

Optimizing planting date and N:K ratios in agricultural fertilizers S2S predictions

Optimal planting date and N:K ratios

Farmers face critical decisions during the growing season regarding planting date, irrigation amount and timing, fertilizer amount and timing, fertilizer N:P:K ratios and harvesting date. Here, we aim to assess the use of S2S forecasts to determine planting date and N:K ratio for Sorghum in Niger.

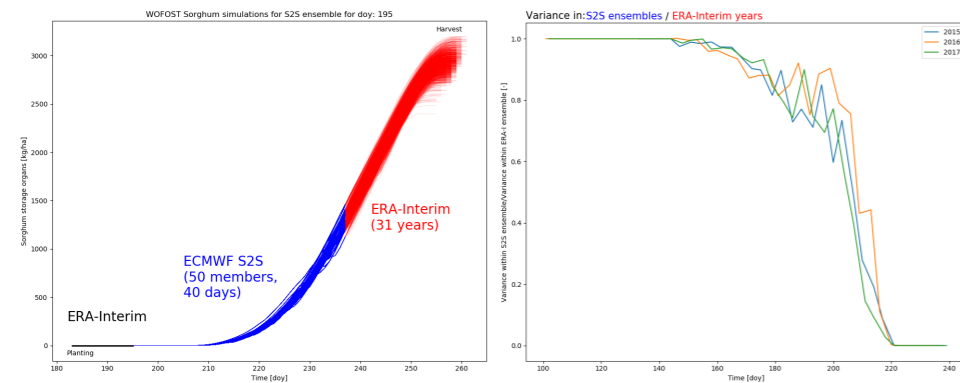


Figure 1: Left, Sorghum biomass as simulated by WOFOST. Right, Variability of the S2S ensemble divided by the variability of the ERA-Interim ensemble.

Approach: WOFOST crop model

- Use new version of WOFOST with NPK-fertilizer input
- Force WOFOST with daily input of q , T_{min} , T_{max} , wind, SW_{down} , P .
- Use ERA-Interim to current day
- Use ECMWF S2S forecast ensemble members for day to day+40
- Use ERA-Interim (31 years) as ensemble members for day+41 to year end
- Optimize for planting date
- Apply 150 kg/ha of fertilizer, 5 days after planting
- Optimize for N:K ratio in fertilizer
- Do this for the time of year when crop yield is sensitive to the 40 day S2S forcing (see Figure 1, right) for 2015-2017.

Sensitivity to Planting date and Fertilizer N:K

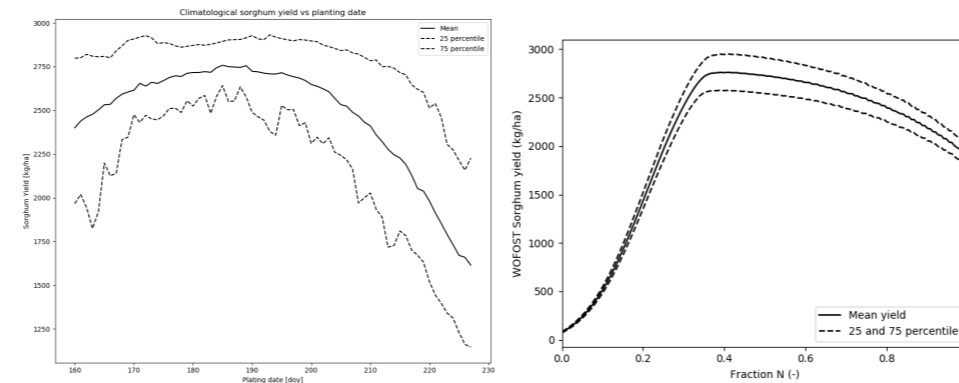


Figure 2: Climatological sorghum yield for different planting dates (left, using climatological optimal N:K ratio) and N:K ratios (right, using climatological optimal planting date). For Niger (13N, 3E) and ERA-Interim climatology.

- Using the climatology, sorghum yield is sensitive to both planting date and fertilizer N:K ratio
- There is a planting date window of about 20 days with optimal yields
- There is a N:K ratio window from a N-fraction of 0.35 to 0.55 with optimal yields

Possible farming strategies

1. **Static strategy:** Use the climatological optimal planting date and fertilizer ratio.
2. **Climatology strategy:** Perform WOFOST simulations to test for the optimal planting date and N:K ratios. Use ERA-Interim for the current year to date and an ensemble of 31 ERA-Interim members from the current day to the end of year. Wait with planting if the expected crop yield for planting at a future date is higher.
3. **Seasonal strategy:** Same as strategy 2, except with WOFOST simulations with the S2S setup in Figure 1, left.

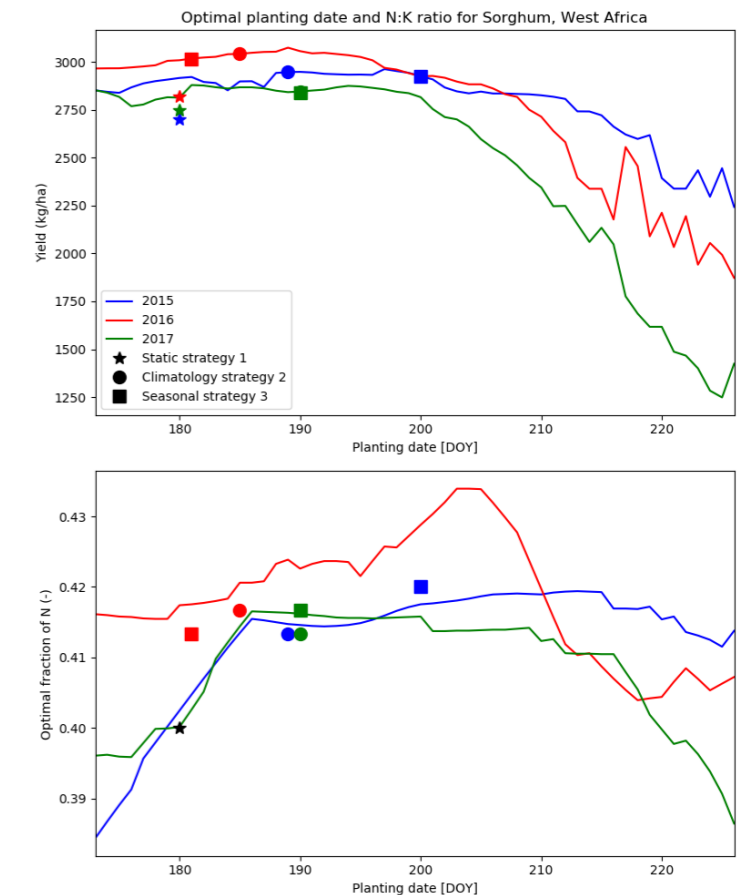


Figure 3: Yield for different planting dates for Niger, for 2015-2017 (top panel). Optimal N:K ratio per planting date for 2015-2017 (bottom panel). Symbols show the planting date and N:K ratios for the three strategies.

Conclusions and Outlook

- Both strategies with a variable planting date and N:K ratios have a 10% higher crop yield than the static strategy.
- The yields for the climatological ensemble strategy is about 1% higher than that of the seasonal ensemble strategy.
- For lower amounts of fertilizer, the seasonal ensemble strategy outperforms the climatological slightly.
- We would like to extend this analysis to other regions and crops. Please contact me for suggestions.