Applying a methodology of production potential based on the type of soil and climate: Mozambique

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Abstract

The diversity of soil and climatic types existing in Mozambique involves a wide range of potential and land use limitations. The methodology used is based in Brazilian soil taxonomic system of classification and comparison between soil type and sugarcane productivity with a method developed by CTC – Sugarcane Technology Center where soil classes were subdivided into different types according to its characteristics, concepts and taxonomic criteria used in classification and based on commercial productivity of its databank with more than a hundred mills. Then, Brazilian System of Soil Classification were correlated with the |International Soil Classification System WRB-FAO. For climate characteristics, Köppen classification adapted was used. It consists in main types, which are represented by the letters A, B, C, D and E. These climatic types are defined criteria for temperature and rainfall. The objective was to draw up a map of potential production of sugarcane in Mozambique, using as basic information: soil, climate and areas with environmental restrictions. It was found that the regions with high and medium potential were the provinces located in the northern and central Mozambique, even using irrigation, due to the soil potential of these regions.

Keywords: sugarcane, potential area, hidric deficit, precipitation.

1. Introduction

Mozambique is located on the east coast of southern Africa, with 799,380 square kilometers of extension, between parallels 10º27 'and 26º56' S and 30º12 'and 40º51' E. It has an estimated population of 21.4 million inhabitants, of which 70% live in rural areas, mainly dedicated to family subsistence farming. Approximately 68% of the national territory is covered by tropical savannahs, known like the Brazilian cerrado.

In order to verify the physical availability of area for the cultivation of sugarcane, slope percentage, soil and climate characteristics and environmental restrictions where considered. Soil classification work was performed according to their productive potential, based on the work of the Technology Center sugarcane (CTC), which correlate production potential with the soil classification [1][2][3] as so as climate potential, using Köppen climate classification System.

2. Experimental Apparatus

The basic information used for the development of the potential for expansion of sugarcane in the country to map were obtained from the basic maps of soils (Paralelos Project - Embrapa), climate (INAM - National Institute of Meteorology of Mozambique), areas of environmental constraints (Agroecologic Zoning of Mozambique, 2008). The soil maps, climate and vegetation were scanned into the Geographic Information System (GIS) ArcGIS.

Soil classes are divided into different types according to the characteristics of each soil, separating them into more homogeneous units. Definitions, concepts and taxonomic criteria used in classification and differentiation of various types of soils are in the Brazilian System of Soil Classification [4], which were correlated with the international system WRB-FAO (World Reference Base for Soil Resources - Food and Agriculture Organization) [5]. The soil map consists of approximately 2,500 polygons, each with information as described in Table 1.

Table 1 – Example of obtained soil information

Carachterisitc	**Description**
Soil group	Coarse texture alluvial soils
Mains characteristics	Sandy loam, greyish brown, deep
Geology and geomorpology	Holocenic alluvial sediments
Type or terrain	Valleys and plains
Slope	0-1%
Texture	Sandy – sandy loam
Drainage	Bad to imperfect
Deepness	> 100 cm
Acidity/ alkalinity	Between pH 6,0 and 7,5
Organic matter	0,5 – 3,5 %
Presence of salts	Not salty
Presence of sodium	No sodic
WRB international classification	Eutric fluvisol
USDA classification (Soil Taxonomy)	Mollic Ustifluvent
Vegetation	Forest
Main limitations	Drainage, sometimes sodium excess

Regarding the climate, we used climate classification adapted of Köppen. This classification is based on the subdivision of the terrestrial climate within five main types, which are represented by the letters A, B, C, D and E. These climatic types are defined criteria for temperature and rainfall. According to the weather map obtained in INAM, the country has seven climatic types (Table 2).

