



# Performance of field crops in a semi-arid environment: climate change assessment



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## 1. INTRODUCTION

The effect of rising temperature combined with fluctuating rainfall and scarcity of water for irrigation is argued to have a pronounced negative impact on crop yield<sup>1</sup>. Consequently, this threatens the food and nutrition security situation in agriculture-based economies, especially in sub-Saharan Africa<sup>2</sup>, where millions of people depend on agriculture for their livelihood support. In Sudan, agriculture is an important sector of the country's economy. Gedaref state is Sudan's hub of rainfed crop production, where crop farming supports livelihood sources for about 80% of its population<sup>3</sup>. The state is characterized by a semi-arid agro-ecological production system. However, there is a lack of science-led evidence and assessment of climate effects on crop yield in Gedaref region. Also, understanding the responses of crops to the shifts in inter-and intra-seasonal rainfall patterns is useful for agricultural planning and designing of adaptation measures.

## 2. METHODS

- Gedaref state is located in the eastern part of Sudan between Longitudes 33°–37° E and Latitudes 12°–16° N (Figure 1).

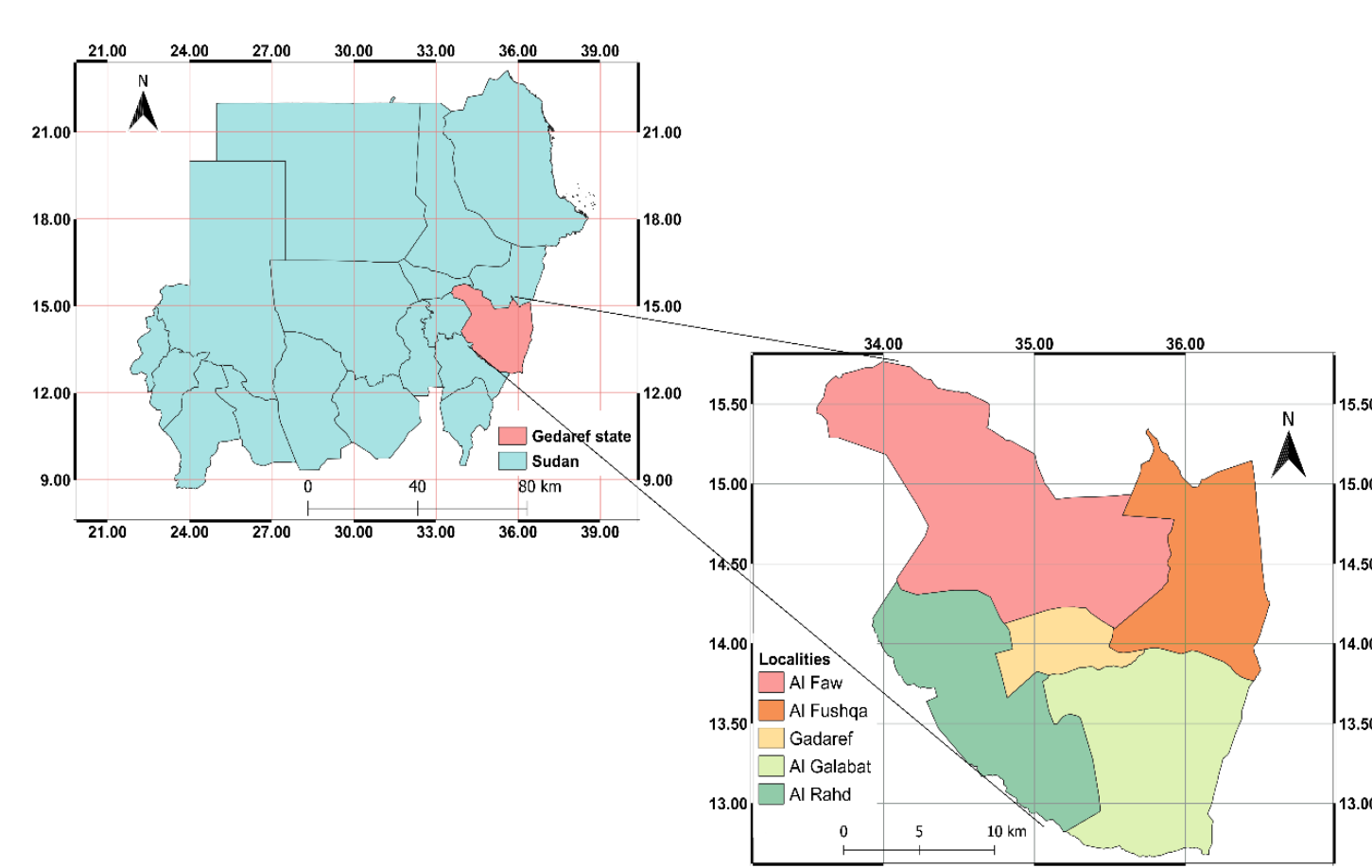


Figure 1. Location of Gedaref state in Sudan

- Daily minimum (Tmin) and maximum temperature (Tmax), diurnal temperature range (DTR), as well as daily rainfall data from 1984 to 2018 were obtained from Gedaref meteorological station.
