Water Limited Yields, Optimum Soybean Sowing Time & Variety Recommendation Summary for the GhanaSoy-Esoko Use Case, Ghana

Background

Soybean is a key food, nutrition and cash crop for Ghana. Potential productivity is currently at 700 000 tonnes but the current production is about 26% of the potential. This is attributed to limited availability and access to inputs, low fertilizer use, and poor soil fertility and significant rainfall variability (FAO, 2024). There is therefore need for improved, soybean crop management through judicious fertilizer use and climate variability management. Specifically, this can be attained through determination of water limited yield computation for variety recommendations and variety selection and timeliness of planning.

Methodology

The CGIAR-Excellence in Agronomy (EiA) Initiative, therefore sought to determine the water limited yields, optimum sowing dates and variety for Soybean in Ghana, through use of the AgWise Water Limited Yield modelling platform. The AgWise modelling framework, comprises of a variety of crop models. The research utilised the spatialised DSSAT 4.8 crop model, coupled with weather and soil from CHIRPS and AgERA5 and soil from ISRIC. Simulations were based on 22-year historical data from, 2000, for 3 generic (short, medium and long), varieties over 12 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 refereed 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 using 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

Early sowing, around Week 1 (1 June) of planting, across all ENSO phases, led to the highest yields, of up to 5-6 t/ha, with the highest and lowest yields obtained under the *La Nina* and *El Nino* phases. The medium seasoned varieties, had 2 optimum dates, of 1 June and 19 July and 2 August, for both the *La Nina* and the *El Nino* phases. For short seasoned varieties, optimum sowing led to high yields under *La Nina*, but yields were generally low, with a difference of 1 t/ha between the maximum and lowest yields (Figure 1).

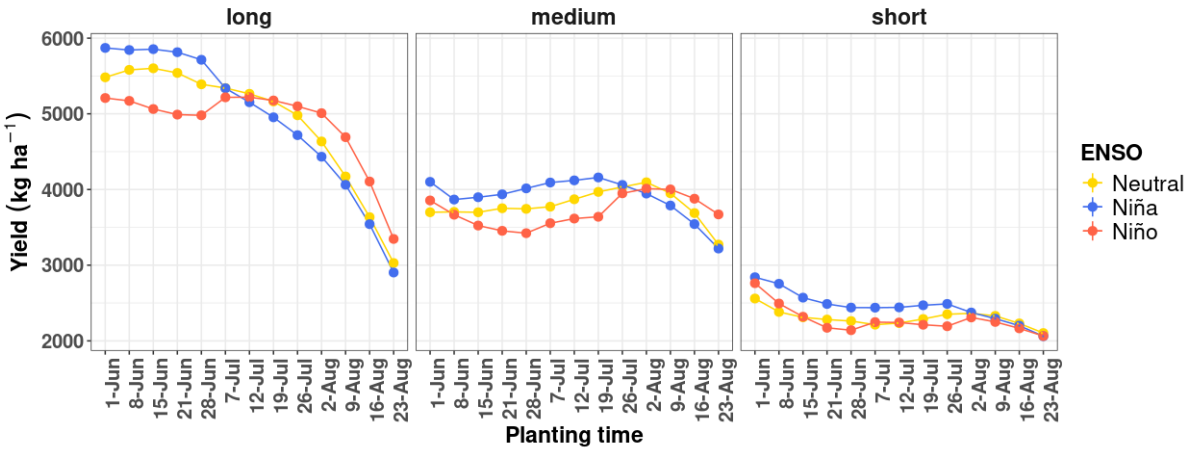

Figure 1: Soybean yield response to varying sowing dates across different varieties and ENSO phases in Ghana.

