Water Limited Yields & Optimum Maize Sowing Time & Variety Recommendation Summary for parts of the Zambezi River Basin

Background

Maize is an important food crop in Eastern and Southern Africa, The crop accounts for at least 40% of the calorific intake, especially amongst the rural and resource-constrained population. It is also a key input for industrial use and animal feed (Woomer et al., 2024). The Zambezi basin, in eastern and Southern Africa, has high maize yield, but production is low due to poor fertility management and climate risks. This research therefore sought to enhance the development of fertilizer recommendations and improve climate resilience. This was undertaken through prediction of potential water limited yields under different season types and varieties at scale.

Methodology

The activity was based on the Zambezi Basin, which covers Malawi, and parts of Mozambique, Zambia, Zimbabwe and Angola. The CGIAR-Excellence in Agronomy (EiA) Initiative, predicted the potential yields and optimum sowing dates and variety for Maize in the Zambezi Basin, through use of the AgWise Water Limited Yield crop modelling platform. The AgWise modelling framework, comprises of a variety of crop models, such as APSIM, DSSAT, WOFOST and Oryza. This activity utilized the spatialized DSSAT 4.8 crop model, which was coupled with weather data from CHIRPS and AgERA5, and soil data from ISRIC. The simulations were done for 22-year historical data from 2000; in addition, 3 generic (short, medium and long) varieties were tested over 9 weekly sowing dates. The simulation outputs were aggregated across different sowing dates, varieties and ENSO phases. This therefore enabled determination of the optimum sowing dates across different varieties and season types. The date with the highest median yield was called the optimum sowing date. Specifically, season types were determined through classification of the season across the 3 ENSO phases. Determination of ENSO phases was undertaken through use of the Oceanic Niño Index (ONI), where an ONI value of greater and less than 0.5 ^{O}C, signifies an *El Niño* and *La Niña* respectively. ONI value between -0.5 and 0.5, is defined as *neutral.*

Results

The analytics aggregated all the Maize yield across different sowing dates, varieties and ENSO phases. Specifically, early sowing on November 2, led to high yields across all ENSO phases, compared to the rest of the sowing dates. However, delayed sowing, showed differences in the maize yield performance across the different ENSO phases, with rapid yield decline under *El Niño*. The pattern was more significant for long season varieties and *El Niño* phase as compared to short and medium varieties and the Neutral and Niña periods (Figure 1).

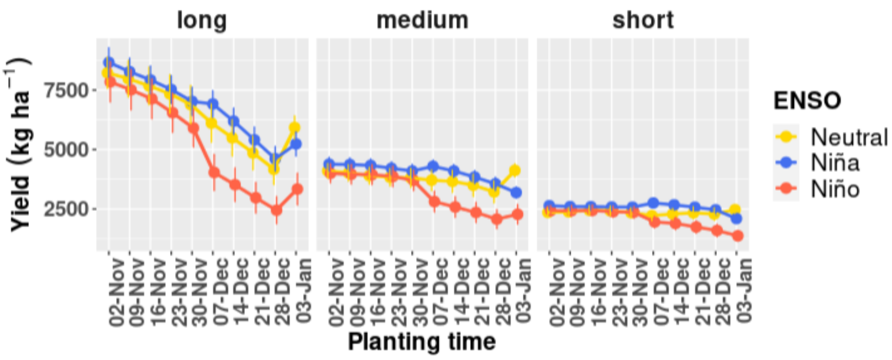

Figure 1: Maize yield response to varying sowing dates across varieties and ENSO phases in the Zambezi River basin.

