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

Background

Soybean is increasingly becoming a preferred legume amongst smallholder farmers in Eastern and Southern Africa. This is due to improved research by governments, universities and other research organizations. Current production levels of 861 000 tonnes are still however outstripped by the demand of 2 million tons. This yield gap is caused by inspect pests and diseases, soil fertility management, and climate risk (Murithi et al., 2015). Significant research is currently being undertaken to manage such challenges, but there is still limited research on the impacts and adaptation to climate variability and change. The Zambezi basin, in eastern and Southern Africa, has high soybean yield, but production is low due to poor fertility management and climate risks. This research therefore sought to enhance development of fertilizer recommendations and improve climate resilience. This was undertaken through prediction of potential water limited yields under different season types and varieties across the Zambezi Basin.

Methodology

The research was based on the Zambezi Basin, which covers Malawi, and parts of Mozambique, Zambia, Zimbabwe and Angola. The basin has high potential but poor productivity. The CGIAR-Excellence in Agronomy (EiA) Initiative, sought to predict the optimum sowing dates and variety for Soybean 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 Oryzae. This research utilized the spatialized DSSAT 4.8 crop model, which was coupled with weather and soil from CHIRPS and AgERA5 and soil from ISRIC. Simulations based on 22-year historical data from, 2000, for 3 generic (short, medium and long), varieties 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 referred to as 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 Nino* and *La Nina* respectively. ONI value between -0.5 and 0.5, signifies it is a *neutral.*

Results

The analytics aggregated all the Soybean yield across different sowing dates, varieties and ENSO phases. Specifically, early sowing on 2-December, led to high yields across all ENSO phases, compared to the rest of the sowing window. Delayed sowing however shows notable differences across the different ENSO phases, in the second half of the season (Figure 1).

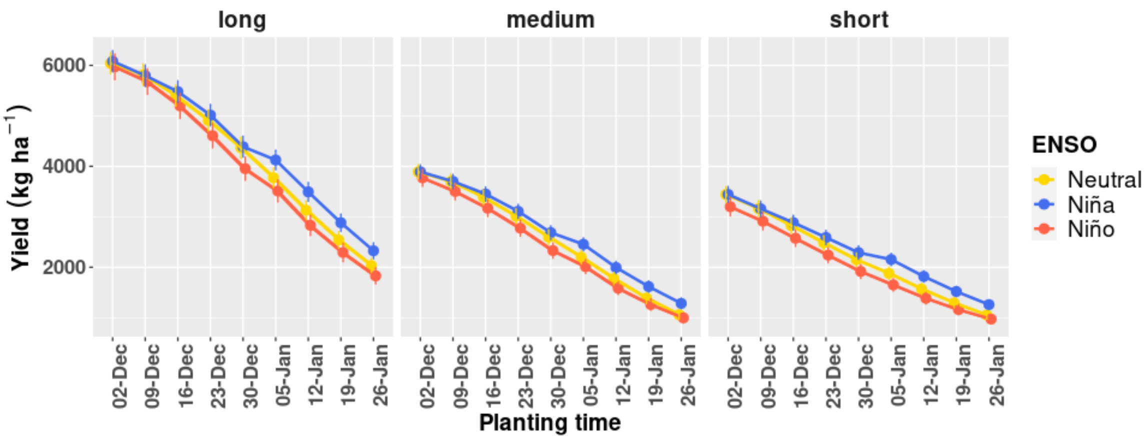

Figure 1: Soybean yield response to varying sowing dates across different varieties and ENSO phases in the Zambezi River basin.