- Data on yield for four major crops viz., sorghum, sesame, sunflower and millet at the Gedaref state scale were obtained from the Ministry of Agriculture, Gedaref, for the same period.
- Due to the effect of non-climatic factors such as crop management practices and new cultivars on crop yield, first difference approach was used to remove such effects.
- The anomalies generated from the first difference for climate variables and crop yield were subjected to a Pearson's correlation analysis to determine the association between the crop yield and climatic variables.
- In addition, a multiple linear regression model was used to quantify the impact of climate change on crop yield.

## 5. CONCLUSIONS

- Temperature variables had a negative relationship with the yield of all crops, while an increase in the amount of rainfall significantly increased the yield of sorghum, sesame, and sunflower.
- There was a high variability in crop yields, for example over 50% variability in the yield of sorghum ( $R^2 = 0.70$ ), millet ( $R^2 = 0.54$ ) and sunflower ( $R^2 = 0.64$ ) could be related to climatic variables.

## 6. IMPACT

Our findings could be used to support awareness creation amongst different stakeholders and policymakers on the impacts of climate variability and change on crop production and the need for resource allocation to support uptake of adaptation practices that ensure resilience amongst agricultural communities within Gedaref state.

## 3. OBJECTIVE

Assess the impact of rainfall and temperature variables on the main crop yields in Gedaref state, Sudan.

