



“Global Change in Africa”



Impacts of Recent Climatic Changes on Some Subsistent Crops in the North of Cameroon

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Outline



1. Background/ Problem Statement
2. Relevant Data and Methodology
3. Presentation of Results
4. Remarks and Summary/Future works
5. Questions and Answer



Background/ Problem Statement



Climate change is real.

Population grows at 3% per year

Yields of major crops grow at 1% a year (FAO,2006)

Agricultural production is very dependent on climate

Poor investigation of the impact of climate change on staple crops in Cameroon.



Background/ Problem Statement



The use of statistical models in climate impact studies on yields have been employed by Vasselin et al. (2001), Jones et al. (2003)

Most recently Lobells and Asner, (2003, 2007) investigated relationships between climate trend variables (minimum and max temperature and production of corn and soy bean in the U.S

Larsson, (1994) showed the dependency of sorghum yields on climate with very correlation between rainfall and yields in the Sahel

Evaluation of how climate change and variability affects crop yields using historical records have been published by many for several decades (Changnon and Wistanley, 2000) and (Thompson, 1986)



Background/ Problem Statement



Some decent works have gone underway with respect to climate change, crop production and adaptations.

Tingem et al.,2008 CropSyst simulation models in assessing crop growth vulnerability to climate changes in the entire country of Cameroon setting adaptation measures for wide range of crops

Richardian Cross Section Approach has been employed for various crops in a plethora of africa country (Mendelson et al., 2006)

Richardian Approach to measure the relationship between climate and the net revenues of some selected crops in Cameroon (Molua & Lambi, 2006)



Background/ Problem Statement



A prerequisite for forecasting and projecting production based on observed measurements and future impacts changes

Knowledge of the recent climatic trends on crop productivity would be an important step in predicting agricultural production.

Thorough understanding of climate-subsistent crop relationships of historical records could be very crucial in the development of adaptive strategies.



Background/ Problem Statement



This study uses statistical models in investigating the impacts of recent climatic changes on two staple crops

Millet *Pennisetum glaucum* L.

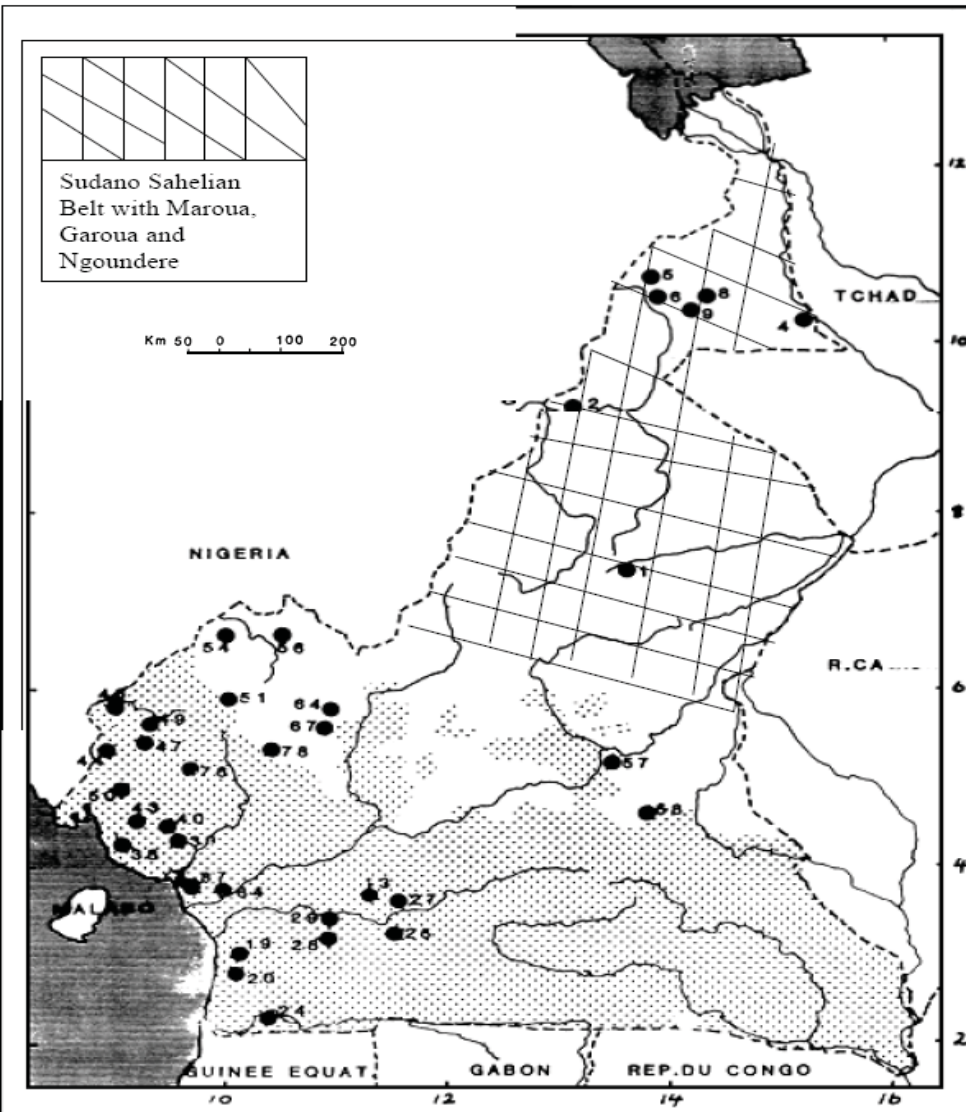
Sorghum *Sorghum bicolor* L. (Moench) in the North of Cameroon.

Have there been changes in the yields of these staple crops?

And to what extent have the recent climatic changes affected or influenced the yields from the period of 1961-2006?



Study area



AW/BS in the Koeppen classification

(Tropical humid with dry Winter- Semi arid)
Unimodal distribution of rainfall and a long dry season.