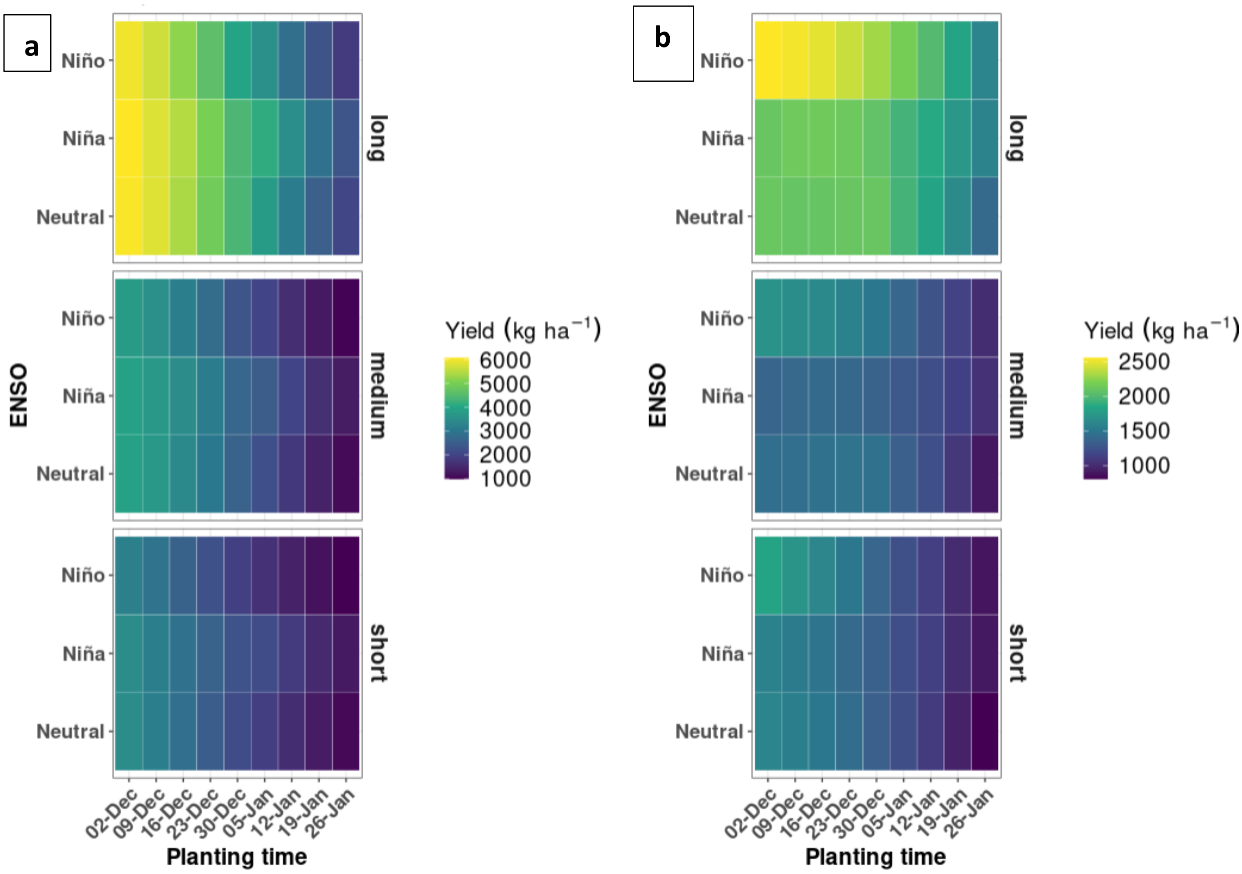

Figure2: Soybean grain yield (a)-summaries, (b)- stability, across different sowing dates, varieties and ENSO phases for the Zambezi River basin.

Despite the relatively, lower yields, there is greater yield stability on cultivation of short and medium season varieties, compared to long seasoned varieties. There was high yield variability under the *El Nino*, conditions, compared to *La Nina* and *Neutral* conditions (Figure 2).

