Water Limited Yields & Optimum Cassava Sowing Time & Variety Recommendation Summary for Rwanda

Background

After bananas and sweet potatoes, cassava is Rwanda's third most important crop (Nyirakanani et al., 2021). The average yield of cassava in Rwanda for 2022 was 14.7 t ha^{-1}, occupying the 8th place in productivity in Africa. However, Rwanda is not among the top ten African countries in terms of area cultivated and total production of cassava (FAO, 2023). This activity aims to identify the attainable cassava yield in Rwanda under water-limited conditions using different growing season types (based on ENSO) and crop durations. The results of this study are an initial attempt to evaluate the potential productivity of cassava in Rwanda. Further research could be necessary to include additional abiotic and biotic growing restrictions.

Methodology

The CGIAR-Excellence in Agronomy (EiA) Initiative determined the optimum sowing dates and variety for Rwanda using the AgWise Water Limited Yield crop modeling platform. The AgWise modeling framework comprises 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 and soil 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 are based on 22-year historical data from 2000 for 3 generic (short, medium, and long) growing durations over 16 weekly sowing dates. The simulation outputs were aggregated across different sowing dates, varieties, and ENSO phases. The date with the highest median yield was the optimum sowing date. In terms of season types, we classified all the growing seasons based on the 3 ENSO phases. The ENSO phases were defined based on the historical values of the Oceanic Niño Index (ONI), where an ONI value of greater and less than 0.5 for a minimum of 5 consecutive overlapping periods signifies an *El Nino* and *La Nina*, respectively. ONI value between -0.5 and 0.5, signifies it is a *neutral* ENSO.

Results

The analytics aggregated all the cassava yield across different sowing dates, varieties, and ENSO phases. There is no clear pattern of cassava's optimum sowing date based on the final yield. *Neutral* ENSO seasons provided better-growing conditions for cassava, with higher yields for all crop durations. Under long (18 months) and medium (12 months) crop durations, lower yields were registered when the growing season was part of *El Niño*. Longer crop durations promoted higher yields for all the years analyzed; however, there was higher variability across the years in the long growing duration. This variability in yield for the long crop duration also increased when the growing season was in *El Niño* and *La Niña* phases. Late planting dates reduced the cassava yield when having a short duration (10 months) specially under *El Niño* and *La Niña* (Figures 1 and 2).