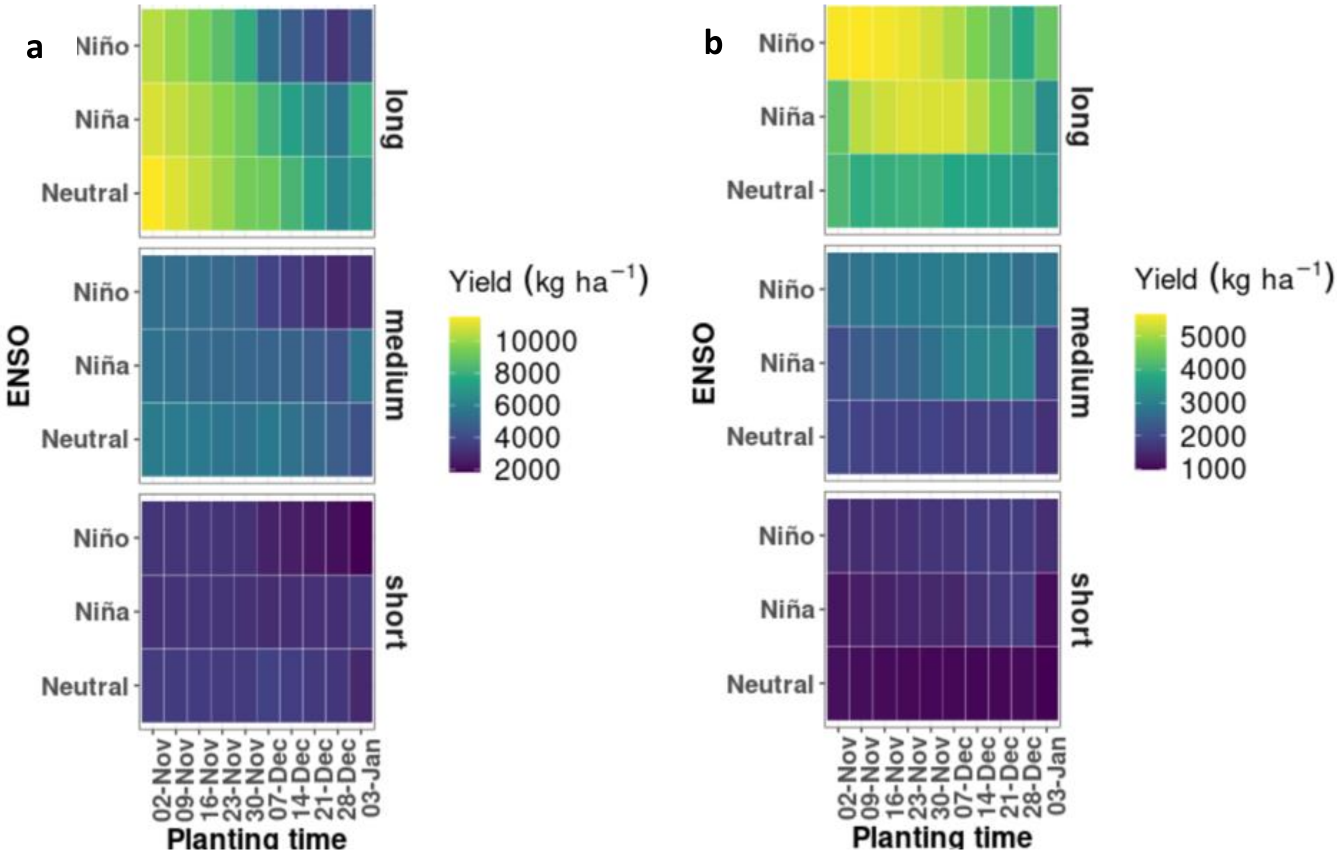

Figure 2: Stability of maize grain yield: (a) median and (b) standard deviation across different sowing dates, varieties, and ENSO phases for the Zambezi River basin.

There is more yield stability in the cultivation of short and medium-season varieties with lower standard deviation in the yield. This was expected due to the lower yields. In contrast, the long-season variety registered higher yield and more variability. There was high yield unpredictability under *El Niño* conditions, compared to La Niña and Neutral conditions, especially amongst the long-season variety and, to a certain extent, the medium-season variety (Figure 2).