Rainy season lasts for about 5 months

(May-September) growing season

2 intermediate months of uncertain rainfall

(April and October)

Millet 0.86t/ha and sorghum 0.88t/ha

Total harvested areas per year

86 thousand hectares for millet

395 thousand hectares for sorghum (FAO Agristat, 2008)



Climatic Variables

Daily climatic variables (Maximum and minimum temperatures and rainfall were obtained from the University Cooperation for Atmospheric Research (UCAR)

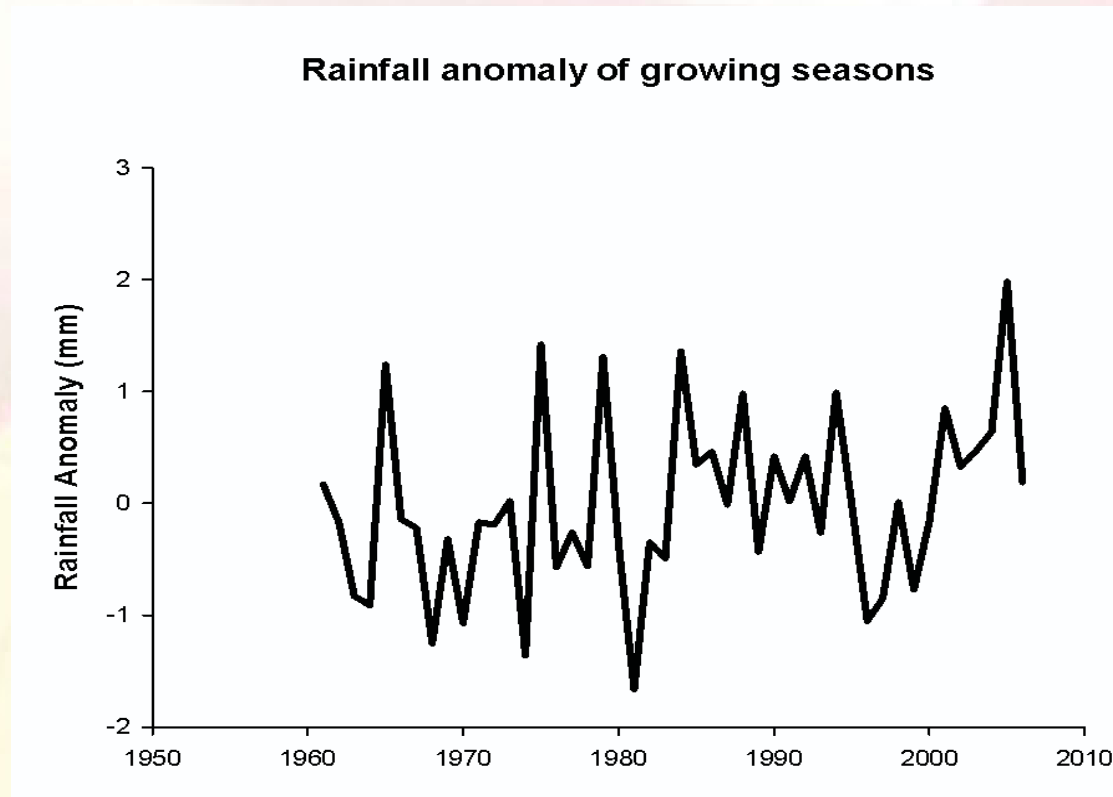
(<http://dss.ucar.edu/datasets>) for the sudano sahelian region of Cameroon

The choice of using the observed weather station data was based on the findings of (Tingem et al., 2008).

Time series for the mean monthly rainfall and mean yearly temperature from 1961 to 2006 for the entire region was computed



Rainfall Anomaly of growing season



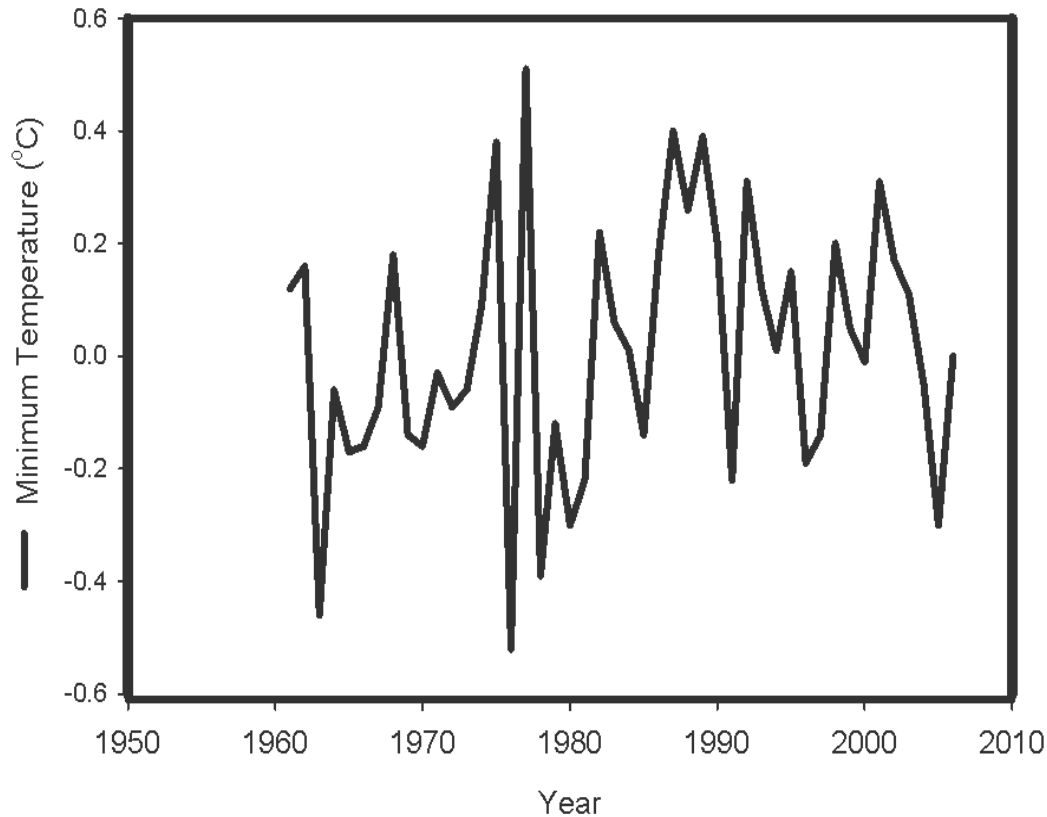
Time series of observed growing season (May-August) 1961-2006 in North Cameroon
(Data Source. UCAR)



Minimum Anomaly of growing season



Minimum Temperature Anomaly in N. Cameroon, (1961-2006)