## 4. RESULTS

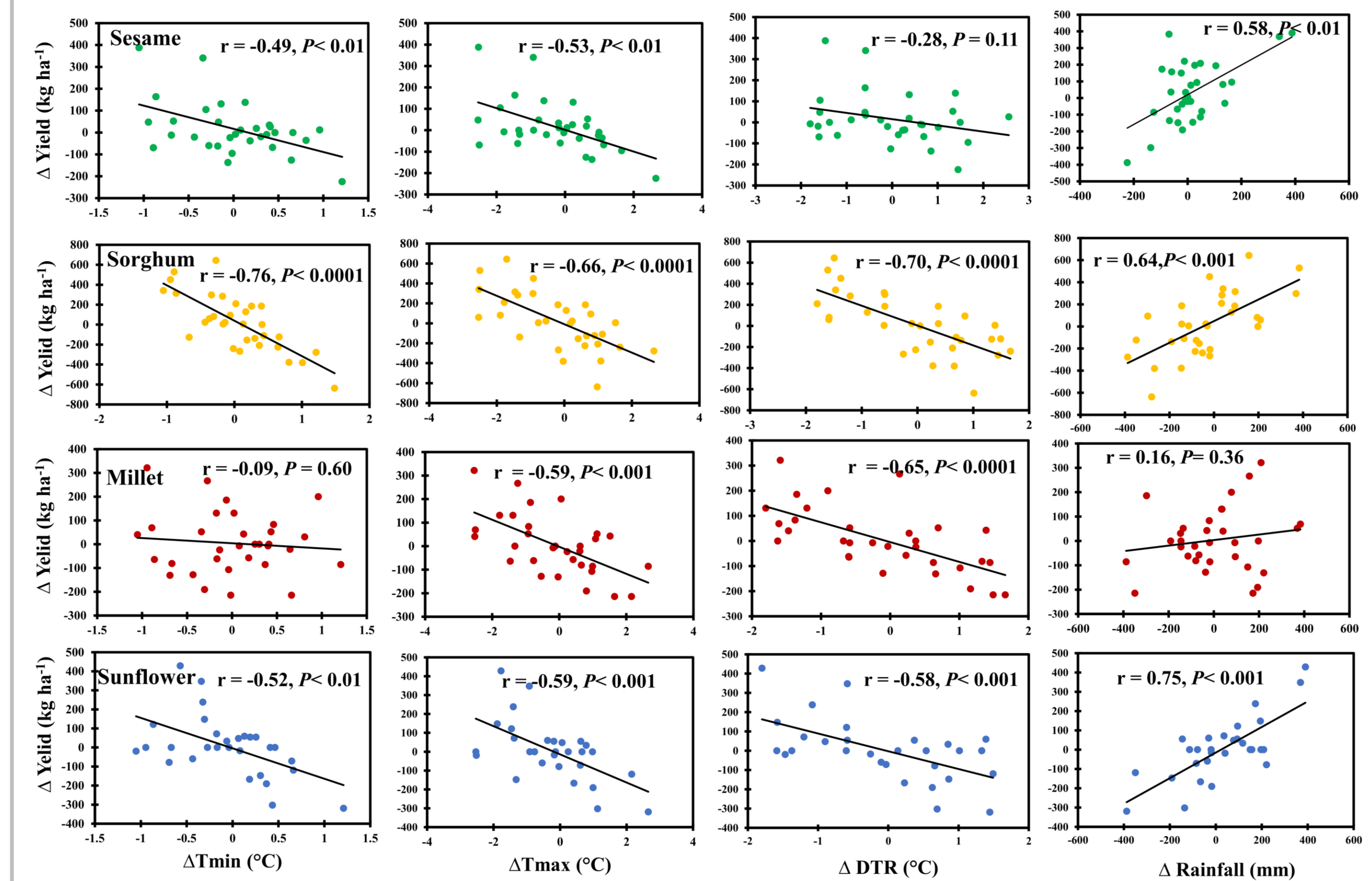


Figure 2. Associations, as assessed by a Pearson's correlation analysis, among climatic variables and yield of five major crops grown in Gedaref State, Sudan.  $r$  is correlation coefficient.

- There were negative relationships among the temperature-based variables (Tmin, Tmax, and DTR) and crop yield, whereas the relationships among rainfall and crop yield were positive (Figure 2).

- The results of the multiple linear regression analysis showed that 50% to 70% of sorghum, millet, and sunflower yield variabilities could be explained by the studied climatic variables (Table 1).

Table 1: Multiple linear regression analysis showed the relationship between the crop yields and climatic variables in Gedaref State

Crop		Intercept	Tmin	Tmax	DTR	Rainfall	R <sup>2</sup>
Sesame	Coefficient	-0.734	-23.337	-32.206	10.891	0.239	0.41
	P-value	0.96	0.59	0.22	0.64	0.07	
Sorghum	Coefficient	33.980	-260.213	40.452	-132.345	0.110	0.70
	P-value	0.293	<0.001	0.42	<0.05	0.65	
Millet	Coefficient	-8.578	217.319	-191.497	102.271	-0.021	0.54
	P-value	0.61	<0.05	<0.05	0.19	0.84	
Sunflower	Coefficient	-16.746	9.8571	-16.042	-25.435	0.536	0.61
	P-value	0.43	0.87	0.65	0.49	<0.01	

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