Comparative Study to Improve Smallholder Peanut Yield in Senegal (Sentinel and DSSAT)

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Introduction

- Crop yields are essential for sustainable agricultural development. Peanut crop in particular is rich in oil and protein and has a high-energy value.
- Senegal is counted as one of the main producers of peanut in Africa with around 40% of peanut of its cultivated land. However, provide optimum peanut yield forecasts involve considerable difficulties.
- Remotely sensed observations may serve as solutions to ensure performance of crop growth models, for instance, maximum vegetation can be used in determining the sowing date.
- The Decision Support System for Agro-technology Transfer (DSSAT) crop growth model allows simulations of crops by taking agronomic, soil and climatic factors in consideration.

Objectives

In this study, several questions were asked, and they lead to the following objectives:

- Which one of DSSAT and Satellite data is a good predictor?
- Which cultivars are most important in increasing the peanut yield?
- Can senescence be used in determining the harvest date?
- Can greenup be used in determining the period of sowing?

Materials and Methods

In this study, the results of JotBi, DSSAT and satellite data are compared.

1. JotBi is the database that contains the agricultural data collected from farmers. The interest of this study focuses on peanut data collected in JotBi from Senegal in 2019. Data merging, translation, and outliers removal processes were applied before analysis. After merging the files 150 plots (fields) were derived.

The data in JotBi is collected from farmers in several villages, which belongs to different communes. Figure [1] shows villages locations.

Figure [1] Villages under study in Senegal.

Materials and Methods

Analyzing JotBi data shows some insights about peanut farming in Senegal. For example, the harvested amount of peanut with respect to the villages refer to Figure [2].

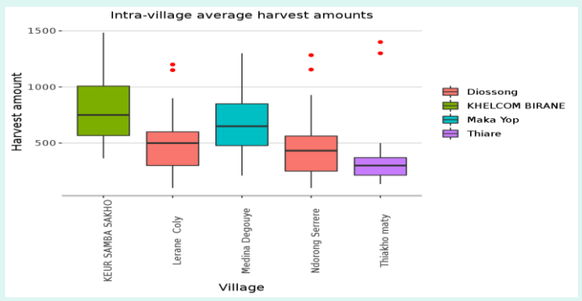

Figure [2] Harvested amount in the 150 plots.

Figure [2] demonstrates that Keur Samba Sakho commune has the highest harvested amount compared to the rest.

Within six different cultivar used, where two are Spanish, the Fleur 11 and 55-437 and the remaining four are of type of Virginia. The four Virginia cultivars are PC 79-79, 73-33, GH 119-20 and H 75-0. The analysis shows that more than a half of the farmers use the Virginia cultivar 73-33 as shown in Figure [3].

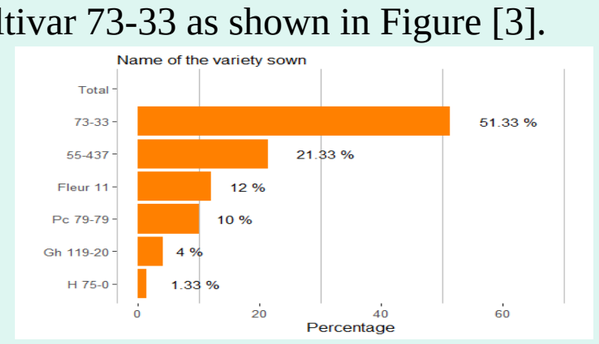

Figure [3] Variety of cultivar sown

2. **DSSAT** is the software used in simulating agricultural crop growth, which takes soil, weather, and management factors as inputs. The weather files, and soil profiles are obtained from NASA Power and ISRIC grid, respectively.

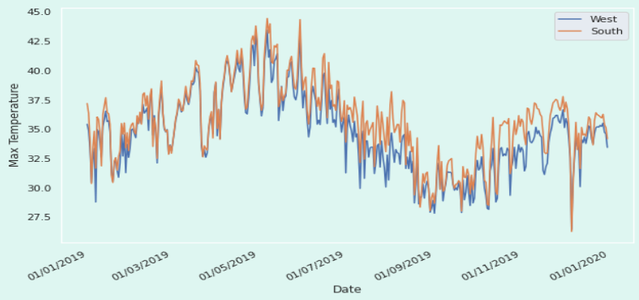

Figure [4] Max temperature for two fields in Senegal.

