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Agro-climatic aptitude for Tanzania guinea grass cultivation in Brazilian semiarid environment

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Introduction

Tanzania guinea grass is a forage plant recognized in Brazil and part of Latin America due to high forage production in intensive production systems (Jank *et al*., 2010). In irrigation conditions, this plant has also shown excellent performance in semiarid areas. In general, this grass develops well in regions with above 700 mm rainfall, medium texture soils and good fertility, and the main limitation for its production in the tropics is the rainfall (Jank *et al*., 2010).

Future scenarios point to temperature increases, directly impacting evapotranspiration, and there are also many uncertainties in relation to precipitation, with studies indicating increasing droughts in semiarid regions and droughts in areas where this is not currently common. Using tools that can predict this grass productivity in drought situation is very useful in the decision-making process and in the search for pasture use more sustainable strategies.

Simulation models use based on biomass production data is a tool that has helped technicians, producers and governments in fast decision-making processes. This study type has evolved along with geographic information systems, enabling geo processing techniques application, allowing crops productive potential areas delimitation in a quick manner and with reliable results. Suitable areas predetermination allows cost, time and risk reduction with Tanzania guinea grass pastures formation. This research was conducted in order to carry out a simulation to determine suitable areas for Tanzania guinea grass cultivation under rainfed conditions, using forage production data in a Brazilian semiarid environment.

Materials and Methods

Tanzania guinea grass estimated productivity was based on the mathematical model proposed by Pezzopane *et al*., (2012), which assumes simple linear regression parameters obtained from 54 growth cycles of this grass, allowing the calculation of dry matter daily accumulation rate (DMDAR day) in function of degree-days (DD) and soil water relative storage (f_{SWRS}), equation 1: (1) DMDAR day (kg DM ha^{-1} day^{-1}) = 10.76 DD f_{SWRS}

DMDAR was initially calculated on a monthly scale to 298 observation posts located in the state of Ceará and surrounding regions, seeking this Brazilian semiarid region spatial analysis. In this study, temperature and rainfall observed and estimated data, considering a historical series of 1961-1990 coming from BHGEO clima tool (Northeastern Brazil Climatological Water Balance Geo referencing), and adapted from (D'Angiolella and Vasconcellos, 2012), as well as observed rainfall data from the Department of Atmospheric Sciences, Federal University of Campina Grande, and maximum and minimum temperatures data of the National Institute of Meteorology (Brazil) were used.

Maximum and minimum temperature monthly values were used in the monthly accumulated degree-days (ADDi) calculation, using equation 2: (2) $ADDi = [(Tmax_i + Tmin_i)/2 - Tb]. MDN$, to $Tmin>Tb$

Where: $Tmax_i$ is the daily maximum air temperature (°C); $Tmin_i$ is the daily minimum air temperature (°C); Tb is base temperature (°C) (equal to 14.3ºC); and MDN is the month days number.

Soil water relative storage (f_{SWRS}) was determined by the ratio between the current soil water storage and the maximum storage, being calculated as the crop dry matter accumulation penalty factor, according to Pezzopane *et al*. (2012), so that their values ranged from 0 to 1. For this, the current soil water storage was estimated by monthly climatic water balance, using the BHGEO clima spreadsheet. In this spreadsheet, the potential evapotranspiration data (PED) were calculated according to Thornthwaite's method (1948), adjusted by Camargo *et al*., (1999) in order to avoid underestimation during the dry season. With PED data, crop evapotranspiration was estimated with the average monthly crop coefficient of 0.6 (Rodrigues *et al.,* 2011).

With DMDAR data, a Guinea grass monthly yield relative frequency occurrence above 2750 kg DM ha^{-1} $month^{-1}$ was obtained, an amount equivalent to 33.000 kg DM ha^{-1} $year^{-1}$ (Jank *et al*., 2010) yield, which is the maximum production obtained in rainfed with the crop, in order to define the culture growing seasons. A 70% occurrence probability of monthly productivity values above 2750 kg DM ha^{-1} $month^{-1}$ was assumed in Ceará main meso-regions agricultural calendar establishment. Tanzania guinea grass annual and monthly dry matter production was mapped to the state through the ArcGIS 9.3 version software, using the Spatial Analyst extension and the Ordinary Kriging method.