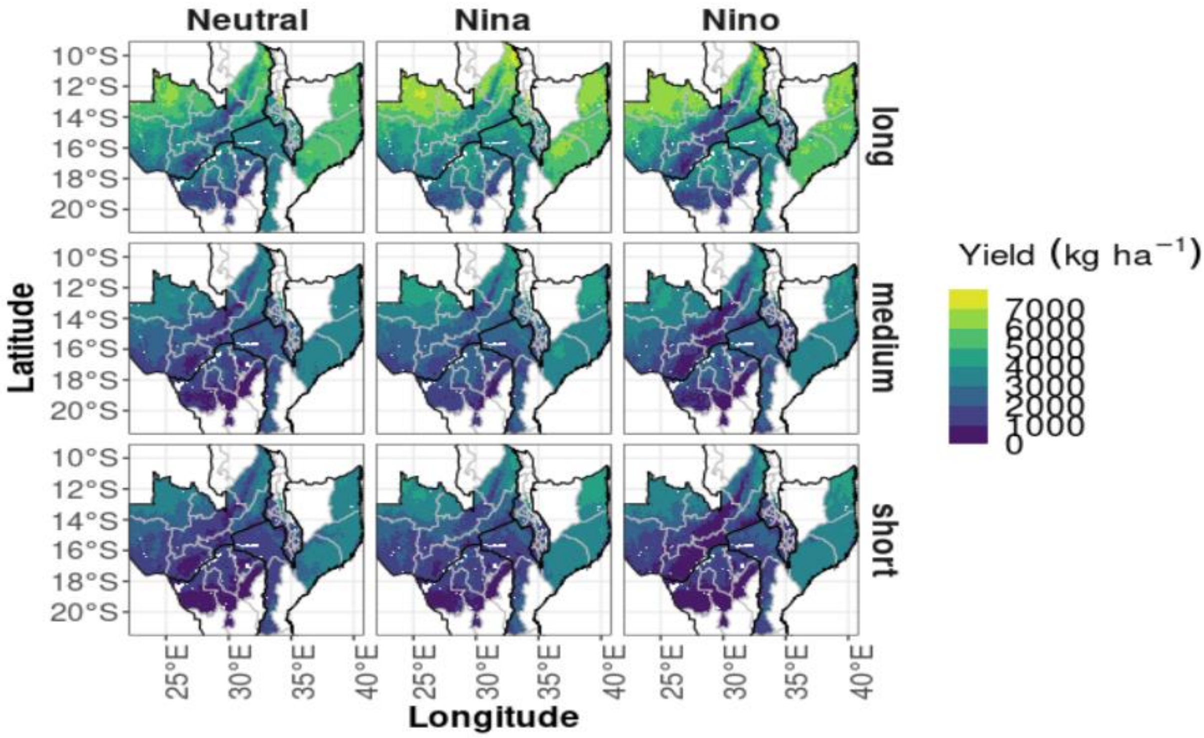

Figure 4: Mean yield distribution across different varieties and ENSO phases for Soybean in the Zambezi River Basin.

El Nino 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 *Nino* mostly having lower yields for the short varieties (Figure 4).