Table 2 – Köppen climatic types of Mozambique (Source:INAM)

Symbol	Climate	Characteristics
Am	Tropical wet climate	Mean temperature above 18ºC in every month of the year. The driest month sees less than 60 mm of precipitation. Annual precipitation is higher than the annual potential evapotranspiration.
Aw	Tropical savanna climate	Monthly mean temperatures above 18 °C in every month of the year with the hottest month with mean temperature above 22ºC and typically a pronounced dry season. Driest month having precipitation less than 60 mm.
BWh	Desert climate	High temperatures, with monthly mean temperatures above 18 °C. Arid climate with less than 250 mm of annual precipitation, which is lower than annual potential evapotranspiration.
BSh	Hot semi-arid climate	High temperatures, with monthly mean temperatures above 18 °C. Semi-arid climate with less than 760 mm of annual precipitation, which is lower than annual potential evapotranspiration.
Cfa	Humid subtopical climate with hot summers	Moderate temperatures with well distributed rainfall and hot summer. Winter with monthly mean temperatures below 18 °C. In warmers months the peak temperatures are greater than 22ºC. Precipitation of the driest month is greater than 30mm.
Cwa	Humid subtopical climate with hot summers and dry winters	Moderate temperatures with dry winter, with monthly precipitation less than 30 mm and rainy and hot summer. Mean temperature of the warmest month above 22ºC.
Cwb	Subtropical with temperate summer	Mild and rainy summer with moderate temperature. Mean temperature in winter and autumn less than 18ºC and the hottest month with less 22ºC. Precipitation of the driest month less than 30mm.

Description of map overlay steps

Environmental and slope constraints where first considered, eliminating areas with environmental restrictions and those with slope with more than 12%. Then, potential of soil and climate where classified. The potential production was classified according to soil classes previously defined by CTC method and divided in 5 types – high, medium, low, restrict and unappropriate. The classification of the climate was made using two potential classes (appropriated and unappropriated). For the climatic classification, was considered rain-fed crop with possibility of saving irrigation – a type of irrigation that uses mobile irrigation systems and aims to not allow that the sugarcane crops dies, applying 60-120 mm of water, and full irrigation (Figure 1).

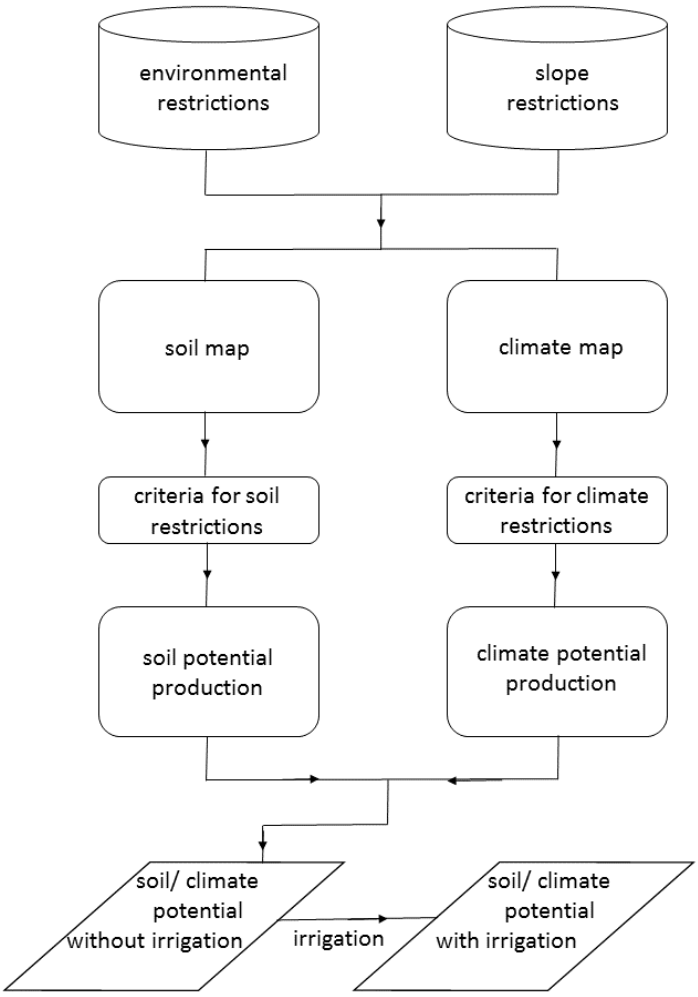

Figure 1 – Steps of map overlay

3. Results and discussion

Considering rain-fed crop, using salvation irrigation if it is necessary, Mozambique has an area of about 45 million hectares suitable for sugarcane crops. Of this area, 2.5 million ha are considered high potential, 28.1 million ha medium potential and 14.3 million ha has low potential. If the full irrigation is considered, the country has 56.5 million hectares for cultivation, with 2.7 million ha considered high potential, 30.4 million ha with a medium potential and 23.3 million ha low potential (Table 3).