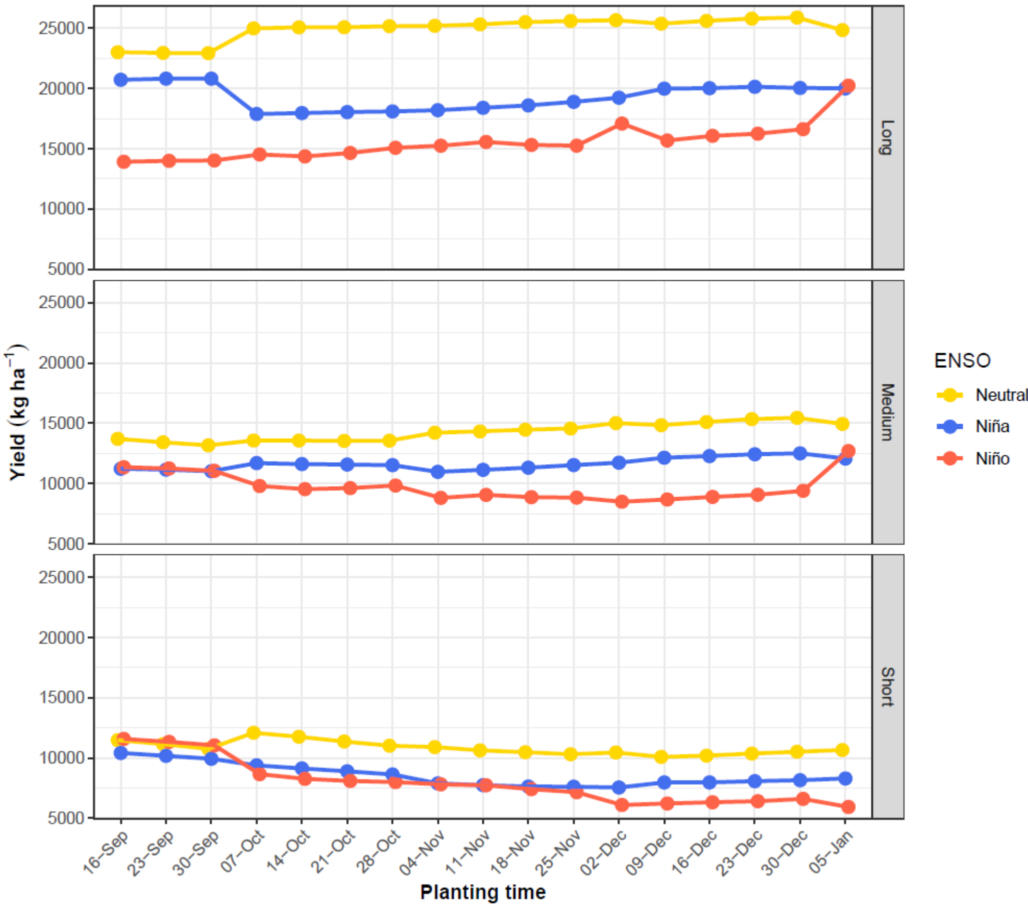

Figure 1: Cassava yield response to varying planting dates across different growing durations and ENSO phases in Rwanda.

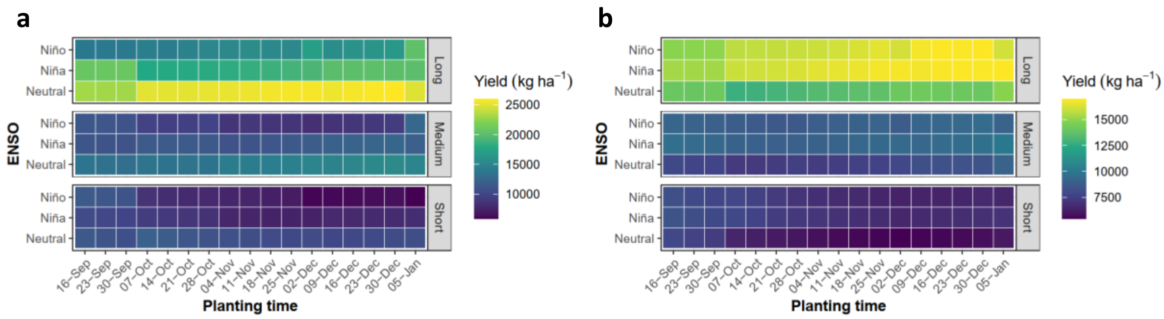

Figure 2: Cassava storage root yield (a)-average, (b)- standard deviation, across different planting dates, crop duration, and ENSO phases for Rwanda.

When analyzed spatially, there was no significant difference in the average yield of cassava among ENSO phases for each crop duration. The crop registered the lowest yields in the high-altitude areas of the Northern, Western, and Southern of Rwanda, where cassava is unsuitable due to the low temperatures (Figure 3). The standard deviation map of yield across crop durations and ENSO phases confirms the higher yield variability when cassava is kept in the field for up to 18 months. Opposite to expected, the variability is even higher when the growing season is considered neutral for ENSO under those long growing periods. The short crop duration had slightly higher variability in yield with El Niño while the medium crop duration did not show a clear pattern (Figure 4).

