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PROBABILIDADE DE SAFRA AGRÍCOLA DE SEQUEIRO NA BACIA DO BAIXO JAGUARIBE

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RESUMO: A dependência exclusiva da chuva para suprir as necessidades hídricas das culturas é um risco permanente no Estado do Ceará, perdas de safra causadas pela “seca” na estação chuvosa são constantes e em anos atípicos as perdas são ocasionadas por “enchentes”. A presente pesquisa foi conduzida, na primeira etapa, via internet onde foram digitados os registros mensais de precipitação de todos os nove municípios sedes da Bacia Hidrográfica do Baixo Jaguaribe, pertencente ao Estado do Ceará no período de 1974 a 2012, em planilhas do Excel, sendo estes dados fornecidos pelos Postos Pluviométricos da Fundação Cearense de Meteorologia – FUNCEME. Na segunda etapa, após a digitação dos dados, foi calculado a Média Aritmética Simples dos registros mensais entre os municípios sedes integrantes da bacia, para cada ano observado, com isso, foram determinadas as Normais Pluviométricas mensais, a Normal Pluviométrica anual, o histórico anual de precipitações, as probabilidades de safra na agricultura de sequeiro para as culturas de feijão e milho e as probabilidades de perda de safra por falta ou excesso de chuva.

Palavras-chave: riscos, agricultura, estiagem, chuva.

LIKELIHOOD OF UPLAND CROPS AGRICULTURAL IN BAIXO JAGUARIBE BASIN

ABSTRACT: Sole reliance on rain to meet crop water requirements is an ongoing risk in the state of Ceará; crop losses caused by "dry" in the wet season are constant, and atypical year losses are caused by "floods". This research was conducted in the first stage, which included the internet monthly rainfall records from all nine-county headquarters in the Baixo Jaguaribe Basin, belonging to the state of Ceará in the period 1974--2012, in Excel spreadsheets, and these data were provided by the rain gauges of the Ceará Foundation for Meteorology - FUNCEME. In the second step, after the data were entered via simple arithmetic means of monthly records between municipality headquarters member basins for each observed year, normal monthly rainfall, normal annual rainfall, annual history of precipitation, probability of harvest in rainfed agriculture for crops of beans and corn and likelihood of crop loss due to a lack or excess of rain were established.

Keywords: risks, agriculture, drought, rain.

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1 INTRODUCTION

In pluviometry, rainfall is characterized by four quantities: rainfall height or sheet, duration or time, average intensity and temporal distribution. However, in this work, we analyze only the slide, as FUNCEME stations use rain gauges, where there is no record of time intervals of less than 24 hours, as in the case of rain gauges.

Owing to its location in the extreme east of tropical South America, Northeast Brazil, NEB, is subject to the influence of meteorological phenomena, which give it peculiar climatic characteristics unique to semiarid regions around the world. Nobre and Molion (1987) suggested that the semiaridity of NEB is due to its proximity to the Amazon Region, where broad and intense convective movements occur. The rising air over the Amazon acquires anticyclonic movement at high levels (Bolivian High), diverges, and part of it moves eastward, creating a descending branch and a strong psychrothermal inversion (Molion; Bernardo, 2002).

According to data from EMATERCE (2011), eight grain crops were planted in the State of Ceará in 2011: cotton, peanuts, rice, beans, sunflower, castor beans, corn and sorghum. However, the sum of bean and corn crops alone was 93.92%, 93.64% and 92.79%, respectively, in relation to the size of the planted area, grain production and harvest value (production × price) of the state.

The water consumption of beans can vary from 250 to 400 mm/cycle, and the water consumption of corn can vary from 400 to 700 mm/cycle, depending on three factors: the cultivar, the soil and the local climatic conditions (Doorenbos; Pruitt, 1997).

Sprinkler irrigation is an irrigation method in which water is sprayed onto the surface of the land, resembling rain, due to the division of the water jet into drops. The water jet and its division are obtained by passing water under pressure through small holes or nozzles (Bernardo, 1982).

For Frizzone *et al.* (2011), irrigation efficiency (corresponding to the fraction of the volume of water effectively used by crops in relation to the total captured at the supply source), in the case of sprinkling, can reach 80%.

This work had the general objectives of determining the monthly rainfall normally, the annual rainfall normal and the annual rainfall history, and, as specific objectives, the harvest probabilities in dryland agriculture for bean and corn crops and the probabilities of crop loss due to a lack or excess of rain in the lower Jaguaribe Basin.

2 MATERIALS AND METHODS

To carry out the research, rainfall data from the monthly precipitation records of the nine municipalities of the State of Ceará, which make up the headquarters of municipalities present in the lower Jaguaribe Basin from 1974--2012, were used; these data were tabulated in Excel spreadsheets, with these data being provided by the Rainfall Stations of the Ceará Meteorology Foundation - FUNCEME (FUNCEME, 2013).

After the rainfall data were entered, the rainfall norms were determined by the monthly and annual averages of the nine municipalities (Aracati, Fortim, Icapuí, Itaiçaba, Jaguaruana, Limoeiro do Norte, Palhano, Quixeré and Russas) for each year. The rainy season was characterized by the sequence of the four months with the highest average rainfall.

The range considered in the study to determine an indicative harvest range was between 250 and 700 mm of ETc, with below 250 mm of ETc characterizing loss due to a lack of rain and above 700 mm of ETc characterizing loss due to excess rain.

Rainfall, such as that released by sprinklers, is not fully utilized by plant roots. In the case of “rain”, in addition to losses due to evaporation, wind dragging drops and deep percolation, there are also losses due to surface runoff.

