# Water Limited Yields & Optimum Common Beans Sowing Time & Variety Recommendation Summary for Kenya

## Background

Kenya occupies the fourth place in the production of dry beans in Africa, and it is the country with the most growing area of this crop in this continent. However, the average yield of common beans in Kenya by 2022 was 492 kg/ha, one of the lowest in Africa (FAO, 2023). The yield gap is attributed to pests and diseases, mid and late-season drought, and N and P deficiencies (Katungi et al., 2020). This research sought to evaluate the attainable yield of common beans by simulating water-limited yields using different planting times and varieties at scale for Kenya.

## Methodology

The CGIAR-Excellence in Agronomy (EiA) Initiative sought to determine the water-limited yields, optimum sowing dates, and variety for common beans in Kenya through the AgWise Water Limited Yield crop modeling platform. The AgWise modeling framework comprises a variety of crop models, such as APSIM, DSSAT, WOFOST, and Oryzae. This activity utilized the spatialized DSSAT 4.8 crop model coupled with weather data from CHIRPS and AgERA5 and soil from ISRIC. DSSAT crop model spatialisation was enabled through of the DSSAT R-Package (Alderman, 2020). The model was calibrated based on a combination of field experimental data and expert feedback. Simulations were based on 22-year historical data from 2000 for 3 generic (short, medium, and long duration) varieties over 16 weekly sowing dates. The simulation outputs were aggregated across different sowing dates, varieties, and ENSO phases. This, therefore, enabled the 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 by classifying the growing seasons across the 3 ENSO phases. To define the ENSO phases, we use the Oceanic Niño Index (ONI), where 5 consecutive overlapping periods with an ONI value of greater and less than 0.5 $^{O}$C signifies *El Niño* and *La Niña*, respectively. ONI value between -0.5 and 0.5, signifies it is a *neutral.*

## Results

The analytics framework aggregated all the common bean yield data across different sowing dates, varieties, and ENSO phases for Kenya. For most of the plantings, at the national level, there were no significant differences in the yield due to the ENSO phase. However, *Neutral* conditions generated higher yields for the initial plantings at the beginning of March, followed by *La Niña* and *El Niño*. Based on the historical analysis, higher yields are obtained when the sowing dates are between March 09 and 30, with short-duration varieties preferring the latest plantings (Figure 1).