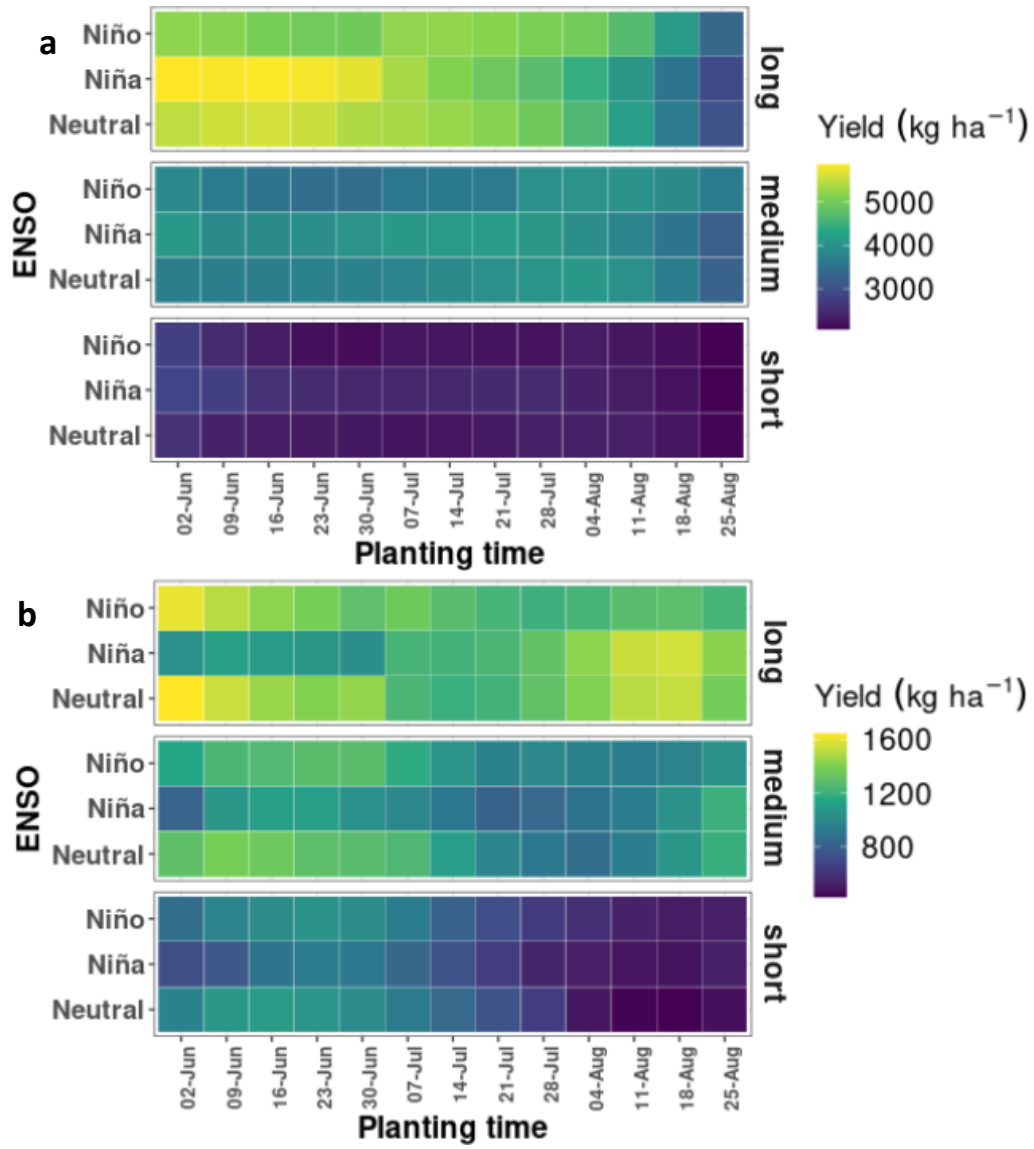

Figure2: Soybean grain yield (a)-summaries, (b)- stability, across different sowing dates, varieties and ENSO phases for Ghana.

Though there is greater yield stability, cultivating short season varieties, there are very low yields. There are relatively higher yields under *La Nina* and *Neutral* as opposed to the *El Nino*, phase, which also has lower yield variability (Figure 2).