Results and Discussion

Tanzania guinea grass production per month is illustrated in Fig. 1. Months where there was higher production were March and April. It is possible to observe, especially during rainy months (January to June), that the productive potential varies depending on the economic mesoregion, which have different climatic conditions, with higher rainfall in the Northwest, North, and Metropolitan regions coastal strip, and also in South Central and Southern regions. From June, part of the "Sertões" and Southern regions, simulated yields were lower than 1250 kg DM, and this pattern is repeated in all the area from August to December, thus with no differences between mesoregions during this period, which is the dry season

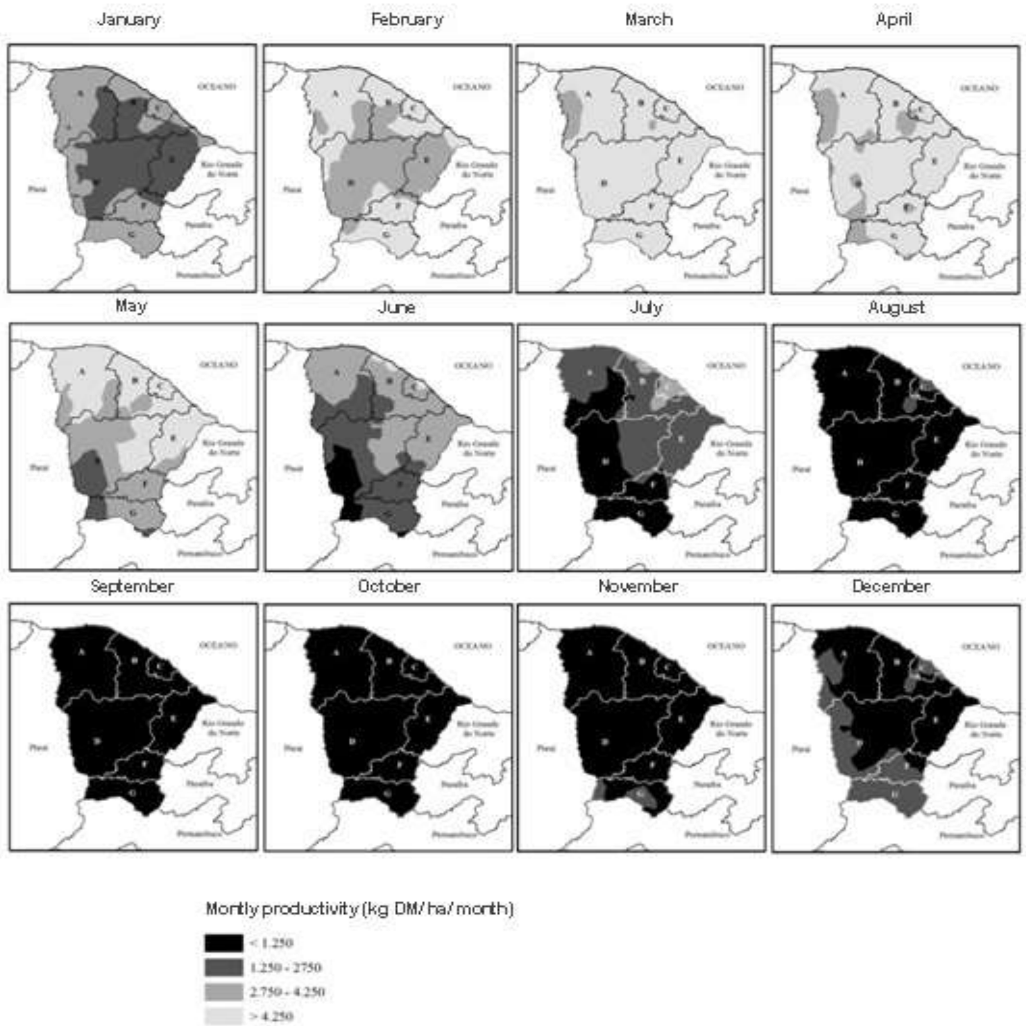

Fig. 1: Tanzania guinea grass monthly productivity (kg DM ha^{-1} $month^{-1}$) in the respective mesoregions of the state of Ceará (A) Northwest; (B) North; (C) Metropolitan; (D) Sertão; (E) Jaguaribe; (F) South-Central and (G) South.

Fig. 2 shows Tanzania guinea grass rainfed cultivation agricultural calendar, in mesoregions representative municipalities of Ceará state which have a weather station. In general, the months from March to May were favorable to graminaceous development. February had relevant production in most mesoregions (Fig. 1).