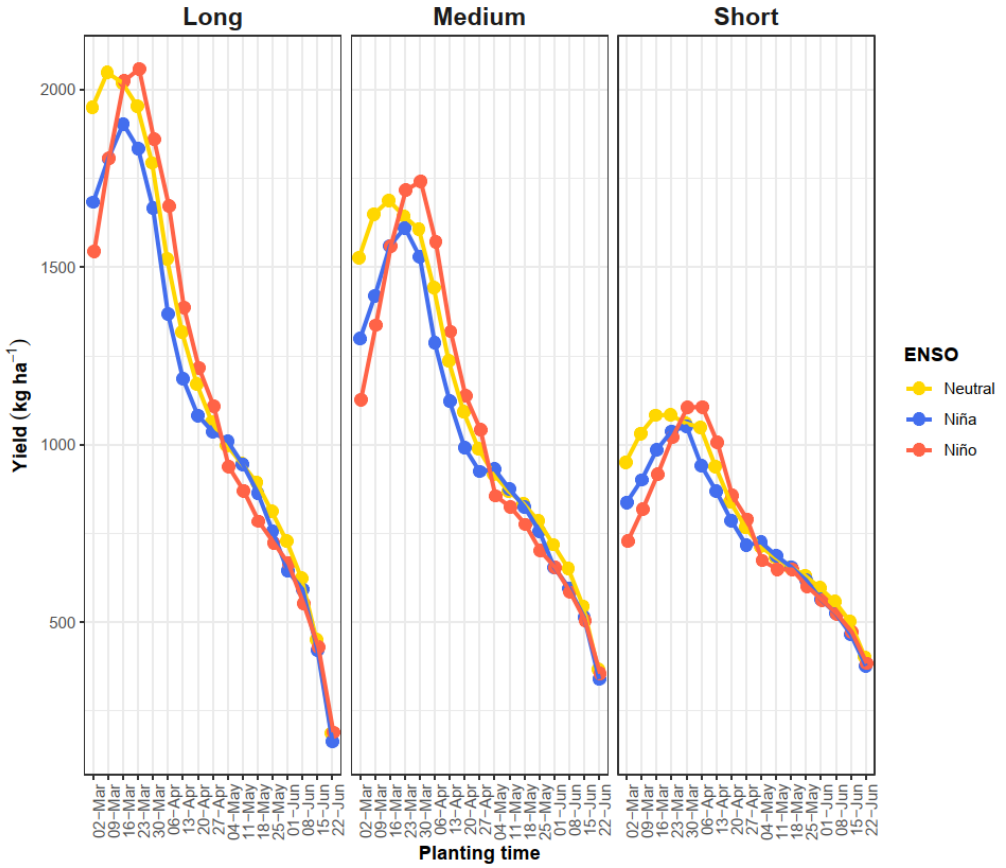


**Figure 1: Common bean yield response to varying sowing dates across different varieties and ENSO phases in Kenya.**

Although the long-season variety generated the highest yield, it also had the highest variability, followed by the medium-duration variety. ENSO phases do not look to affect the average yield and its variability (Figure 2).

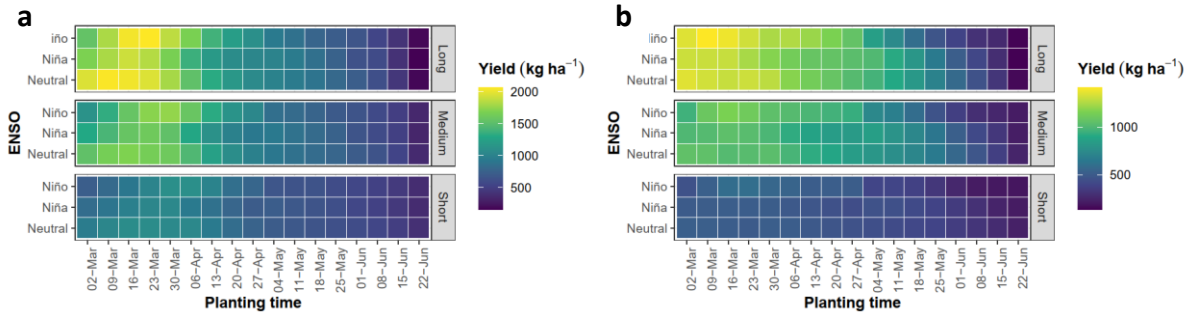


**Figure 2: Common bean yield (a)-mean, (b)- standard deviation, across different sowing dates, varieties, and ENSO phases for Kenya.**

The highest common bean yield is obtained for all the varieties in the Southwest of Kenya. There are no differences among ENSO phases in the average spatial yield pattern across the different years and planting dates of simulations (Figure 3).