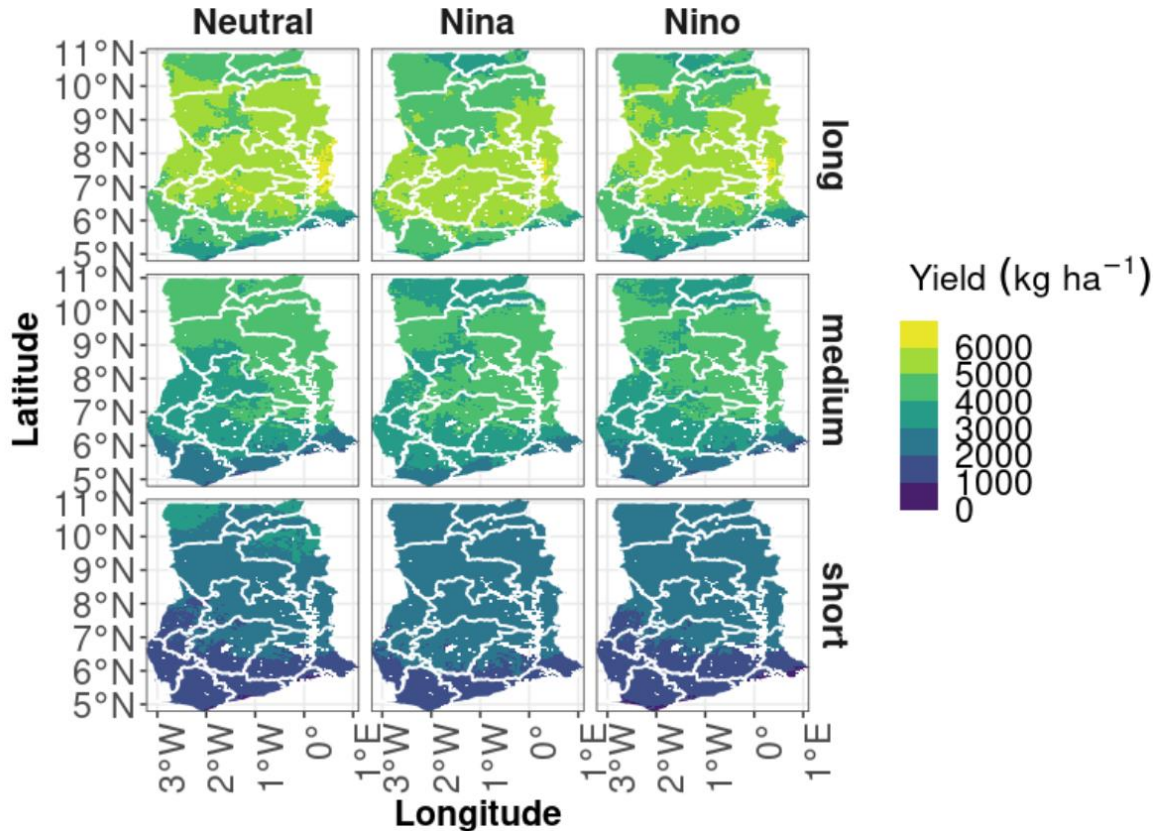

Figure 4: Mean yield distribution across different varieties and ENSO phases for Soybean in Ghana.

Southern and extreme northern Ghana, attains lower soybean yields as opposed to central Ghana. The pattern was similar, though with different intensities, across all the varieties. Under the *neutral* phase of ENSO, long seasoned varieties, have better yields for most of Ghana, as opposed to other ENSO phases. Medium seasoned varieties, had the best yields under *Nina* and *Nino* scenarios (Figure 4).

