A new long-term experiment to explore the impact of rainfall extremes on the agronomic and environmental performances of cropping systems in the sub-humid tropics

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Background

- Extreme rainfall events, such as droughts, dry spells, and erratic and very heavy rainfall events, have been more frequently observed in Southern Africa over the past decades.
- These events often lead to water stress or waterlogging, reducing crop growth.
- Soil-crop processes may also be adversely impacted, for instance through soil nitrogen (N) leaching, erosion or peaks of nitrous oxide emissions.

Objective

- Assess the long-term agronomic and environmental performances of innovative cropping systems under extreme rainfall events in sub-humid Zimbabwe, combining field monitoring and soil-crop modelling.

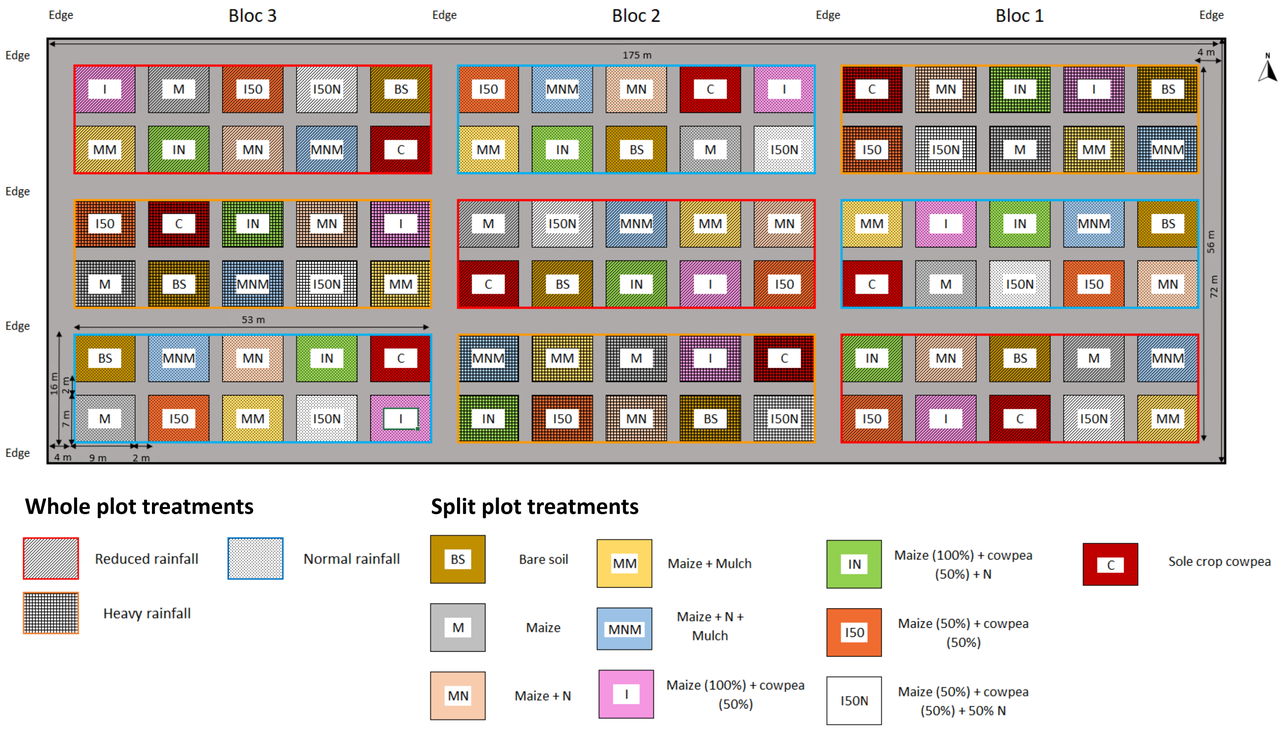

Figure 1. Experimental design of the University of Zimbabwe Farm (UZF) trial.

