MAPPING AND CHARACTERIZATION OF CUPUAÇU OCCURRENCE AREAS IN COMMUNITIES OF FAMILIAR FARMERS IN THE MUNICIPALITY OF ANAJATUBA, MARANHÃO STATE, BRAZIL

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ABSTRACT – The municipality of Anajatuba, in the Baixada Maranhense, stands out for the tradition in the cultivation of cupuaçu and for the great potential of economic and sustainable exploitation of native tropical fruit trees. Thus, the mapping and characterization of the production areas was carried out. The objective of this work was mapping the areas of cupuaçu crop aiming to identify areas of familiar farmers with potential for participatory evaluation of BRS Carimbó cultivar. It was observed that the cupuaçu crops are located in areas generally covered by "Plintossolos" with flat slope to gently undulating land. The methodology developed will allow the same procedure to be performed in regions with the same environmental characteristics of the studied area.
Key words: Amazon, Mapping, Cupuaçu.

MAPEAMENTO E CARACTERIZAÇÃO DE ÁREAS DE OCORRÊNCIA DE CUPUAÇU EM COMUNIDADES DE AGRICULTORES FAMILIARES NO MUNICÍPIO DE ANAJATUBA, MA

RESUMO – O município de Anajatuba, na Baixada Maranhense, destaca-se pela tradição no cultivo de cupuaçu e pelo grande potencial de exploração econômica e sustentável das fruteiras nativas. Assim, realizou-se o mapeamento e a caracterização das áreas de produção. O objetivo do trabalho foi o mapeamento de áreas de cultivo de cupuaçuzeiro visando identificar áreas de agricultores familiares com potencial para avaliação participativa da cultivar BRS Carimbó. Observou-se que as plantações de cupuaçuzeiros localizam-se em áreas geralmente cobertas por Plintossolos com declividade plana a suavemente ondulada. A metodologia desenvolvida permitirá a realização do mesmo procedimento em regiões que possuam as mesmas características ambientais das áreas de estudo.

Palavras chave: Amazônia, Mapeamento, Cupuaçu

1. INTRODUCTION

Cupuaçu (*Theobroma grandiflorum* (Willd. ex Spreng.) Schum.) is a fruit tree, belonging to Malvacea family (ALVERSON et al., 1999), typically Amazonian, which is found in the wild in the southern and south-eastern part of Eastern Amazon and Northwest of Maranhão State. The species is currently spread throughout Amazon basin, sporadically found in other countries as Colombia, Venezuela, Ecuador and Costa Rica (VENTURIERI et al., 1985). Cupuaçu is one of the most attractive fruits from Amazonia, due to its flavor and aroma of the pulp, it is used for juice production, ice creams, liquors, jams, jellies, creams and sweets (CALZAVARA et al., 1984; VENTURIERI et al., 1985). Together with ease industrialization, the fruit raises interest not only in the regional market but also in the national and even international market (FERREIRA, 2005).

The cupuaçu fruit, also called "cupu", are 12 - 25 cm in length, and 10 - 12 cm in diameter, presenting on average weight of 1.0 kg, of which 30% is pulp and 15% -20 % are seeds (35 units) (FRAIFE FILHO, 1984). It is composed of a drupe berry, ellipsoid, with obtuse or rounded ends (VENTURIERI et al., 1985) depending on the variety. Its skin is hard and woody, covered with a rusty layer and accounts for around 40-50% of the fruit's weight (RIBEIRO, 1995), being used locally and on a small scale for cattle food and fertilizer, similar to the use of cocoa skin (DITTMAR, 1953) and in the manufacture of costume jewelry.