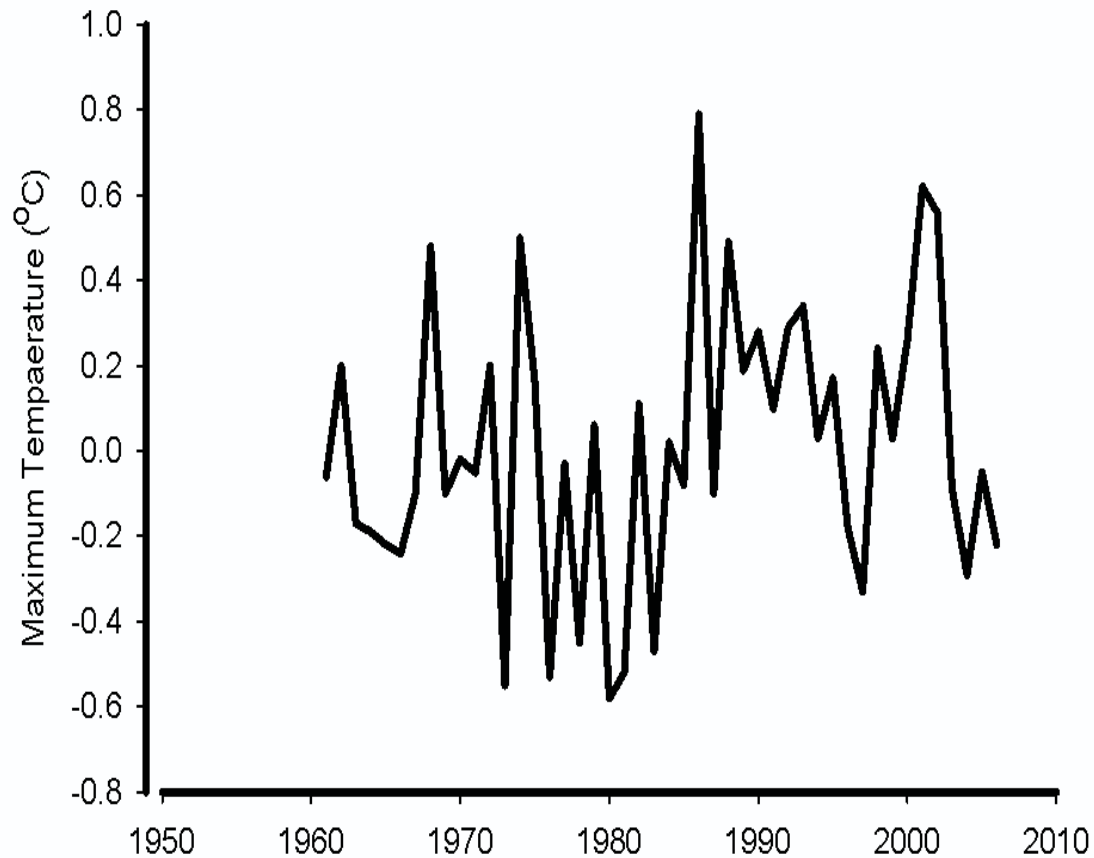
Time series of observed growing season (May-August) 1961-2006 in North Cameroon (Data Source. UCAR)



Minimum Anomaly of growing season



Maximum Temperature anomaly in N. Cameroon (1961-2006).



Time series of observed growing season (May-August) 1961-2006 in North Cameroon (Data Source. UCAR)



Yield Functions



Multiple regression models was developed using time series yield anomalies as the predictand

Climatic parameters for growing season from May –August acted as the predictor.

Inclusion of harvested areas anomalies as the sole non climatic variable

Exploring individual climatic variables relationships with yields for the entire growing period using the Pearson Product moment Correlation coefficient

The Statistical software SPSS 17.0 was used at a 95% confidence interval level.



Methodological Approach



Provides the option of investigating individual input effects variables

Model is that it does not explicitly consider

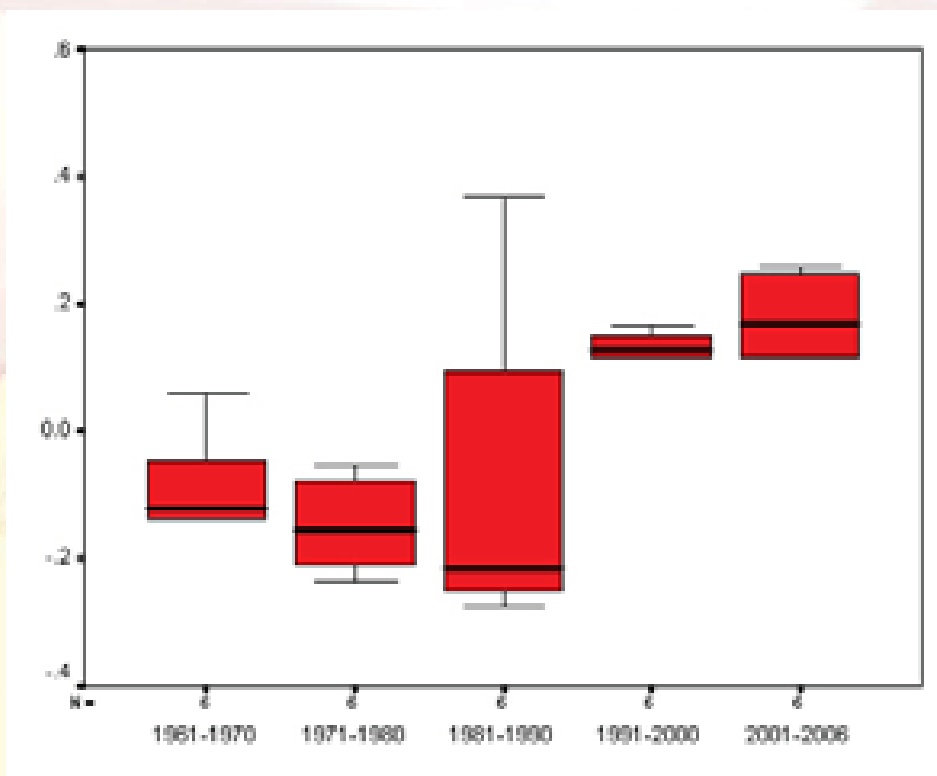
management changes

carbon dioxide fertilization

It thus assumed a degree of uniformity in those factors other than climate that could influence crop production.