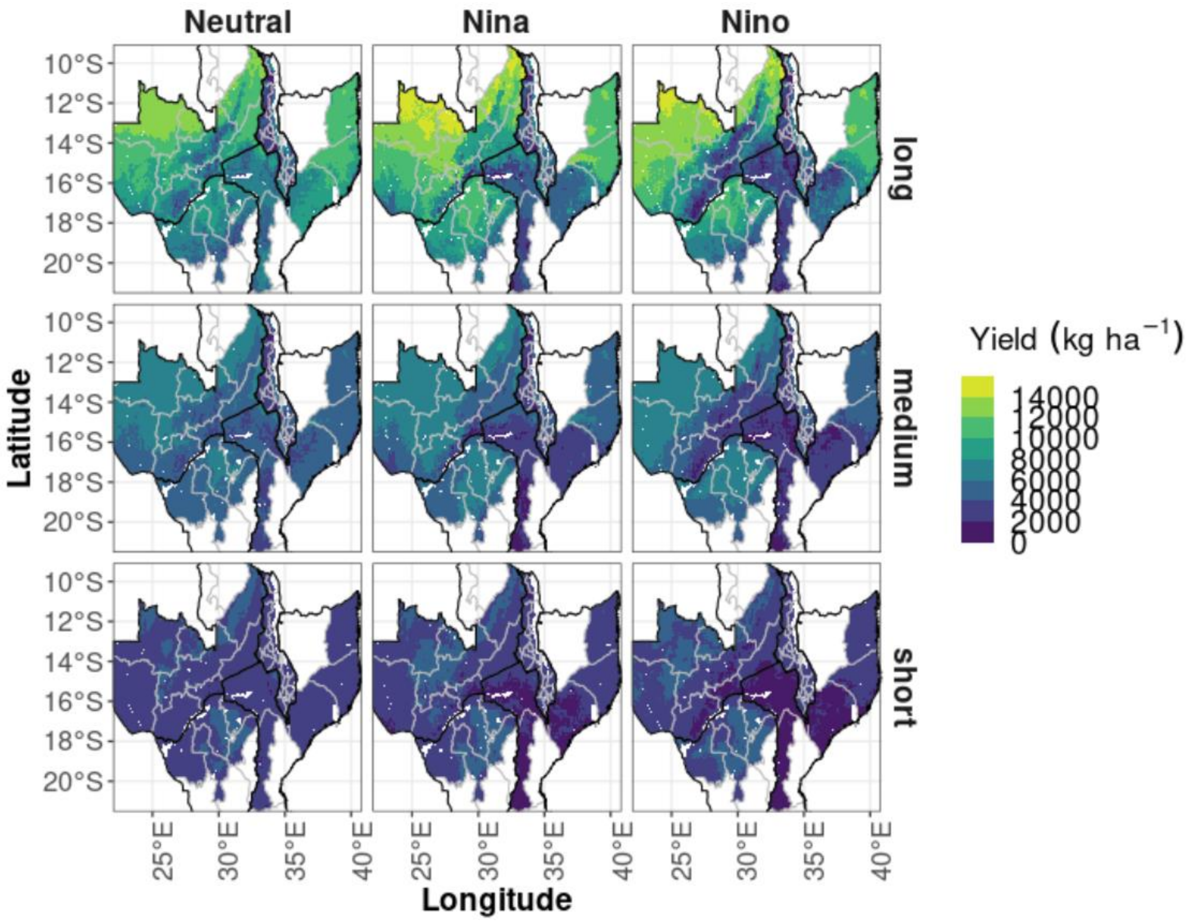

Figure 4: Mean yield distribution across different varieties and ENSO phases for Maize in the Zambezi River Basin.

El Niño caused lower yields in the middle and southern part of the basin, compared the northern and north-east and west parts of Zambia of the Zambezi basin. The pattern is similar across the different varieties, with *Niño* leading to lower yields for the short varieties, relative to other varieties (Figure 4).

