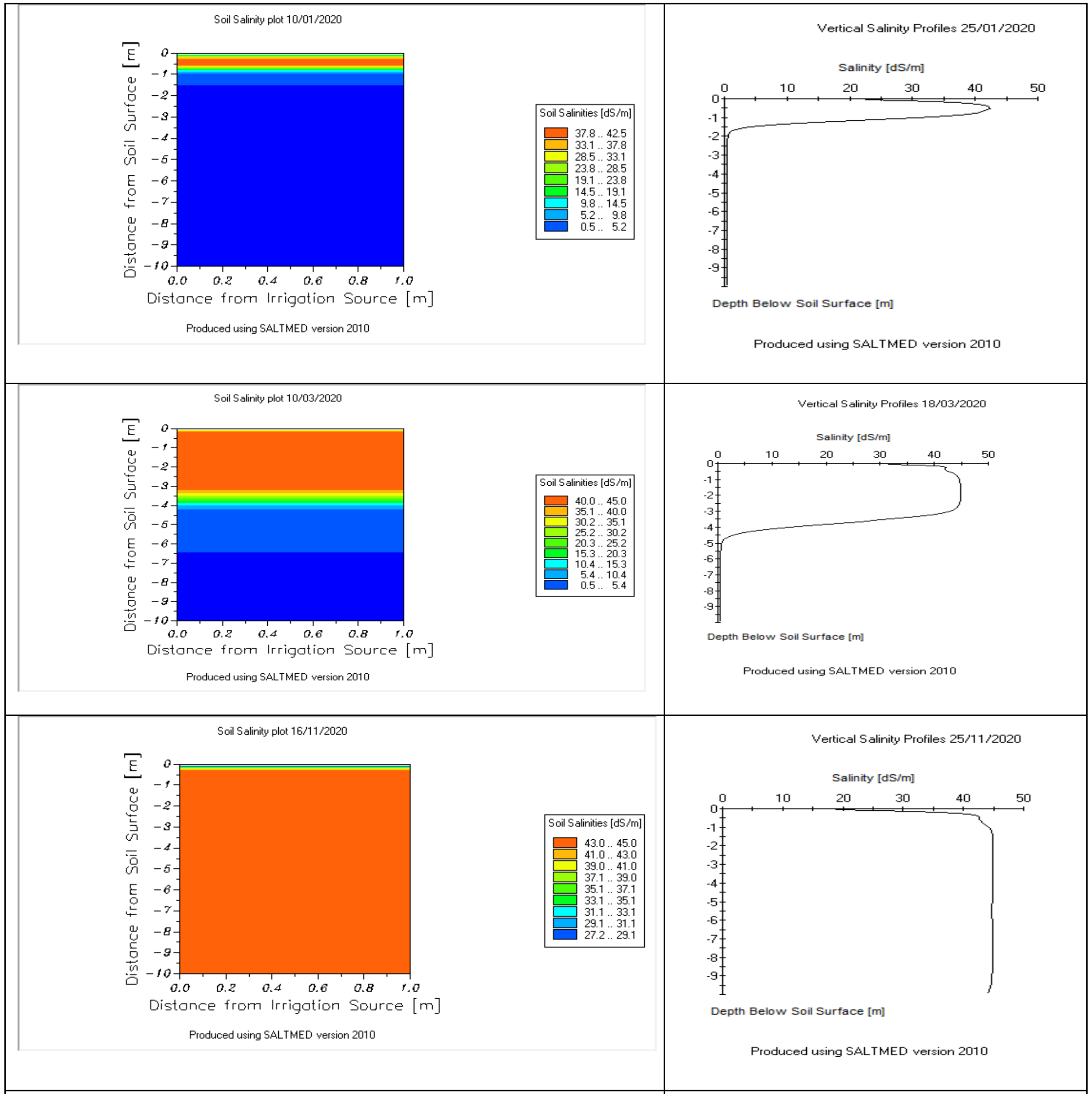
Site 2 grass 2020 2030



25/01/2020

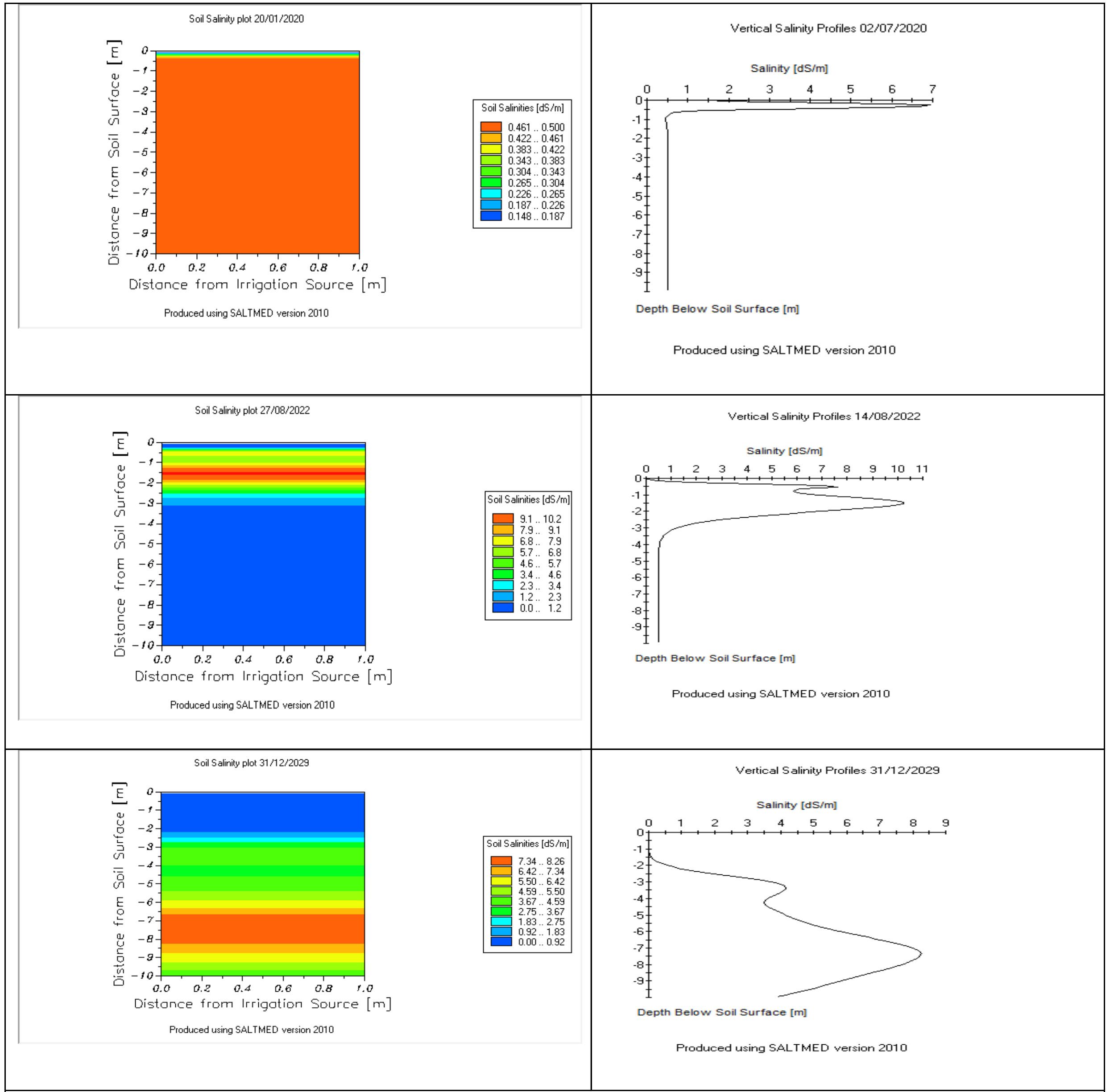
18/03/2020

25/11/2020

Site 2 grass, 2020 2030, evolution of soil salinity over time.

UK Centre for Ecology & Hydrology

Site 2-Parrett Estuary, Grass



Site 5, spring barley, 2020-2029, soil salinity evolution over time.