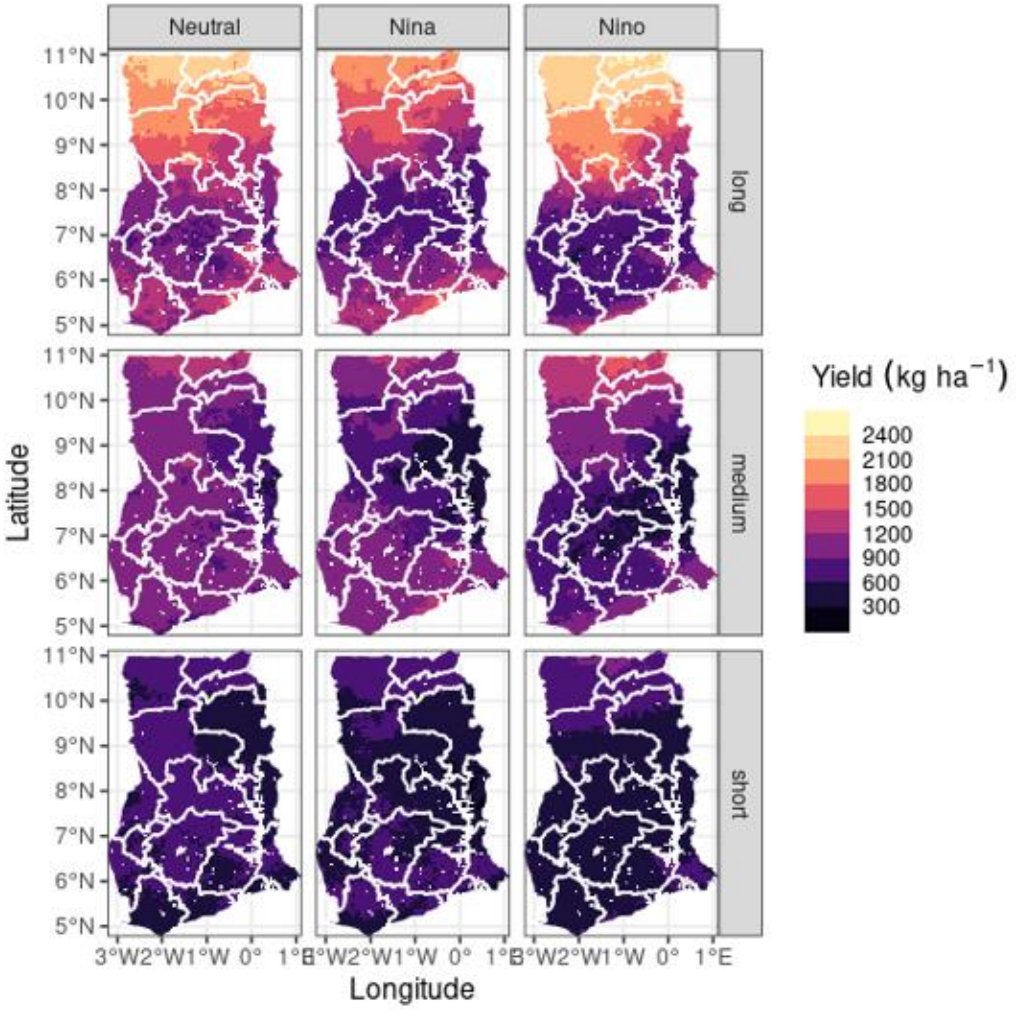

Figure 5: Soybean grain yield standard deviation across different varieties and ENSO phases for Ghana.

There is higher standard deviation, translating to low yield stability, in the northern Ghana as opposed to southern Ghana. Similarly, there is greater yield variability in northern Ghana for both medium and long seasoned varieties, as opposed to central parts of Ghana. Specifically, the *El Nino* and *Neutral* phases show greater yield variability as compared to *La Nina*. This is more pronounced when the variety is medium and long (Figure 5).