Changes in millet yields



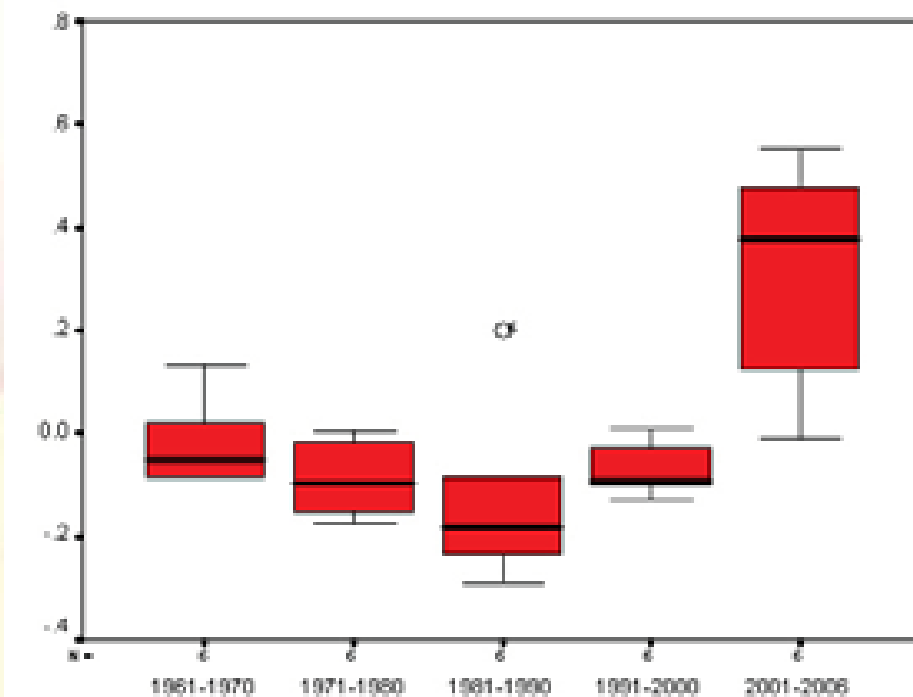
Box plots of decadal crop yields anomalies impact of climate trends (1961-2006).

The negative values show loss in yields.

Error bars show 95 % confidence interval.



Changes in sorghum yields

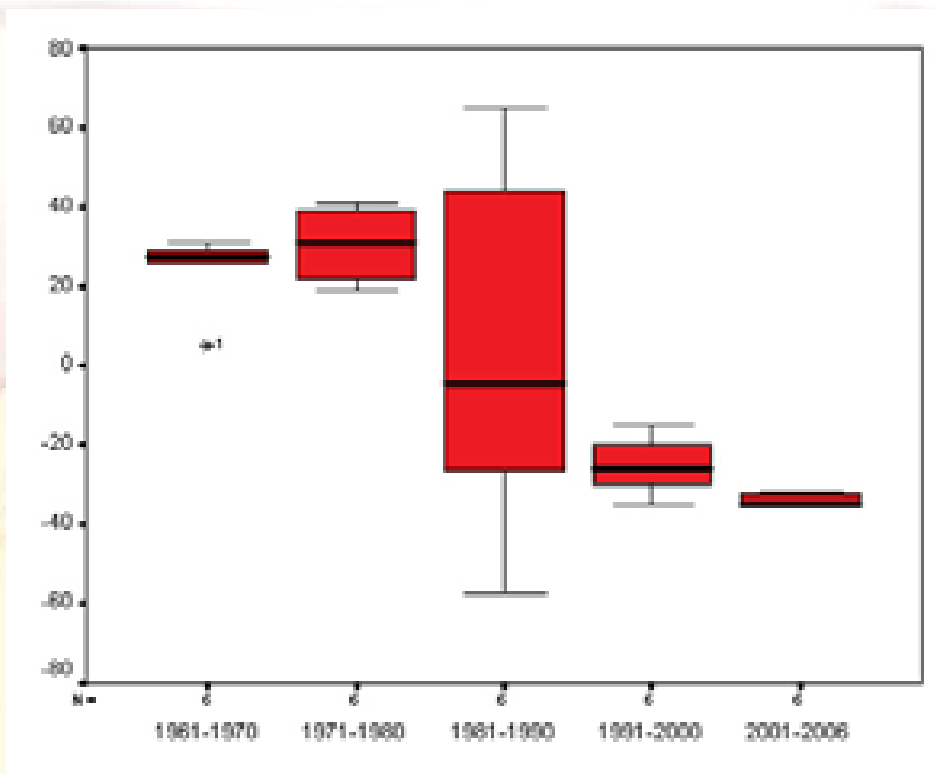


Box plots of decadal crop yields anomalies impact of climate trends (1961-2006).

The negative values show loss in yields.
Error bars show 95 % confidence interval.



Changes in harvested areas for millet

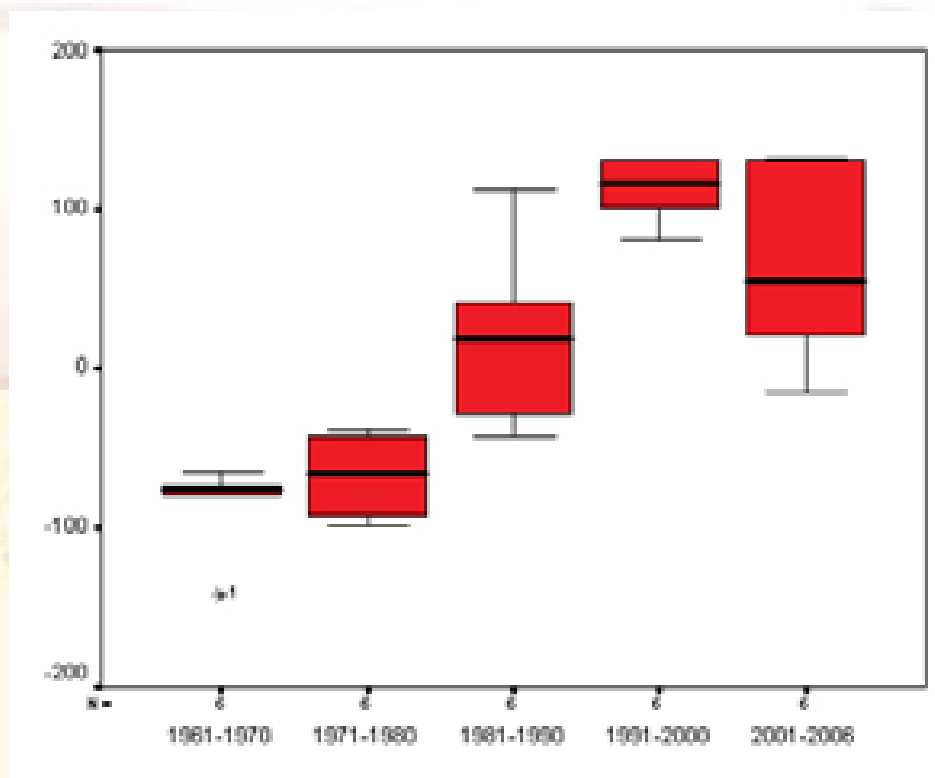


Box plots of decadal crop harvested areas anomalies impact of climate trends (1961-2006).