02/07/2020

14/08/2022

31/12/2029

Site 5-Norfolk Broads, Spring Barley

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What would happen to soil & vegetation when seawater level rises around the UK

Site Number & dominant cover	Dominant Soil Series	Total infiltration m^3 / m^2	Total salt input Kg /m^3	Total actual water uptake in 10 years m^3 /m^2	Potential water uptake in 10 years m^3 /m^2	Salinity Stress factor Actual water Uptake/ potential water uptake	Plant Survival of 45 dS/m seawater storms
Site 2 (Parrett estuary) grass	NEWCHURCH						
2020-2029		331.5417083	9377.457	57.61550033	3283.349481	0.017547782	poor
2030-2039		411.2073888	11686.19	51.906173	3245.54476	0.015993054	poor
2050-2059		456.5501557	13008.33	48.74004033	3181.788209	0.015318443	poor
2090-2099		561.5917276	16039.62	2.337677333	3095.881074	0.000755093	poor
Site 2 (Parrett estuary) Wheat	NEWCHURCH						
2020-2029		331.5235445	9376.921	9.070197667	2481.439676	0.003655216	poor
2030-2039		411.2410595	11687.12	5.880679333	2471.548233	0.00237935	poor
2050-2059		456.6374276	13010.85	7.423725667	2425.575759	0.003060604	poor
2090-2099		561.5878094	16039.51	4.270008333	2385.872823	0.001789705	poor
Site 4 (The wash) Wheat	DOWNHOLLAND						
2020-2029		5494.643781	158221.3	3.391779333	2415.109179	0.0014044	poor
2030-2039		5628.826092	162092.4	3.432572667	2442.316022	0.001405458	poor
2050-2059		5683.617784	163674.8	3.332805	2377.219109	0.001401976	poor
2090-2099		5746.718686	165497.7	3.327336667	2377.117974	0.001399736	poor
Site 4 (The wash) Sugar Beet	DOWNHOLLAND						
2020-2029		586.860102	158220.8	5.123983667	1359.168574	0.00376994	poor
2030-2039		589.089121	161959	5.153719	1356.038201	0.003800571	poor
2050-2059		5685.148735	163718.9	5.003739333	1332.275641	0.003755784	poor
2090-2099		5745.999332	165477	4.999648333	1335.626207	0.003743299	poor
Site 5 (Norfolk Broads) grass	WALLASEA						
2020-2029		6.482023445	13.824	2394.41603	3205.495808	0.746972129	Very good
2030-2039		11.09544722	146.9754	2043.525754	3207.031765	0.637201594	Good
2050-2059		10.18018813	132.2666	1667.397392	3052.385846	0.54626036	Medium
2090-2099		22.50068807	485.3053	730.6811833	3008.23567	0.242893597	Low
Site 5 (Norfolk Broads) S.Barley	WALLASEA						
2020-2029		6.481784621	13.824	971.5905983	1358.26169	0.715319151	Very good
2030-2039		11.16790046	149.0516	771.3702503	1360.443417	0.566999142	Medium
2050-2059		10.41429629	138.9685	389.2875787	1311.331899	0.296864264	Low
2090-2099		22.50573849	485.4552	105.8353537	1312.507925	0.080635973	poor
Site 5 (Norfolk Broads) Sugar Beet	WALLASEA						
2020-2029		6.481805485	13.824	986.2030943	1310.779776	0.752378937	Very good
2030-2039		11.16794538	149.0516	890.5547287	1300.889724	0.684573575	Good
2050-2059		10.36775411	137.6468	513.419012	1263.00519	0.406505861	Medium
2090-2099		22.50968453	485.5661	198.8705273	1242.536888	0.160052011	Low

To predict the impact of possible seawater inundation on vegetation survival and soil salinity, the CEH SALTMED model was applied on three lowland coastal sites using seawater with salinity 45 dS/m and different climate change and seawater surge scenarios : Sites: 2-Parrett estuary, 4-The Wash, 5-Norfolk Broads. Sites 2 and 4 require more salt tolerant varieties in order to survive the possible inundation.


Thank You!