Figure [4] shows the maximum temperature of two fields of two villages in the Western and Southern regions, the difference in the temperature varies between 0.5 to 3 degrees.

The results of JotBi agronomic analysis are used to obtain the management practices, for example, fertilizers , sowing and harvesting dates.

3. **Satellite data** files contain details about variables as maximum Normalized Difference Vegetation Index (NDVI) (see Figure [5]), greenup, maximum vegetation and senescence. In this experiment, the correlation between the previous variables and yield, PWAM, amount of fertilizer, and sowing date are derived.

Materials and Methods

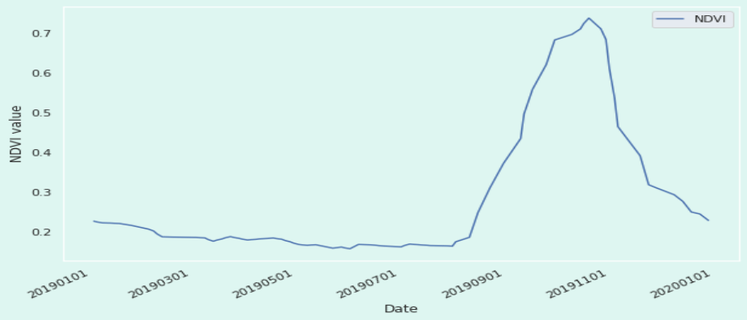

Figure [5] NDVI values at one of the plots in Senegal.

Among the 150 plots, only 70 plots were found to have values from the satellite images. These plots were then used in the comparison between the satellite data and DSSAT simulation results.

Results and Discussion

DSSAT shows better simulation of Leaf Area Index (LAI) and grain weight for the Virginia type of cultivar in comparison to the Spanish, simulation results are presented in Figure [6].

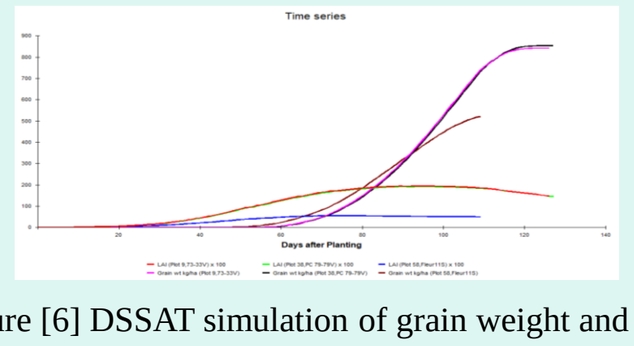

Figure [6] DSSAT simulation of grain weight and LAI.

On the other hand, the max NDVI shows a strong positive correlation with yield by 0.63, which implies that max NDVI can be used to determine the yield Figure [7].

Figure [7] Correlation map of the satellite data.

Other satellite variables were investigated, like greenup, which demonstrates a higher correlation with yield (0.72) Figure [8]. The results presented in this section are only for 37 plots.

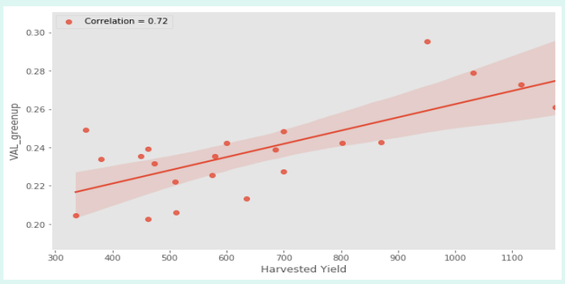

Figure [8] Correlation between NDVI and yield.

Conclusion

More variables like harvest date, fertilizer amount were experimented for up to 70 plots however they demonstrated less correlation. The positive correlation observed between greenup value and yield in Figure [8] leads to the conclusion that this value can actually be used to determine the time of sowing. In the future, this experiment needs to be extended to include a larger number of plots.