From the seeds can be obtained a product similar to chocolate, homemade or industrial, of very high quality, which in this case is called *cupulate*. This technology to obtain *cupulate* was developed by Embrapa Amazônia Oriental, in Belém, in studies conducted by Nazaré et al. (1990). The seeds when processed for butter extraction, consist in an important raw material for the cosmetics industry, with application in the manufacture of various products in different segments as personal hygiene, perfumery and cosmetics. Cupuaçu butter is also added to cocoa butter in the manufacture of chocolate, in order to achieve the minimum required by Brazilian legislation. This alternative was reinforced by the RDC 264 Resolution, from September 22, 2005, from ANVISA (National Health Surveillance Agency) (ANVISA, 2010), which allows the partial replacement of cocoa butter with alternative fats in chocolate. According the Brazilian legislation, chocolate must contain, at least 25% (m/m) of cocoa derivatives (liqueur, butter and/or powder). According to European legislation (Directive

73/24/EEC), in the manufacture of chocolates, in addition to cocoa butter, it is allowed the addition of other vegetable fats up to the level of 5% on the final product (SIMONEAU et al., 1999). Moreover, the fat added needs be classified as a fat equivalent to cocoa butter, or CBE - Cocoa Butter Equivalent. Cupuaçu butter fits this requirement, opening up more prospects of its national and international application if the seeds are used for this purpose. The pie, also resulting from the processed seeds, is used in the food industry for production of chocolate bars and chocolate powders. Another possibility for the use of cupuaçu seeds is in manufacture of animals and fish food.

More recent studies indicate the use of cupuaçu seed components to restrict the dental caries, which may increase the interest in the crop. Studies carried out by the researcher Mirela Sanae Shinohara, at the Odontology Department of the University of Illinois, USA, concluded that cupuaçu seeds extracts have antioxidant components with properties capable of restricting dental caries to evolve (BARBOSA, 2010).

Said (2011) points out that previous observations on agricultural practices in Amazon resulted in considerable waste of cupuaçu seeds; on the other hand, the use of cupuaçu butter is widespread in the cosmetic industry and the seed processing industry demands increasing amounts of these.

In the last three decades, with the increase in demand, the exploitation of cupuaçu tree went from extractive to the cultivated form and, as a consequence, the cultivation expansion to other Brazilian regions occurred (SOUZA et al., 2002). Cupuaçu is a highly-recommended species for the composition of Agroforestry Systems - SAFs, a practice indicated as a more appropriate alternative for land use in the region and widely disseminated among rural properties in the Amazon (HOMMA, 2006; CALZAVARA et al., 1984; SOUZA et al., 1999; MULLER et al., 1995; NOGUEIRA et al., 1991). When SAFs are associated with other production systems, a great potential for contribution to the quality of life of the small farmer is initiated and emphasizes its sustainability, since the use of land is optimized, and ecological damages reduced.

Yet, there are several problems related to the cupuaçu crop, as the high susceptibility to “witches' broom disease" (*Crinipellis perniciosa*) and the short shelf life of the fruit

Research institutions in the northern region of Brazil have been carried out breeding programs emphasizing the selection of genotypes with characteristics of high fruit

yield, pulp yield and resistance to witch's broom, the main disease of the crop.

Recent changes in the global economy and society, especially those related to environmental matters in the effort to guarantee the sustainability of natural resources and the maintenance of Amazonian ecosystems, have resulted in the loss of competitiveness of logging and traditional regional agriculture, especially in places more distant from large urban centers, as well as industry and trading.

The micro-region "Baixada Maranhense" belongs to the northern mesoregion of Maranhão, with an area of 17,579.366 km², being divided into 21 municipalities: Anajatuba, Arari, Bela Vista do Maranhão, Cajari, Conceição do Lago-Açu, Igarapé do Meio, Matinha , Monção, Olinda Nova do Maranhão, Palmeirândia, Pedro do Rosário, Penalva, Peri-Mirim, Pinheiro, Presidente Sarney, Santa Helena, São Bento, São João Batista, São Vicente Ferrer, Viana and Vitória do Mearim (IBGE, 2010). It is located in the central-north portion of the transition area between the Amazon and the Brazilian Northeast (SILVA; MOURA, 2004) and its territory is included in the Amazônia Legal. It is drained by the hydrographic basins of Mearim and Pindaré rivers, in addition to the secondary river basins of Turiaçu and Pericumã rivers, assuring the ecological dynamic linked to the rainwater cycle and, consequently, fluvial.