The negative values show loss in yields.
Error bars show 95 % confidence interval.



Changes in harvested areas for sorghum



Box plots of decadal crop harvested areas anomalies impact of climate trends (1961-2006).

The negative values show loss in yields.

Error bars show 95 % confidence interval.



Multiple Linear Regression



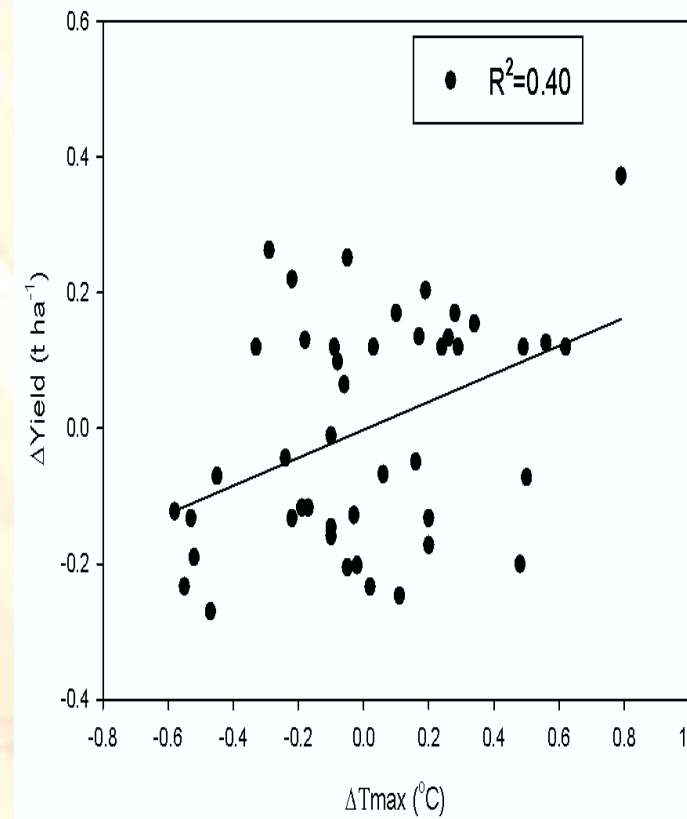
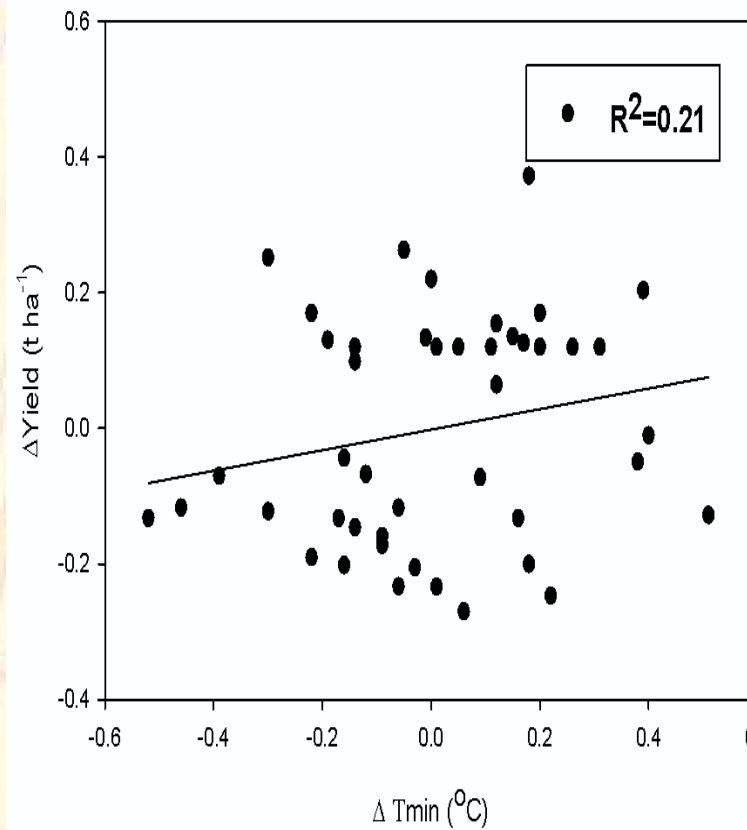
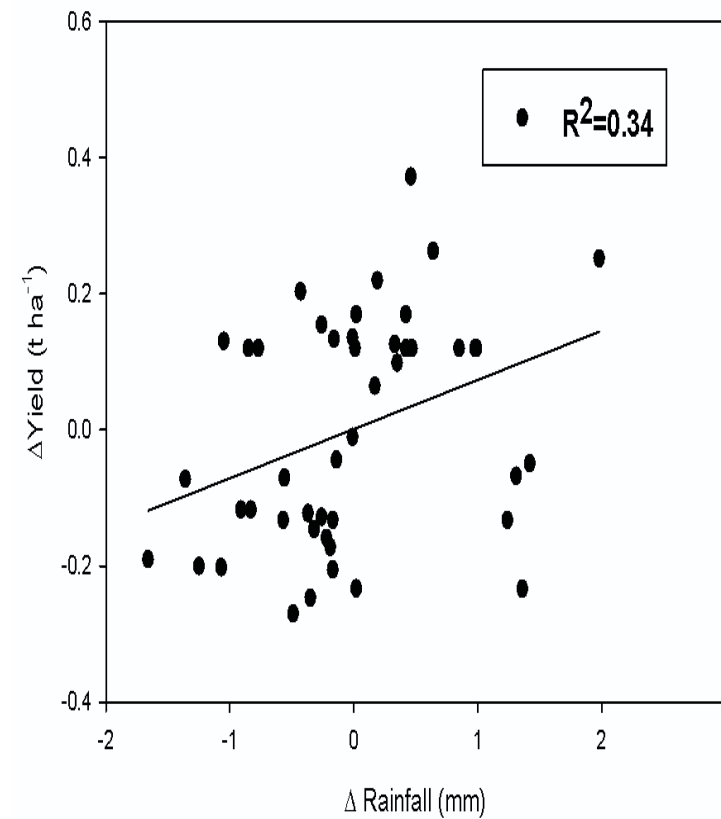
	R	R ²	SE	df1	df2	Sign. F
Millet	0.483	0.233	1510.1	3	42	0.010
+Harvest ed Areas	0.767	0.588	1120.5	4	41	0.000
Sorghum	0.345	0.119	1843.4	3	42	0.147
+Harvest ed Areas	0.345	0.119	1865.7	4	41	0.257

Results of multiple linear regression model based on anomalies of yields and climatic variables (growing season 1961-2006)

+ shows the inclusion of harvested areas as the sole non-climatic variables in the model.