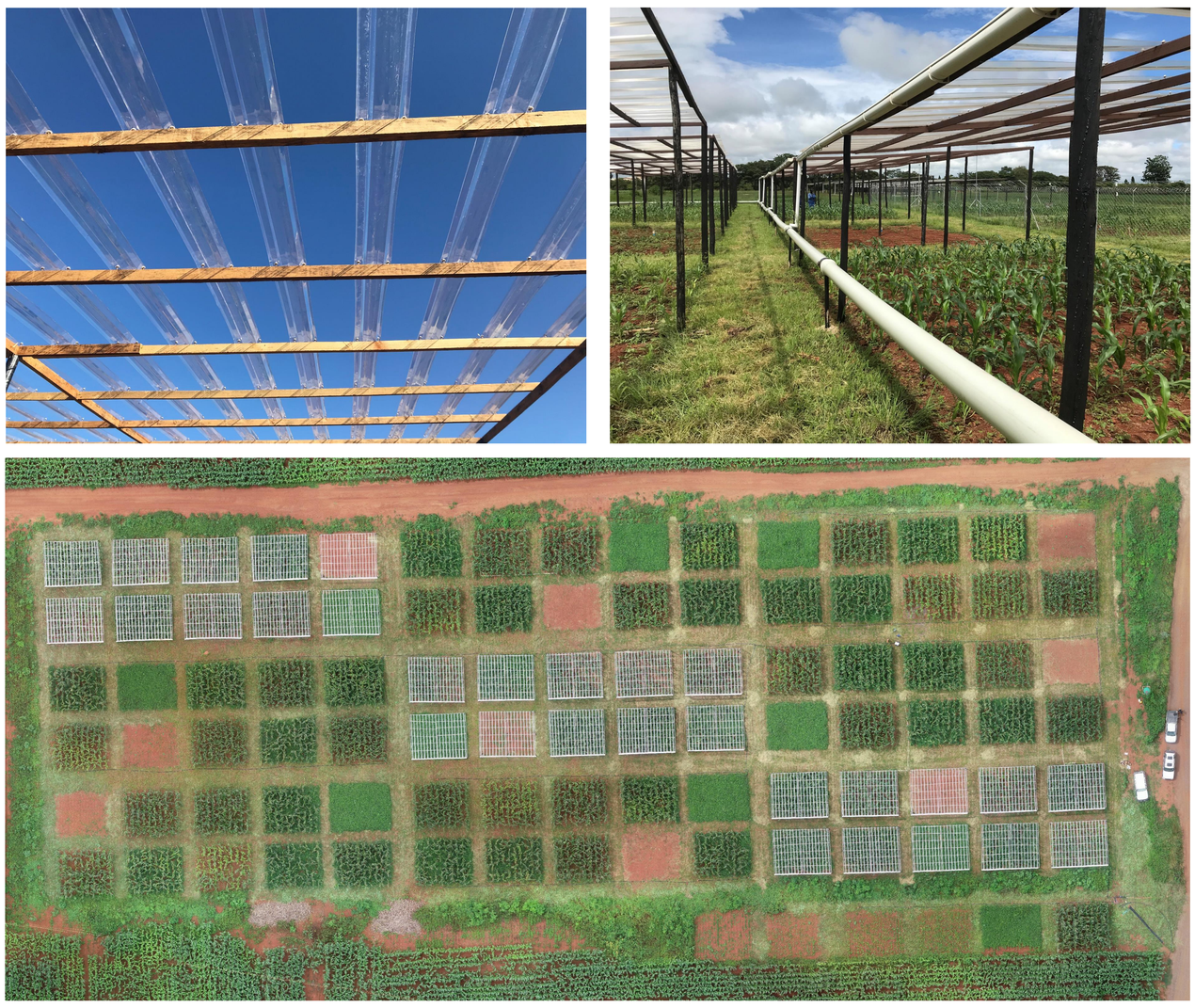

Figure 2. Rainfall exclusion system (top) and aerial view of the University of Zimbabwe Farm (UZF) trial (bottom).

Description of the experiment

- The experiment has been established in October 2022 on 1.4 ha at the University of Zimbabwe Farm (UZF) (17°42'13.5"S, 31°00'29.4"E).
- A split-plot design was used. Three whole plot treatments are repeated three times (**Figure 1**):
  - Reduced rainfall (-30%)
  - Normal rainfall
  - Heavy rainfall events (100 mm/24h)
- The split plot treatments are:
  - Bare soil
  - Maize
  - Maize + N
  - Maize + Mulch
  - Maize + N + Mulch
  - Maize (100% density) + cowpea (50% density) intercropping
  - Maize (100% density) + cowpea (50% density) intercropping + N
  - Maize (50% density) + cowpea (50% density) intercropping
  - Maize (50% density) + cowpea (50%) intercropping + 50% N
  - Cowpea
- The mulch is made of maize residues from the previous season applied at 6 t DM/ha. Mineral nitrogen fertilizer (+N) is applied at 80 kgN/ha/yr.
- Grass strips (2-4 m wide) were planted to prevent lateral water flows between treatments.
- The reduced rainfall treatments are achieved with a rainfall exclusion system (**Figure 2**), with transparent shelters covering 30% of the surface.
- The heavy rainfall events are obtained with an irrigation system installed at the site. At least 2 events per season are simulated. The date of these events can vary one year from another.

Monitored variables

Plant

- Crop phenology, plant height, leaf area index (Licor LAI 2200C, SunScan) during the season. Crop biomass at flowering stage. Crop biomass, yield and yield components at harvest. Biological nitrogen fixation (^{15}N dilution method). Plant transpiration (sap flow). Mulch decomposition.

Soil

- Initial basic soil properties (texture, pH, P-Olsen, CEC, SOC, total N) down 1m depth.
- Regular measurements of soil mineral nitrogen and soil water content along the profile. Continuous measurements of soil moisture and temperature at 1, 5, 15 cm.
- Greenhouse gases emissions (CO_2, N_2O, CH_4) using static chambers.

Climate

- Weather station for common climatic variables.
- Photosynthetically active radiation under rainout shelters.
- Shortwave and longwave radiation using radiometers (energy balance).

Ongoing projects

https://raiz.org.zw/
https://intercropvalues.eu/
https://dscatt.net/
https://faircarbon.wordpress.com/

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