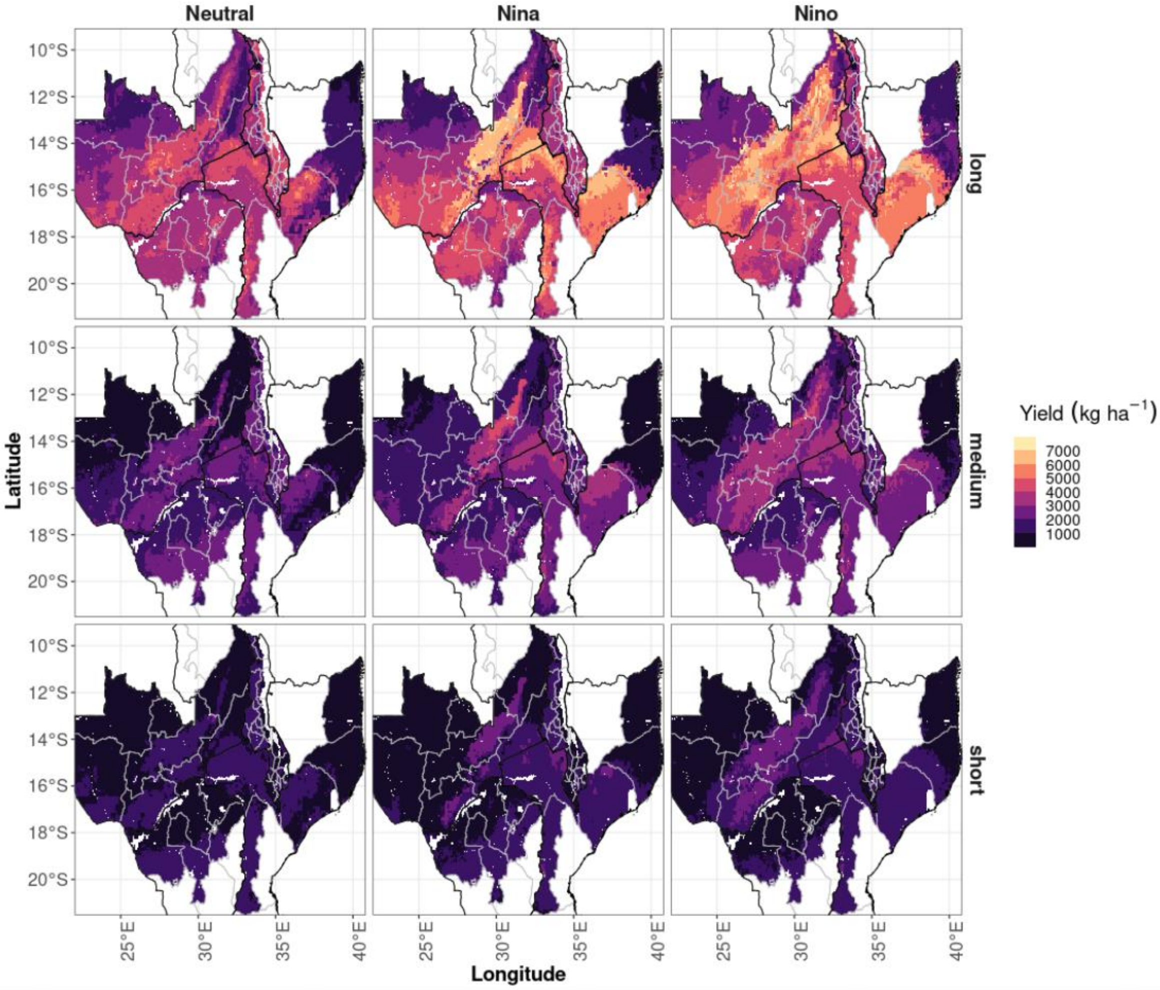

Figure 5: Maize grain yield standard deviation across different varieties and ENSO phases for the Zambezi River Basin.