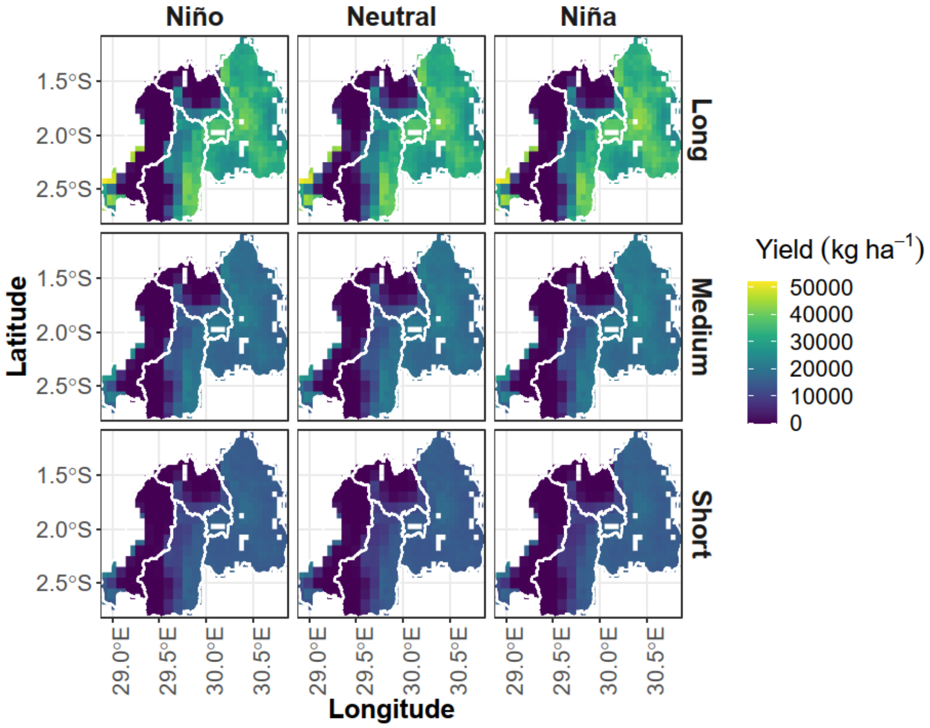

Figure 3: Mean storage root yield distribution across different crop durations and ENSO phases for cassava in Rwanda.

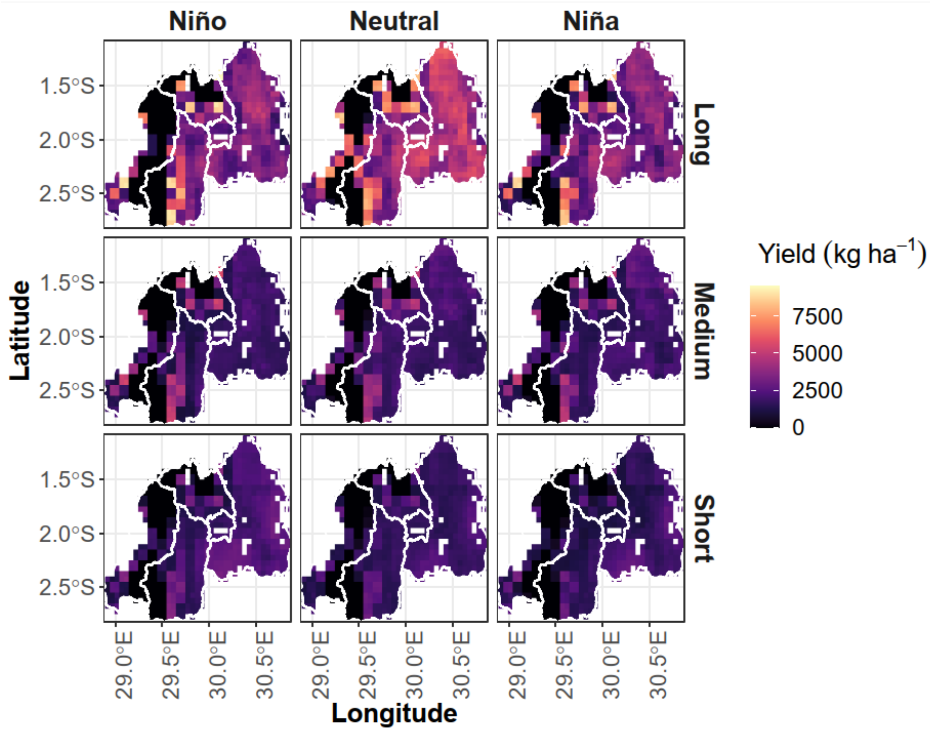

Figure 4: Cassava storage root yield standard deviation across different crop durations and ENSO phases for Rwanda.