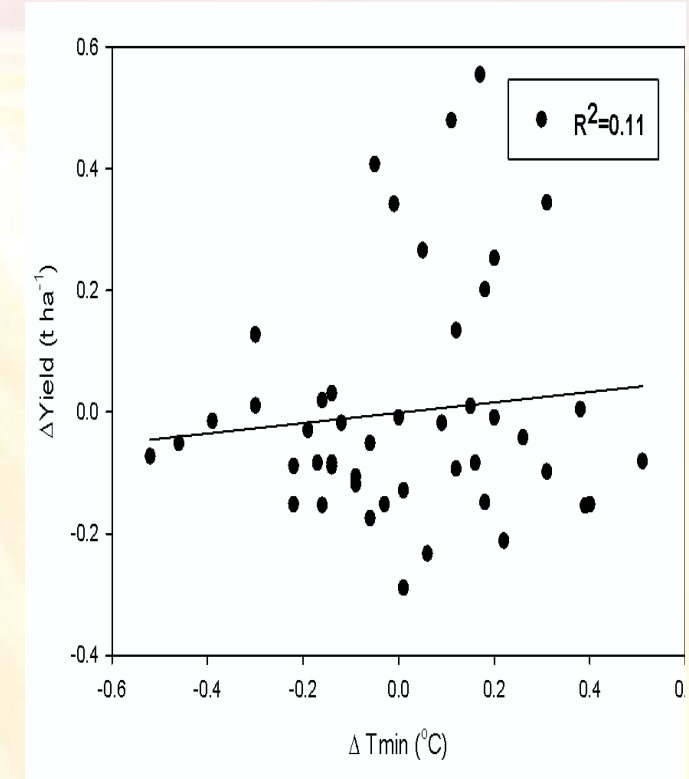
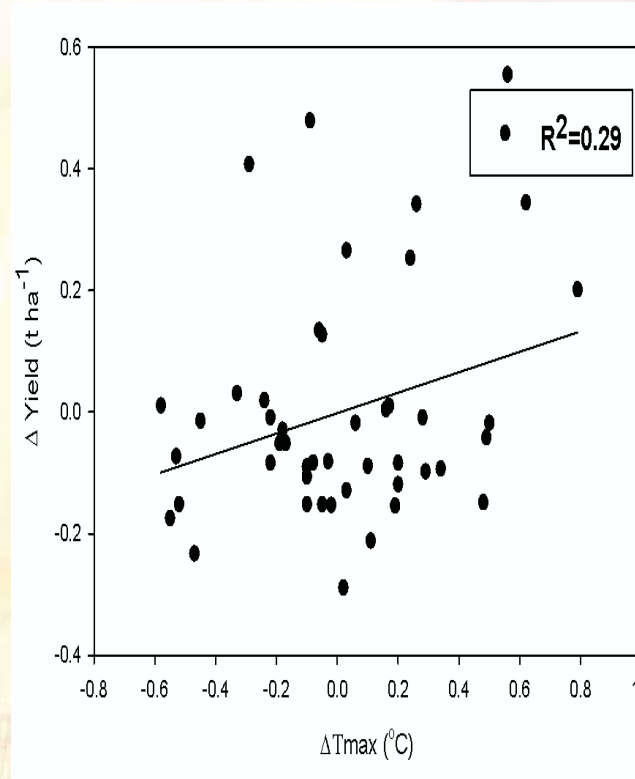
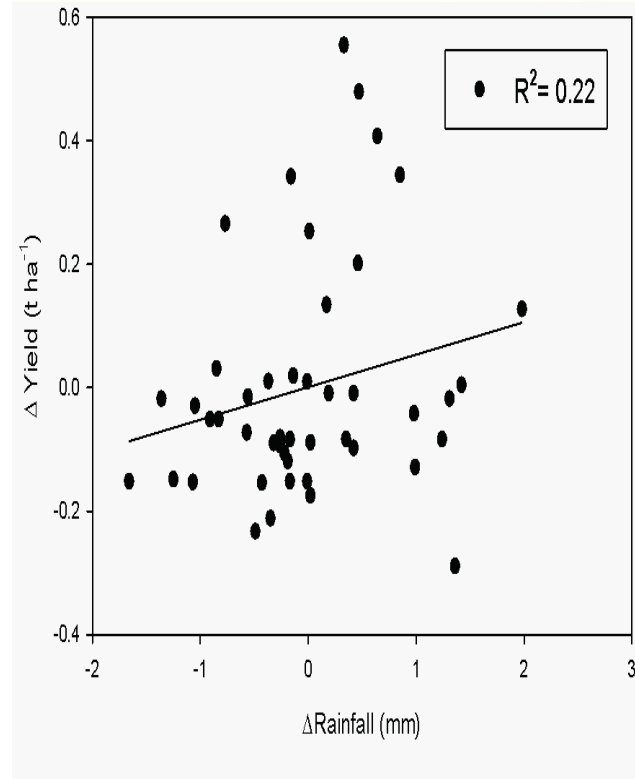
Correlation Coefficients (Millet)



Best fit regression line and R^2 are shown with significant correlations with yield changes ($p < 0.05$)



Correlation Coefficients (Sorghum)



Best fit regression line and R^2 are shown with significant correlations with yield changes ($p < 0.05$).



Discussion



Higher correlations obtained for the maximum temperature with crop yields

Crop responses to temperature depend on the temperature optima for photosynthesis leading to growth and yield which may vary for different crops

low temperatures may delay anthesis which could affect final yields of crops (Bannayan et al., 2004).

Temperature extremes during flowering can also reduce grain or seed numbers (Matsui and Horie 1992).



Discussion



Climatic variables had more impact on yields of millet than for sorghum.

It should be noted that the addition of harvested areas as a predictor variable did not improve the yield variance for sorghum although an aggregated 59% yield variance was observed for millet with the climatic predictors included.

This is an indication that the unexplained variances in the regression analyses most probably were due to factors not evaluated in the model.

Lobells (2006)

Such unexplained variables could include crop management practices, introduction of new cultivars and varieties, disease resistant controls, carbon dioxide fertilization, possible technological changes as well as population influence.



Discussion



Difference in yield response to climatic variables between millet and sorghum

Sorghum is more cultivated than millet but recent increase in yield trends for millet with decrease in harvested areas are indications there are other factors contributing to this trend Larrison

Sorghum is not very sensitive to water shortages and in the case of the Sudano Sahelian region of Cameroon, they are mostly grown on black cotton soils with high water holding capacity.