Nogueira (2003) evaluates that the ecological importance of Baixada Maranhense comes from flooding of lowland areas during the water cycle, contributing to the development of a typical and unique ecosystem in the State, of which biological productivity reaches high levels. The Baixada Maranhense is one of the seven ecological regions of Maranhão, and is also an Environmental Protection Area (APA) created by Decree No. 11,900 of July 11, 1991. The region is based on a predominantly low and flat relief, area of fluvial plains, and constitutes a complex that includes rivers, lakes, estuaries, and extensive floodplains that justifies the enormous ecological importance of this region. The region covers a significant part of the Maranhão population (9%) (BERNADI, 2005), which exerts heavy pressure on local natural resources.

The Baixada Maranhense consists of soils with low capacity of cation exchange, high degree of weathering and low fertility due to the geological, geomorphological and climatic characteristics of this region. Soils developed from the Itapecuru Formation in the microregion are called "Plintossolos", with a restricted localization to the higher areas.

"Plintossolos" are formed under conditions of water percolation restriction, present predominantly in areas of flat or gently undulating and rarely undulating (EMBRAPA, 2013).

The cultivation of native fruits of Amazon is pointed out as an important alternative for development of the region through the economic exploitation of its plant species diversity, especially those species whose productive chain is more diversified and can favor several networks within this chain. In the Baixada Maranhense, cupuaçu is found in the remaining forests, subject to the itinerant agriculture regime of logging and burning. In this region, the municipality of Anajatuba stands out, where the species is cultivated in areas of family-based farming.

One of the easiest ways to map land using satellite imagery is through the supervised classification method. The classification process requires previous knowledge of land use, in order to provide training samples to the system that, therefore, will obtain the necessary statistical parameters for processing the entire image.

Geographic information systems (GIS) perform the computational processing of geographic data and retrieve information based on the spatial location of the data and its alphanumeric characteristics. It is a tool that offers the possibility of integrating data from different sources and types, since it incorporates principles of databases, graphical algorithms, network analysis and zoning interpolations (LOCH, 2006).

Considering the great potential of economic and sustainable exploitation of native tropical fruit trees and the tradition of the municipality of Anajatuba in cupuaçu cultivation, the production areas were mapped. The objective of this work was to map cupuaçu cultivation areas aiming to identify areas of family farmers with potential for participatory evaluation of BRS Carimbó cultivar.

2. MATERIAL AND METHODS

The method used in the research was hypothetico-inductive inference consisting of observation and experimentation. Initially, a bibliographic survey was carried out, followed by field recognition, where the physical environment features of the studied area were observed. Observations and integrations of geological and geomorphological characteristics, of relief features and elements, soil types, use and occupation of economic activities were collected, as well as data extracted from Colares et al. (2003). The field work consisted in identification of

cupuaçu plantations, which were georeferenced with a GPS device, Garmim Etrex model, and observations were recorded through photographs. The distribution of cupuaçu was modeled based on the results of previous activities and characterization of environmental factors, where the main occurrences of cupuaçu in the region are located. The geo-referencing of the cupuaçu populations was used to obtain, in a GIS environment, the correct positioning of areas where the species occur, so that they serve as training samples during the digital classification process. A potential map of the occurrence of cupuaçu was generated, which allowed the mapping to specific areas, reducing the cost of new mapping and associating environmental characteristics with the species occurrence.

3. RESULTS AND DISCUSSION

Studied area

The municipality of Anajatuba is located in the northern portion of the State of Maranhão, on the right bank of the Mearim River, with a population of 25,291 inhabitants. and population density of 25 inhab / km² (IBGE, 2010) in the transition area from the Amazon Forest to the Cerrado between Universal Transverse Mercator Coordinates - Projection UTMs, latitude 23S; 530000/565546 mN and 340530/372000 mE. The main road access, between São Luís, the state capital, and Anajatuba, is made by BR-316 and BR-222 (Figure 1A).