Although the time series (Figure 1) did not elucidate a clear optimum planting date, we found different patterns when analyzed spatially. For most of the growing areas, excluding the regions with a high elevation and low suitability of cassava, early planting around mid-September is recommended for a short crop duration. The other crop durations suggested a different planting time which also varied based on the ENSO season. Therefore, under neutral and La Niña conditions with a medium crop duration, most areas found an optimum late planting around the end of December and the beginning of January. However, under *El Niño* conditions, the medium crop duration had better yield with intermediate plantings around October and November in the Southern and Kigali provinces. Finally, the long crop duration had diverse responses of optimum planting per ENSO season and location. Under *El Niño* conditions, Eastern, Kigali, and Southern got higher yields with plantings in early December, while under neutral conditions, the planting is suggested to be in late December or the beginning of January (Figure 5).

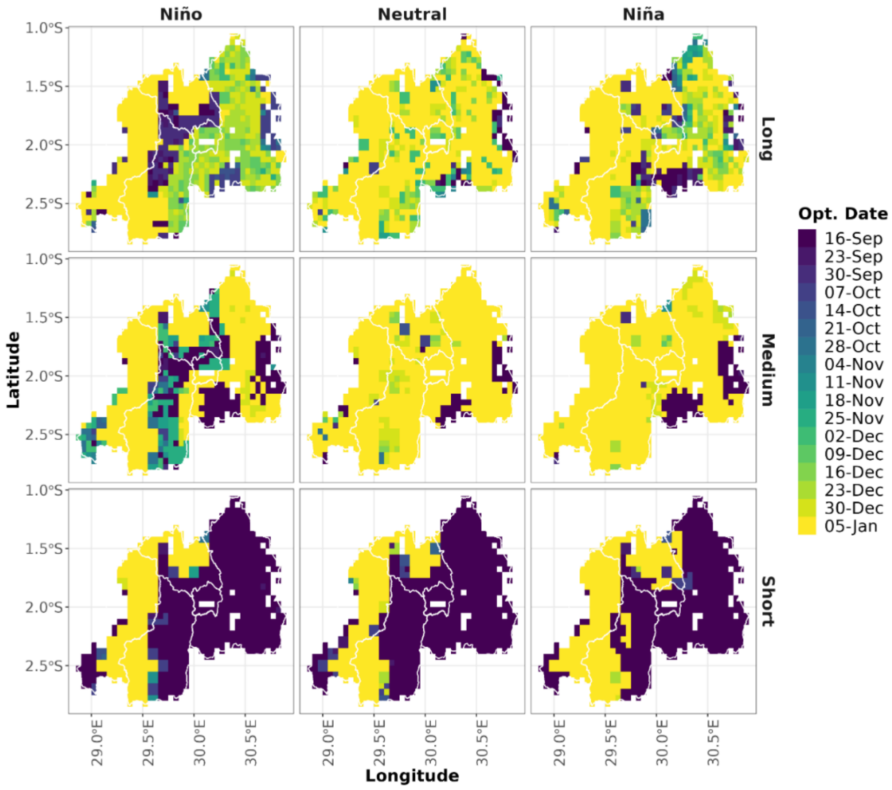

Figure 5: Optimum planting dates for cassava across different crop durations and ENSO phases in Rwanda.

Conclusion

Long crop duration in cassava produces a higher yield in Rwanda. However, it is important to do further research on the higher variability of this yield across the years and the feasibility of having cassava for 18 months in different regions, including possible pests and diseases.

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

Mkuhlani S, Moreno P, Chernet M, Chimonyo VGP, Urfels A, Bendito EG, Sila A, llanos L, Degifie T, Seid JA, Mudereri 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. 5pp.

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

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