Prolonged Sahelian (Serigne et al., 2006)

Sorghum and millet as C4 plants



Conclusion



Variability in the climate of the growing season between May and August appeared to have contributed to the differences in the yield trends for both millet and sorghum.

Crop diversification in the agricultural practices

statistical model in assessing the recent climatic impacts of climate changes on yield of subsistent crops

A synergism of factors should be considered when carrying out such studies because climate change in not the only variable affecting crops yields.



Thanks

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- **References**

- Bannayan M, Hoogenboom G, Crout N.M.J. (2004) Photothermal impact on maize performance: a simulation approach. *Ecol Model* 180:277–290
- Changnon, S. A., Winstanley, D., and Kunkel, K. E. (1997) An Investigation of Historical Temperature and Precipitation Data at Climate Benchmark Stations in Illinois, Circular 184, Illinois State Water Survey, Champaign, IL., pp. 55–56.
- Conroy, S., Seneweera, A.S., Basra, G. R., and Wooller B.N. (1994) Influence of rising atmospheric CO₂ concentrations and temperature on growth, yield and grain quality of cereal crops. *Aust. J. Plant Physiol.* 21, pp. 741–758
- Jones, J.W., Hoogenboom, G., Porter, C.H., Boote, K.J., Batchelor, W.D., Hunt, L.A., Wilkens, P.W., Singh, U., Gijsman, A.J. & Ritchie, J.T. (2003) The DSSAT cropping system model. *Eur. J. Agronomy* 18(3-4):235-265.
- Juan J.A., Fazli, M., Zhou, X., Edward G.G., and Smith L.D. (2008) Climate change, weather variability and corn yield at a higher latitude locale: Southwestern Quebec
- *Climatic Change* 88:187–197



Relevant Literature



- Kandji, S.T., Verchot, L., and Mackensen, J. (2006) Climate Change and variability in the sahel Region : Impacts and Adaptation Strategies in the Agricultural Sector
- KENGA, R., M'BIANDOUN, M., NJOYA, A., HAVARD, M., and VALL, E. (2002) Analysis of constraints to agricultural production in the Sudan-sahelian zone of Cameroon using a diagnostic survey Actes du Colloque, 27-31 Mai 2002, Garoua Cameroun
- Lobell, D. and Asner, G., (2003) Climate and management contributions to recent trends in US agricultural yields. *Science*, 299:1032.
- Lobell, D. B., Field, C. B., Cahill, K. N., and Bonfils, C. (2006) Impacts of future climate change on California perennial crop yields: Model projections with climate and crop uncertainties. *Agricultural and Forest Meteorology* 141:208–218.
- Lobell D.B, Field C.B. (2007) Global scale climate–crop yield relationships and the impacts of recent warming. *Environ Res Lett* 2:014002. doi:10.1088/1748-9326/2/1/014002
- Matsui, T., and Horie, T., (1992) Effect of elevated CO₂ and high temperature on growth and yield of rice. II. Sensitivity period and pollen germination rate in high temperature sterility of rice spikelets at flowering. *Jpn J Crop Sci* 61:148–14



Relevant Literature



- Molua E.L., Lambi C.M. (2006) The economic impact of climate change on agriculture in Cameroon. CEEPA Discussion paper No.17. Centre for Environmental Economics and Policy in Africa, University of Pretoria.
- Nicholls, N., (1997) Increased Australian wheat yield due to recent climate trends. *Nature* 387, 484–485.
- Ravallion, S., and M. Chen, (2004) How have the worlds poorest fared since the early 1980s? *The World Bank Research Observer*, Vol. 19, No. 2, 141–169.
- Ringius, L., Downing, T.E., Hulme, M., Waughray, D. and Selrod, R. (1996). *Climate Change in Africa: Issues and Challenges in Agriculture and Water for Sustainable Development*
- Rosenzweig, C., and Hillel D., (1998) *Climate Change and the Global Harvest: Potential Impacts of the Greenhouse Effect on Agriculture*. Oxford University Press.