Table 3 – Potential production of sugarcane in Mozambique

Potencial Production	with irrigation (ha)	without irrigation (ha)
High	2.515.858	2.767.551
Medium	28.123.241	30.457.294
Low	14.343.769	23.265.037
Unappropriated	35.176.154	23.669.140
Total	80.159.022	80.159.022

The largest areas of high potential of Mozambique are located in the provinces of Cabo Delgado and Zambezia (Figure 2). Since the medium potential, apart from these two provinces, large areas have been identified in Tete, Niassa, Nampula and to a lesser extent in Manica. Then we can say that the larger areas with the possibility of implementation of the sugar cane are in the north central part of the country. The provinces of Gaza and Inhambane have large areas unappropriated for cultivation, mainly due to the climate, but as the province of Maputo and Sofala, even eliminating the climate factor, they have predominant soils with low potential production for sugarcane.

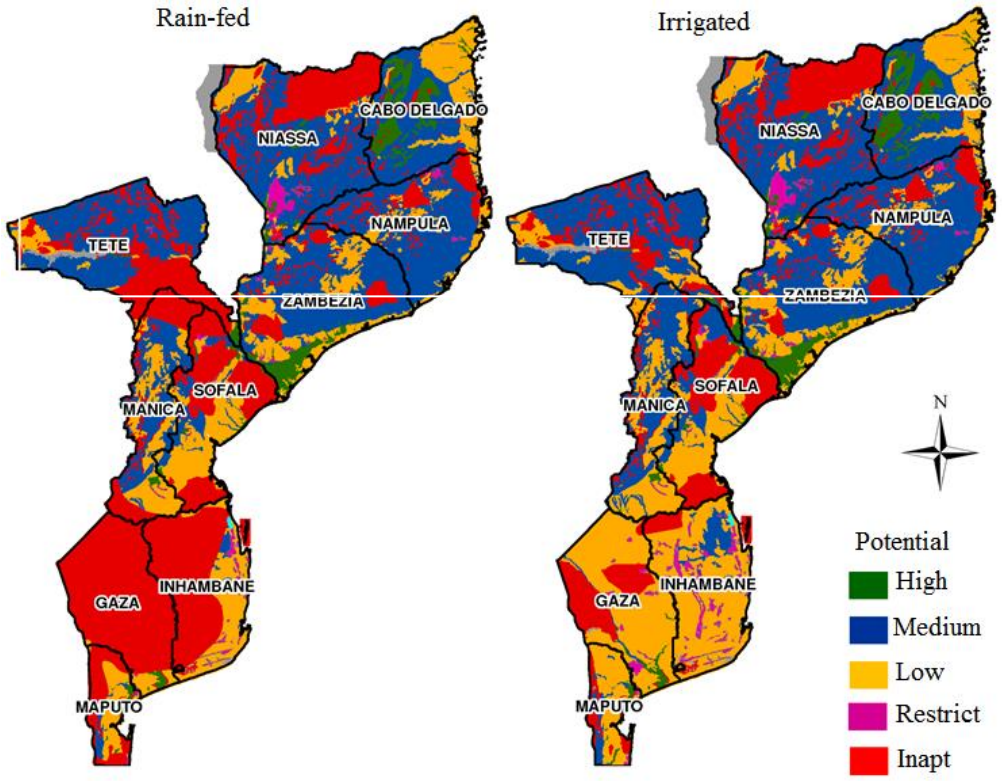

Figure 2 – Potential production of sugarcane (rainfed and fully irrigated)

Is worth emphasizing that this study seeks only to find physical restrictions, incorporating this restriction with those relating to environmental conservation already defined by the government of Mozambique. Other areas of constraints, such as DUATs (Right of Use of Land) granted for other uses, minerals and forest concessions and other possible restrictions were not considered.

4. Conclusions

a) There is great production potential for sugarcane, mainly in the provinces located in the north and central region of the country, even excluding the environmental criteria;
b) If we consider the possibility of irrigation, yet the north-central region it is the one with the largest extension in areas with medium and high potential production.

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