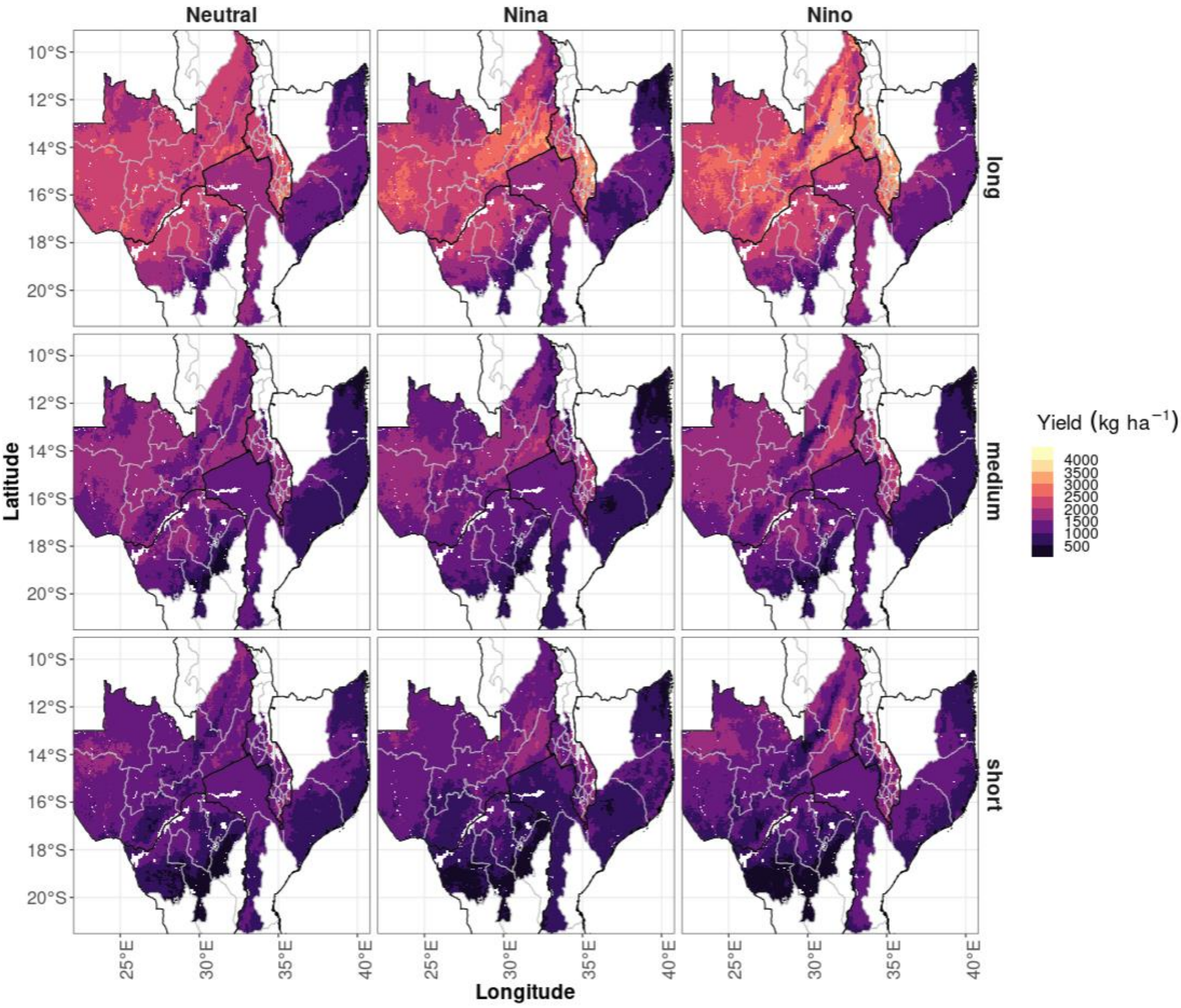

Figure 5: Soybean grain yield standard deviation across different varieties and ENSO phases for the Zambezi River Basin.

There is higher standard deviation, translating to lower yield stability, in the northern parts of the basin as opposed to the central and southern parts. Despite the higher yields in Northen Mozambique, there was low yield variability (Figure 5).