There is lower standard deviation, translating to higher yield stability, in the northern parts of the basin as opposed to the central and southern parts. There is therefore a higher chance of attaining reliable yields in the north as opposed to the southern parts of the basin (Figure 5).

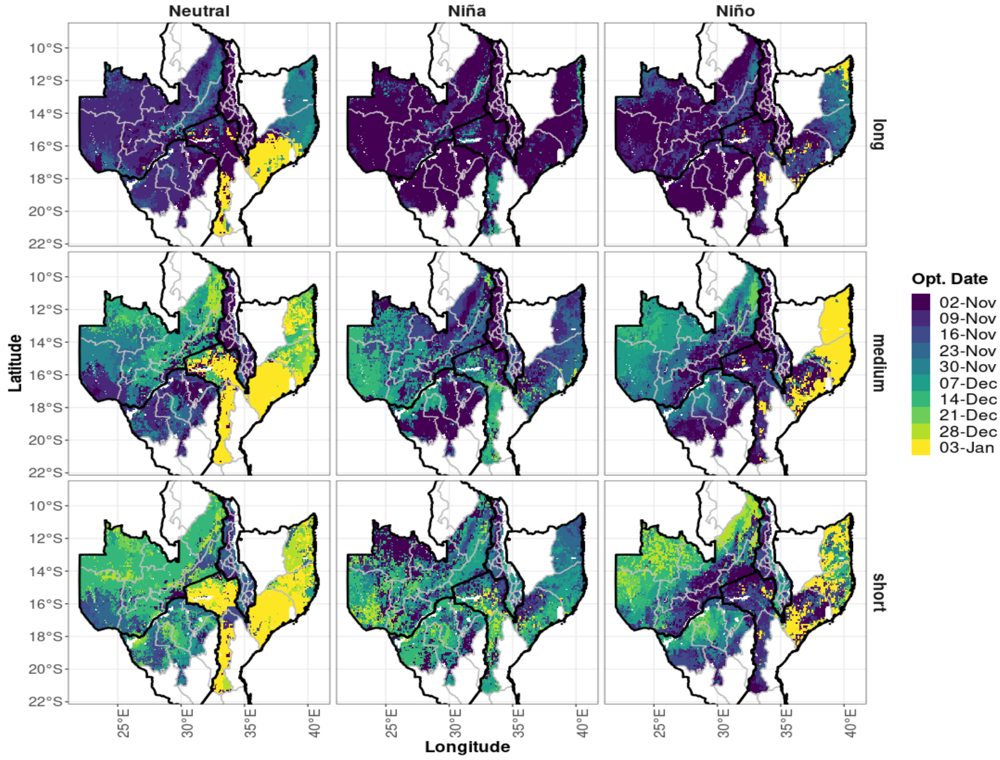

Figure 6: Optimum sowing dates across different varieties and ENSO phases for Maize in the Zambezi River Basin.

The earliest sowing dates (early-November), are mostly realized for long season varieties across the 3 ENSO phases. The pattern is more pronounced for the *Niña* and *Niño* phases of ENSO. Medium and short season varieties, have generally slightly delayed optimum sowing dates, compared to long season varieties. Northen-Mozambique, has relatively delayed sowing dates, for *Neutral* and *Niño* season, as opposed to the *Niña* seasons (Figure 6).

Conclusion

Early planting leads to higher yields but this is dependent on the variety and season type. Specifically, Extreme wet and dry seasons, would be suitable for delayed sowing in the Eastern parts of the Zambezi basin. There are higher chances of getting higher yields in northern parts of the basin compared to the southern parts of the basin.

Reference

Kornher L., 2018. Maize markets in Eastern and Southern Africa (ESA) in the context of climate change. Background paper for The State of Agricultural Commodity Markets (SOCO) 2018. Rome, FAO. 58 pp

NB: The outputs should only be used to provide a general recommendation, due to the potential uncertainty from the use of gridded geo-spatial data sets. The recommendations therefore need to be used in consultation with local experts.