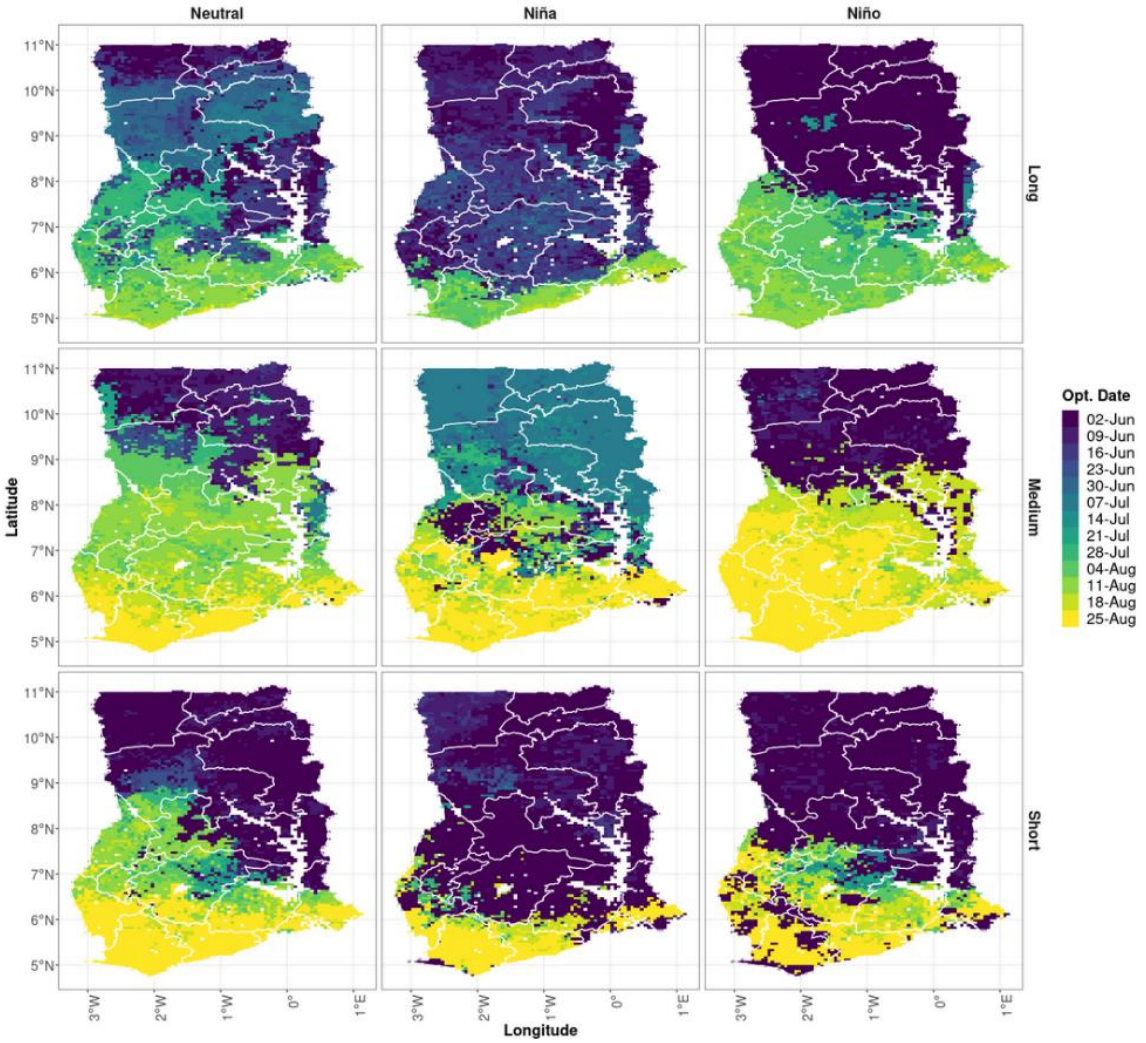

Figure 6: Optimum sowing dates across the different varieties and ENSO phases for Soybean in Ghana.

The earliest sowing dates (early June), are realised in the north of the country, with Southern Ghana having delayed sowing dates. Specifically, *Neutral* and *La Nina* phases of ENSO, mostly have early sowing dates, whilst *El Nino* has mostly delayed sowing dates. There is greater variability of optimum sowing dates in *Neutral* and *La Nina* as opposed to *El Nino*.

Conclusion

Time of planting needs to be carefully determined for Nino seasons as compared to Nina and Neutral, as realised by the greater variability. Long seasoned varieties provide fewer opportunities for sowing, whereas medium varieties may have more than one sowing opportunity and short season varieties have multiple opportunities. There is higher yield variability in high yielding areas as opposite to low yielding areas. Similarly, short seasoned varieties, have higher yield stability as opposed long seasoned varieties.

Reference

FAO, 2024. Unlocking the true potential of soybean farming in Ghana. https://www.fao.org/ghana/news/detail-events/en/c/1642964/

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.