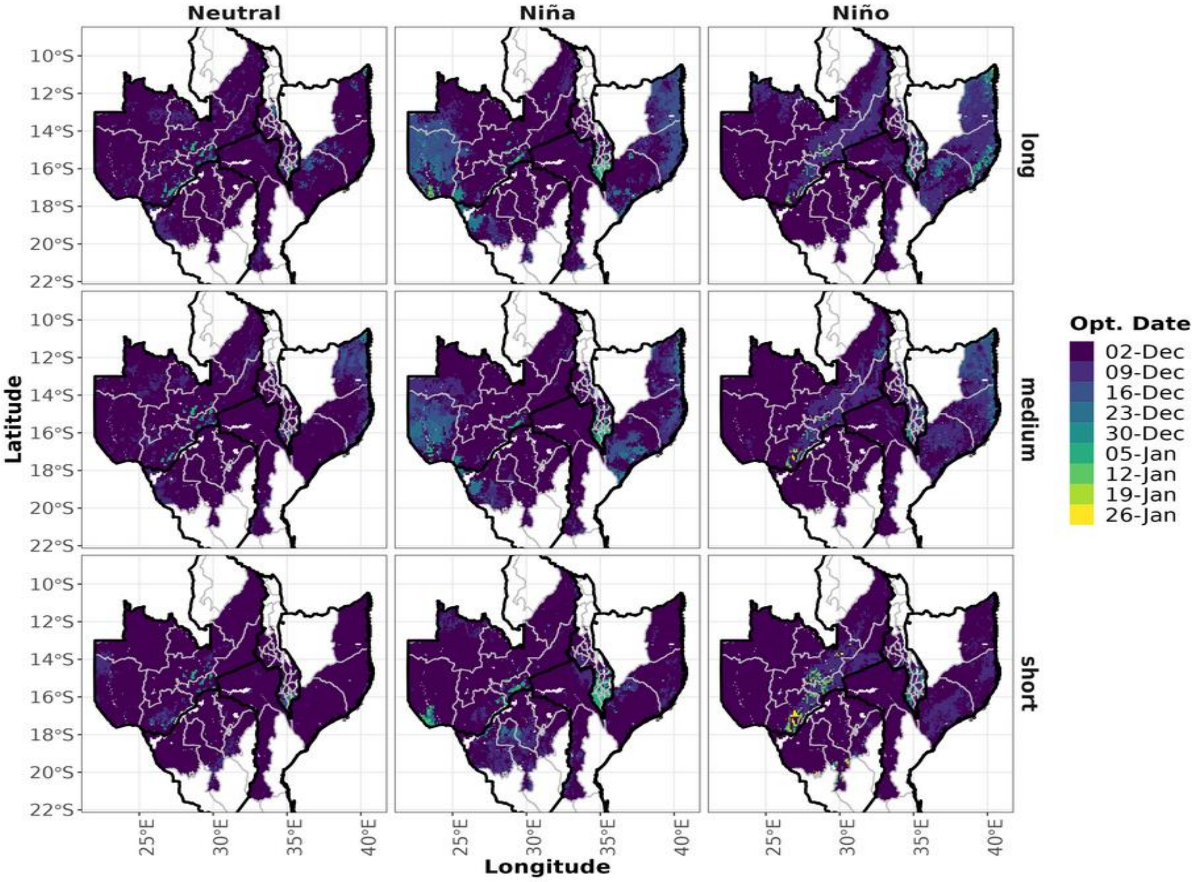

Figure 6: Optimum sowing dates across different varieties and ENSO phases for Soybean in the Zambezi River Basin.

The earliest sowing dates (early-December) are realized in almost 90% of the basin, across all ENSO phases. The pattern is more pronounced for the *neutral* ENSO phase. *Nina* phase under long and medium varieties, have optimum dates of late December for Eastern Zambia. *Nino*, has optimum, sowing dates of end December in Eastern Southern Zambia and Northern Mozambique for medium and long seasoned varieties (Figure 6).

Conclusion

Soybean has a narrow optimal sowing dates window in the Zambezi Basin. Early planting leads to higher yields regardless of season type and variety for soybeans. There are, however, some regions, which might need careful assessment of the season type and variety, as the optimum dates differ depending with the location and season type. Yield reliability is higher with very short-seasoned varieties, despite the poor yields.

Reference

Murithi H. M., Beed F, Tukamuhabwa F., Thomma B. P. H. J., Joosten M. H. A. J. 2015. Plant pathology.65:2. https://doi.org/10.1111/ppa.12457

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.