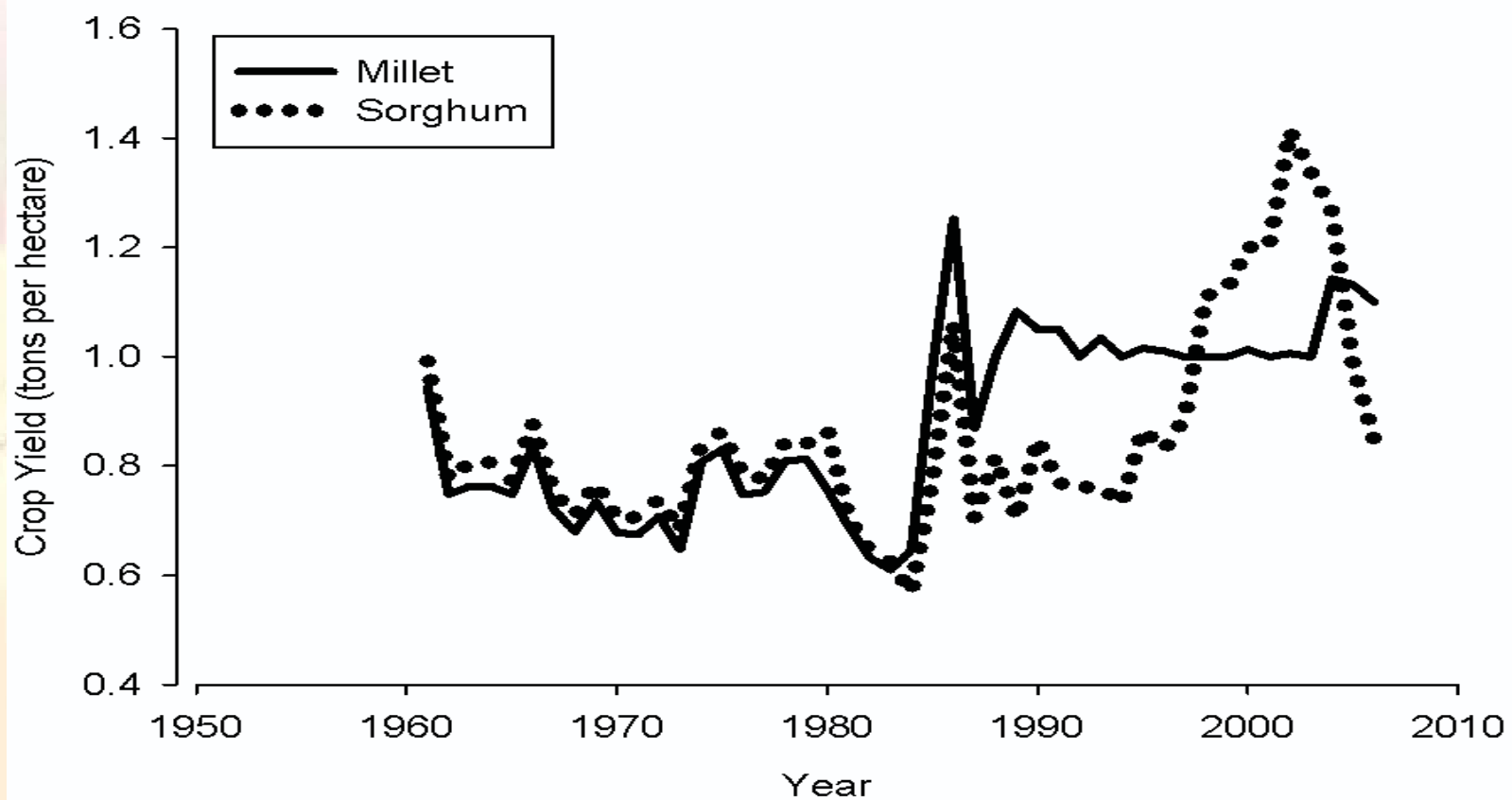
Relevant Literature



- Tao, F., Yokozawa, M., Hayashi, Y., Lin, E. (2003) Changes in agricultural water demands and soil moisture in China over the last half-century and their effects on agricultural production. *Agric For Meteorol* 118:251–261
- Thompson L.M (1986) Climatic change, weather variability, and corn production. *Agron Journal* 78:649–653
- Tingem M, Rivington M, Bellocchi G, Colls J.J., (2008) Crop yield model validation for Cameroon. *Theoretical and applied climatology*. doi: 10.1007/s00704-008-0030-8.
- Vasselin A. A., and Hoogenboom, G. (2001) Climate variation and crop production in Georgia, USA, during the twentieth century. *Climate Research* 17:33-43.
- Watson, R.T. (2001) Climate Change 2001. Synthesis Report. Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, UK.
- Zaal, F. and Dietz, T. (2004) Sahelian Livelihoods on the Rebound. A critical analysis of rainfall, drought index and yield in Sahelian agriculture. *Environment and Policy*. 39:61-77



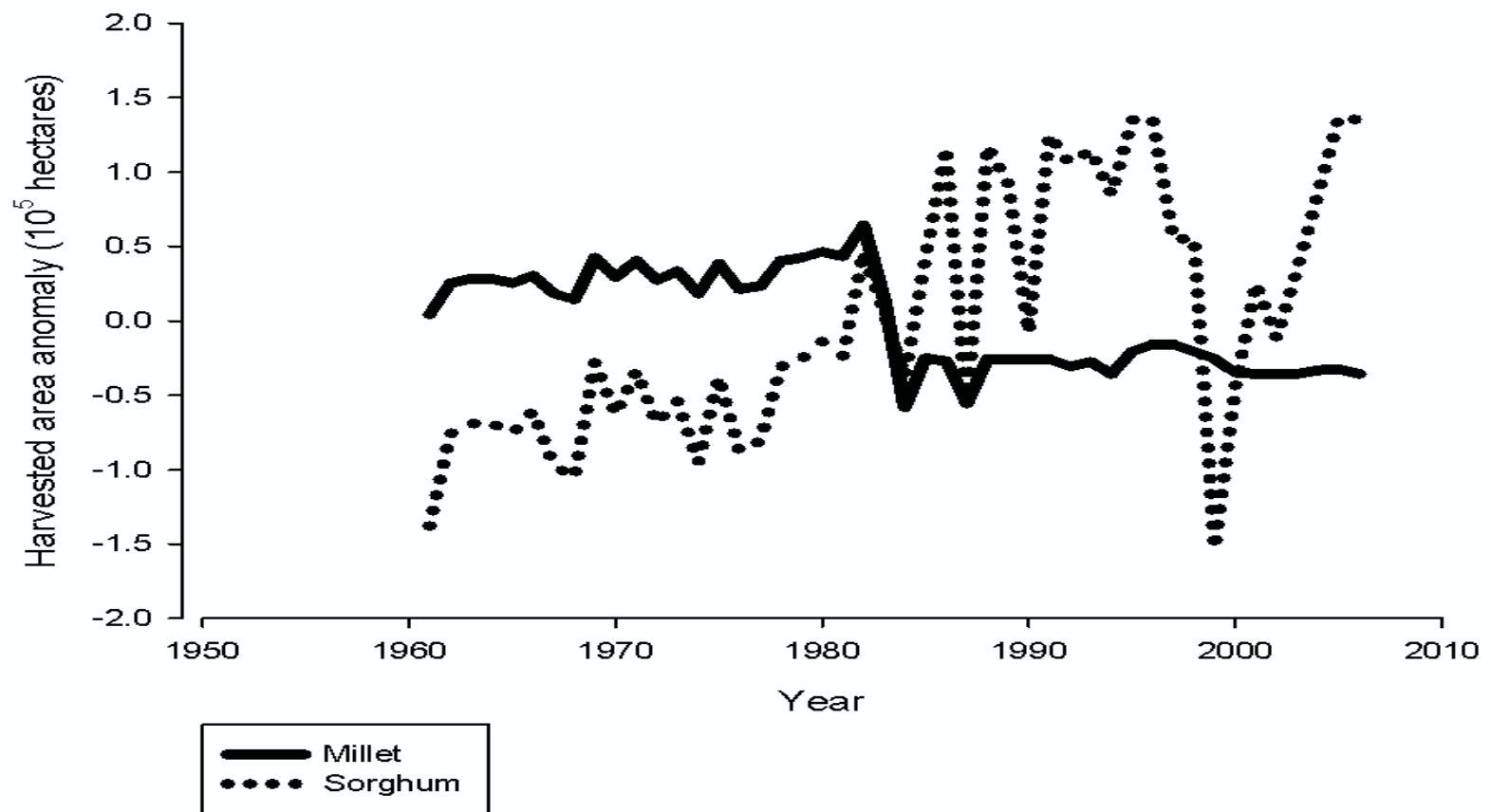
Average millet and sorghum yield since 1961



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Total harvested area Anomaly (1961-2006)



Impacts of Recent Climatic Changes on Some Subsistent Crops in the North of Cameroon.

Study area