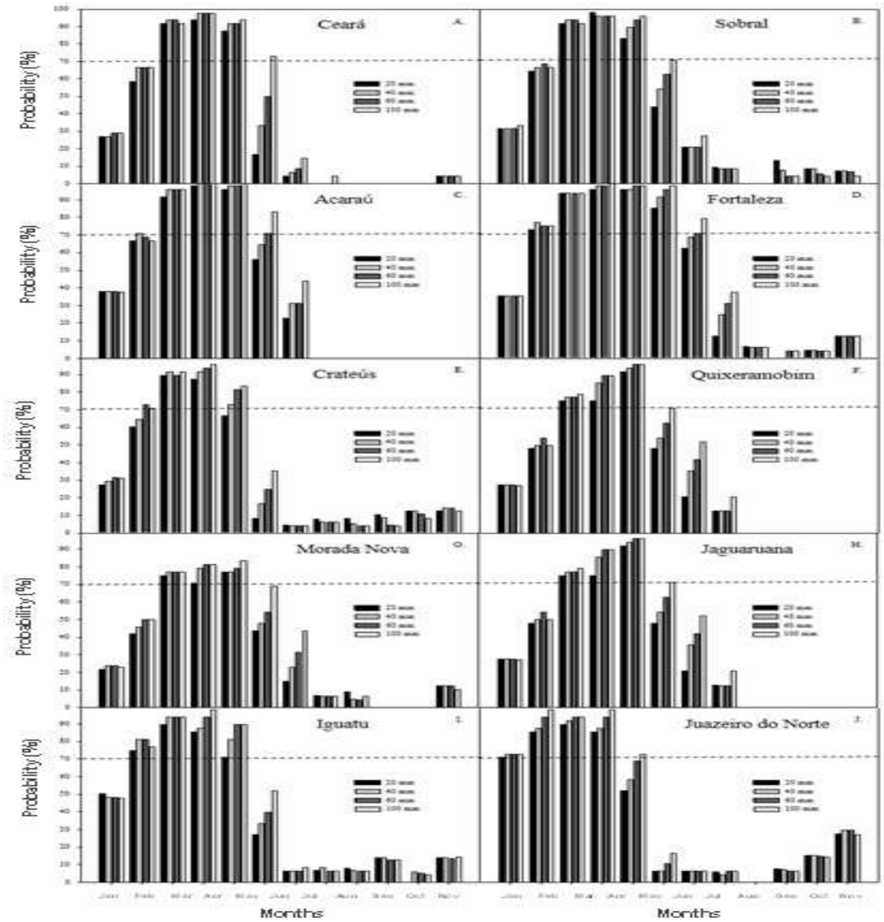

Fig. 2: Tanzania guine grass cultivation agricultural calendar in Ceará based on an at least 70% productivity values occurrence probability above 2.750 kg DM ha^{-1} month^{-1}

Frequency analysis points to Tanzania guinea grass production ability from March to May in the northern mesoregion, represented in Fig. 2, by Sobral and Acaraú municipalities (Fig. 2B and 2C). In the "Sertão" region (Fig. 2E and 2F), represented by Crateús and Quixeramobim, only two months were favorable, but it is possible to see a difference between "Sertões dos Inhamuns" (Crateús) and "Sertão Central" (Quixeramobim) as to the most favorable period, with the first having it earlier (March and April) and the second later (April and May). This difference can be attributed to the regions rainfall regime occurring in different periods. In Jaguaribe, there is production ability in rainfed conditions for three months, being February, March and April in Morada Nova and March, April and May in Jaguaruana. In the South, in Iguatu, city inserted in the center-south mesoregion, it has the potential to produce Tanzania guinea grass (Fig. 2I) pasture in the months from March to May. Similarly, but starting in February, Juazeiro do Norte, southern Ceará, has potential to produce this grass for three months.

These results, it is observed that Tanzania guinea grass cultivation in rainfed becomes a high-risk activity in this Brazilian semiarid region. Rainfall distribution irregularity makes it necessary to look for alternatives, such as irrigation, to enable this grass use, which has high quality and biomass production.

Conclusion

The semiarid region studied in this paper has aptitude for Tanzania guinea grass in rainfed conditions production during only four months, predominantly from March to May. Weather conditions do not favor this grass growth in the remaining months

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