Therefore, it was necessary to apply an adjustment coefficient, which quantifies the

water level applied to the crop on the basis of the water level naturally precipitated through rain. This coefficient was 0.7; that is, the efficiency of rain application to the plant was considered 70%. Correcting the ETc values, we obtain the following ranges:

- h_{ec} <357.14 mm (250 mm/0.7) →crop loss due to lack of rain,
- 357.14 mm ≤h_{ec} <571.43 mm (400 mm/0.7) →bean crop,
- 571.43 mm ≤h ≤1000 mm (700 mm/0.7) →corn crop,
- h_{ec} >1000 mm →crop loss due to excess rain.

where $h_{and\ c}$ are the rainfall heights in the rainy season.

The observed data of $h_{and\ c}$ were statistically analyzed, and then the theoretical probabilities of occurrence were evaluated. They were ordered in descending order, and each one was assigned its order number *m* (*m* ranging from 1 to *n*, where *n* = number of years of observation).

The *probability (P*) with which an event of order *m was equaled or exceeded* was determined via the Kimbal method (equation (1)).

$$P = m/(n + 1) \quad (01)$$

3 RESULTS AND DISCUSSION

The monthly rainfall norms for the Lower Jaguaribe Basin are presented for the first half of the year in Table 1 and for the second half of the year in Table 2.

Table 1. Normal rainfall (mm) in the lower Jaguaribe Basin for the 1st half of the year.

January	February	March	April	May	June
87.7	125.2	201.4	186.3	111.6	47.8

Table 2. Normal rainfall (mm) in the lower Jaguaribe Basin for the 2nd half of the year.

July	August	September	October	November	December
23.6	4.5	2.5	3.0	2.2	15.7

The annual rainfall norm is the sum of the monthly rainfall norms, which, in the specific case of the lower Jaguaribe Basin, has a value of 811.4 mm.

The rainy season in this basin is concentrated from February to May and has an average value of 624.4 mm .

On the basis of the annual rainfall values from 1974--2012, a comparison was made with the annual rainfall norm to facilitate visualization of the years in which rainfall fell below or above the historical average (Figure 1).

Figure 1. Annual rainfall in the lower Jaguaribe Basin from 1974--2012 compared with normal rainfall.

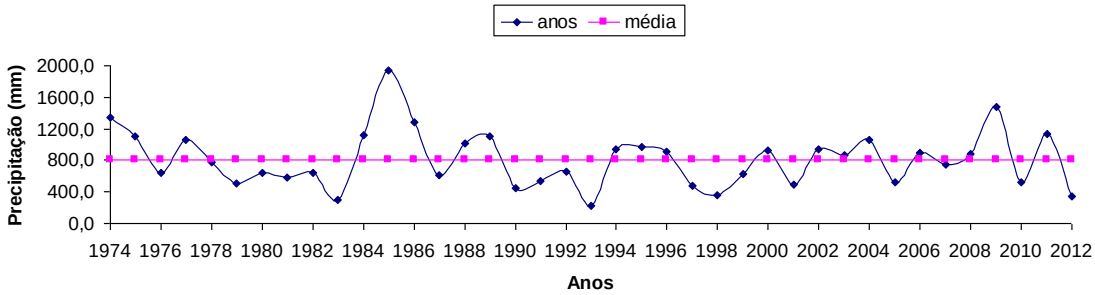
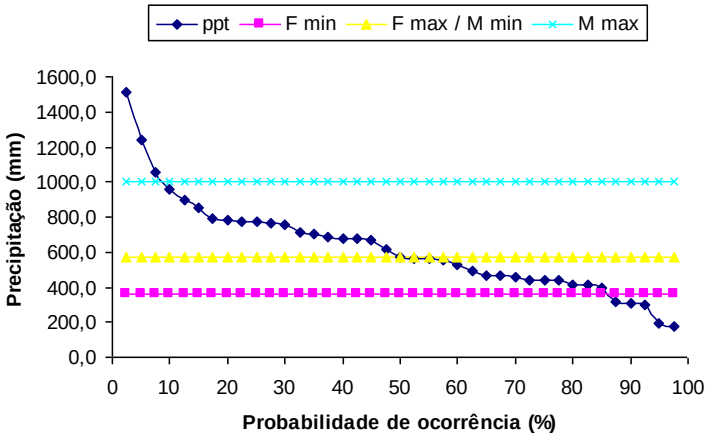


Figure 2 shows the probabilities of precipitation occurrence (in dark blue), the upper precipitation limit for the corn crop (in light blue), the lower precipitation limit for the corn crop and the upper precipitation limit for the bean crop (in yellow) and the lower precipitation limit for the bean crop (in pink).

Figure 2. Permanence curve in the lower Jaguaribe Basin.



Four distinct bands can be identified: above the light blue line, crop loss due to excess rain; between the light blue and yellow lines, corn crop; between the yellow and pink lines, bean crop; and below the pink line, crop loss due to a lack of rain.

To identify the precipitation values of interest and probability of occurrence, linear interpolation was performed on the data obtained through equation (1). The probabilities were 86.13%, 51.06% and 8.84% for the corresponding precipitation amounts of 357.14 mm, 571.43 mm and 1,000 mm, respectively. Thus, we have the following probabilities:

- Crop loss due to lack of rain = 100.0% - 86.13% = 13.87%
- Bean harvest = 86.13% - 51.06% = 35.06%
- Corn harvest = 51.06% - 8.84% = 42.23%
- Crop loss due to excess rain = 8.84%
- Crop loss due to a lack or excess of rain = 13.87% + 8.84% = 22.71%

4 CONCLUSIONS

The probability of a corn crop occurring was greater than the probabilities of a bean crop occurring and crop losses. However, the risk of corn crop loss was 57.77%, a value considered high, which makes dryland agriculture a risky activity in the lower Jaguaribe Basin.

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