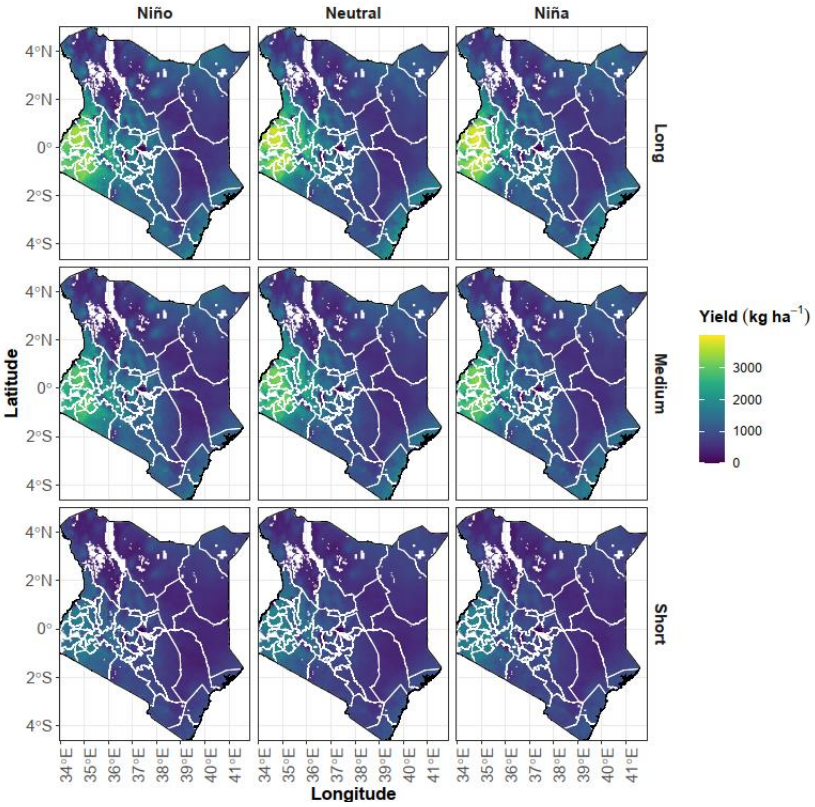


**Figure 3: Mean yield distribution across different varieties and ENSO phases for common beans in Kenya.**

*El Nino* caused higher variability in the yield, compared to *La Nina* and *Neutral* conditions. This variability is more evident in the areas with higher attainable yield (Figure 4).

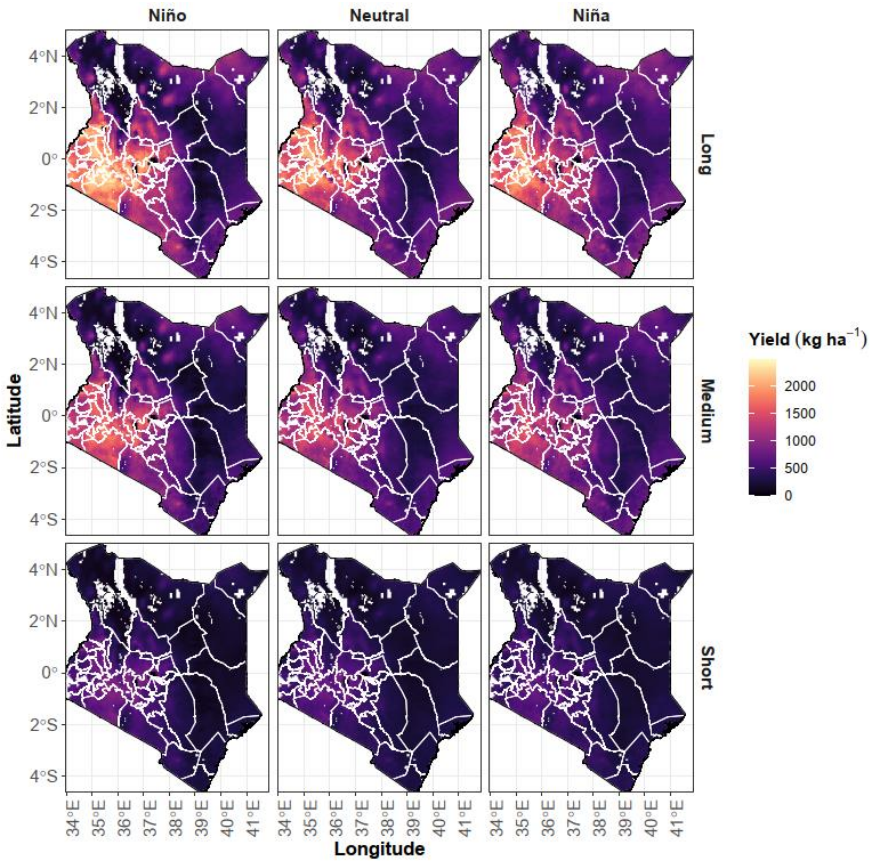


**Figure 4: Standard deviation of the yield in common beans across different varieties and ENSO phases for Kenya.**

Most of the areas in the country prefer early planting. However, under *El Niño*, it is suggested to delay the planting time for some weeks. Some areas in the West and Southeast of Kenya under *El Niño* prefer late plantings. Compared to Neutral conditions, La Niña seasons also suggest some delay in the planting time, especially in the Southwest and Southeast of the country; however, this delay in planting is for fewer weeks than under *El Niño*. In general, the short-duration variety prefers later plantings than the medium and long-duration varieties (Figure 5).

