



Rising nutrient availability may have much more impact than climate change on pearl millet in Senegal

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Rising nutrient availability may have much more impact than climate change on pearl millet in Senegal

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Context and objectives

- Semi-arid Africa (Senegal)
- Traditional food crops productions low and far from attainable yields
- Assessing the impact of climate change on millet yield
- Comparing climate change impact with crop intensification (*i.e.* increased fertilization)



Methods

Climate modelling

- CIMP5 ensemble
- 3 time horizons (1985, 2050, 2080), 30-years time spans, 2 radiative forcing (RCP 2.6, RCP 8.5)
- Future scenarios = projected changes applied to observed local weather data

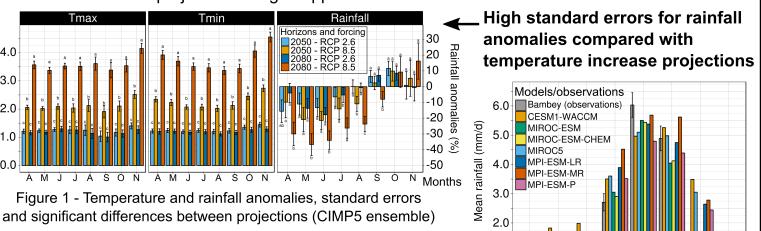


Figure 1 - Temperature and rainfall anomalies, standard errors and significant differences between projections (CIMP5 ensemble)

MIROC models better fit with observed rainfall and predict rainfall increase in all scenarios (not shown)

- 6 future scenarios :
- RCP 2.6 (MIROC / All Models)
 - RCP 8.5 2050 (MIROC / All Models)
 - RCP 8.5 2080 (MIROC / All Models)

Figure 2 - Comparison between observed and simulated rainfall for 7 closest models

Crop modelling

- CELSIUS crop model
- Calibrated against observed data under varying weather, soil and nutrient management)
- Millet crop simulations:
 - Present and future climate, 30-years time spans
 - Severe and moderate nutrient limitations.

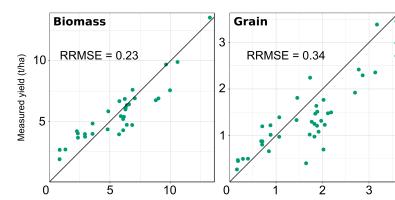


Figure 3 - CELSIUS performances for biomass and grain yield over varying observed situations

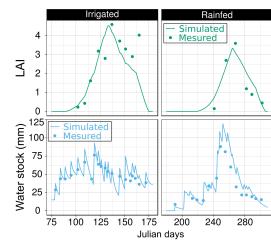


Figure 4 - Comparison between observed and simulated values for millet LAI and soil water content in two contrasted situations

4 nutrient limitation levels :

- F0 : 25% of potential yield (Y_p)
= current representative yield level
- F1 : 50% of Y_p
- F2 : 75% of Y_p
- F3 : 100% of Y_p

Results

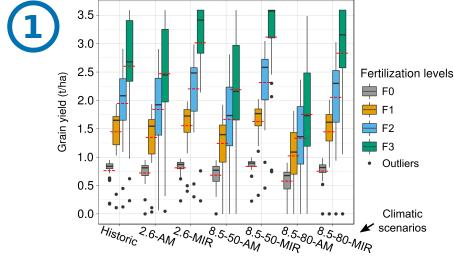


Figure 5 - Grain yield distribution per climatic scenario and fertilization level. MIR = MIROC models; AM = CIMP5 ensemble.

- Yield interannual variability increases in the future, under CIMP5 ensemble projections
- Contrasting trends depending on climate models

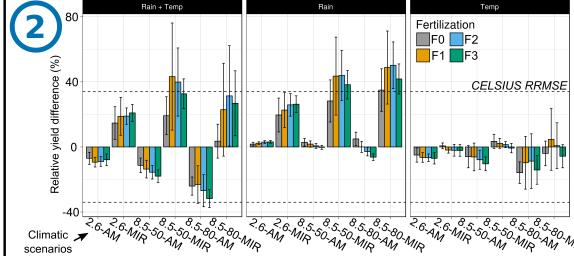


Figure 6 - Relative yield differences under 6 climatic scenarios with unchanged fertilization between present and future

- Relative yield differences lower than model RRMSE, especially for temperature impact
- Strong differences depending on rainfall projections

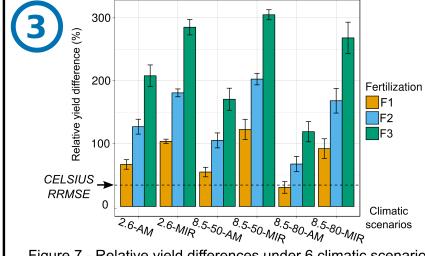


Figure 7 - Relative yield differences under 6 climatic scenarios with increased fertilization between present (F0) and future (F1, F2, F3)

- The lowest tested level of nutrient supply (F1=35 kg.ha⁻¹) is sufficient to provoke a substantial increase in yield
- Relative yield differences significantly higher than CELSIUS RRMSE

Discussion

- In our simulations, climate change impact on yield differences depends above all on rainfall. However, rainfall scenarios still remain uncertain.
- Millet currently grown under severe nutrient limitations (continuous cropping, insufficient recycling and external supply)
- Our simulations suggest that fertilization have more impact on millet yield compared to climate change scenarios.
- Strong yield increase could be expected from increasing organic or inorganic fertilization.