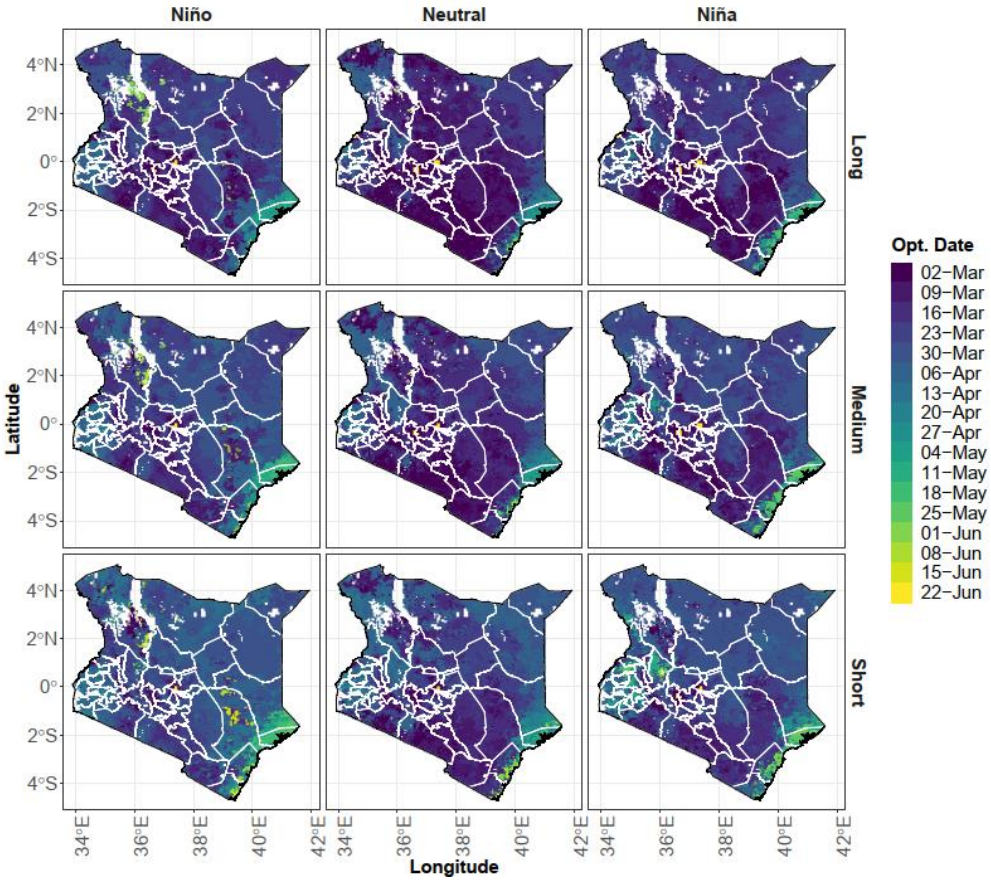


**Figure 5: Optimum sowing dates across different varieties and ENSO phases for common beans in Kenya.**

## Conclusion

Our study suggests maintaining early planting with some window of delayed planting for short-season varieties. Although at the national level, there are not high differences in the average yield due to ENSO, the model results report higher variability under *El Niño*.

## Additional information

The scripts used for simulations and analysis are available on github.
The data used for DSSAT model calibration is publicly available.

## Suggested citation

Chernet M, Moreno P, Mkuhlani S, Chimonyo VGP, Urfels A, Bendito EG, Sila A, llanos L, Degifie T, Seid JA, Waswa B, Abera W, Devare M. 2024. Maize water-limited yields, optimum maize sowing time and variety recommendations summary for Nigeria. CGIAR Excellence in Agronomy (EiA) Initiative. AgWise-Potential Yield. Use Case-Country Reports. 6pp.

## Reference

Alderman, P. D. (2020). A comprehensive R interface for the DSSAT Cropping Systems Model, Computer, Electronics, Agriculture. 172, 105325, https://doi.org/10.1016/j.compag.2020.105325

FAO, 2023. FAOSTAT: Crops and livestock products [WWW Document]. URL https://www.fao.org/faostat/en/#data/QCL (accessed 9.23.24).

Katungi, E., Ojara, M., Ongom, B., Farrow, A., 2020. Bean production in Africa, in: Farrow, A., Muthoni Andriatsitohaina, R. (Eds.), Atlas of Common Bean Production in Africa. Pan-Africa Bean Research Alliance (PABRA); International Center for Tropical Agriculture (CIAT), Nairobi, Kenya.

**NB: i-The outputs are constantly under revision**
**ii-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.**