Physiographic Characterization

The municipality of Anajatuba is part of the Structural Province of Parnaíba and three stratigraphic units are identified in the municipality area: Itapecuru Formation, Fluvial Lagoon Reservoir and Swamp and Mangrove Reservoir (Figure 1B). The Itapecuru Formation from Cretaceous period is formed by a set of sandstones with intercalation of siltstones and reddish shales of predominantly fluvial continental origin (RODRIGUES et al., 1994). Mangrove deposits are located in the NW portion of the focused area generally subject to tidal action and associated with fluvial-marine deposits. The deposits of fluvial and lacustrine sedimentary cover are composed of alluvial sediments originating from meandering and lacustrine river systems, according to Colares et al. (2003). The area of Anajatuba municipality is characterized by an area of vast fluvial and fluvial-marine plain of the Golfão Maranhense with low predominating altitudes of 30 meters with flat slope to gently undulating.

The highest altitude reaches 85 meters with undulating slope.

In the municipality of Anajatuba there are 3 soil units, such as “Plintossolos” (PT), “Gleissolos” (G) and, the indiscriminate mangrove soils (EMBRAPA, 1986). The presence of the “Plintossolos” is associated to the intensely dissected hills of the Itapecuru Formation, and “Gleissolos” is associated to the fluvial-marine and fluvial Mearim River Basin plains (Figure 2A). The plantations were mapped in the localities of Picada, Engenho, Sipaú, Mato Grande, Boca do Caminho, Cajueiro, Santarém, Olho D'agua, São Roque, Fomento, Bacabal, São Pedro, Flores and in Anajatuba town (Figure 2B), where plantations are usually found in backyards of familiar farmers are usually covered by “Plintossolos” with flat to gently undulating slope.

According to Câmara (1995), there are three major applications for GIS systems: geographic database management technology, support for spatial analysis and as a tool for cartographic production. The geometry and attributes of the data in GIS must be georeferenced, that is, located on the terrestrial surface and represented in a cartographic projection (CAMARA et al, 2001).

The methodology used, based on previous knowledge of land use, will allow the same procedure to be performed in regions with similar environmental characteristics of the studied areas.

a) b)

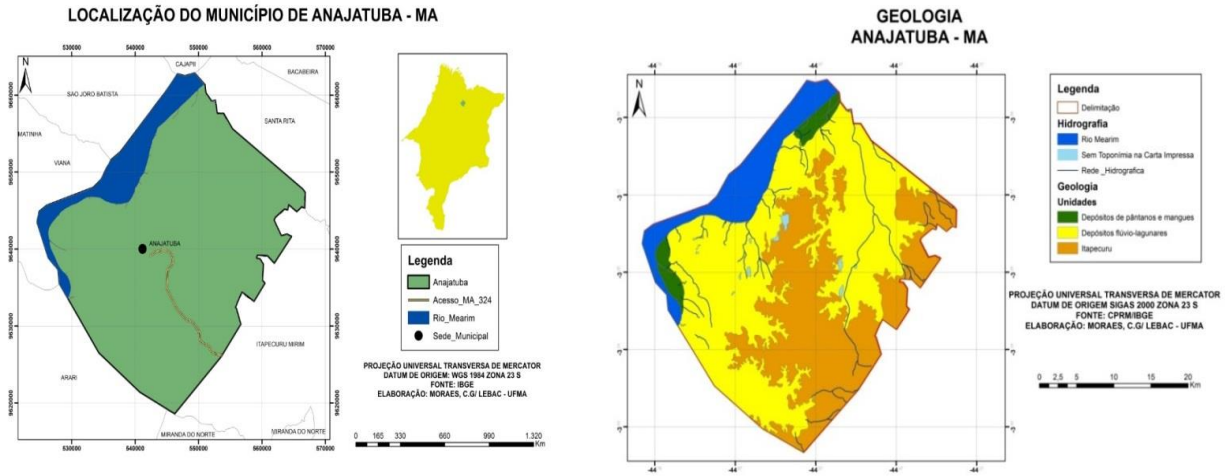
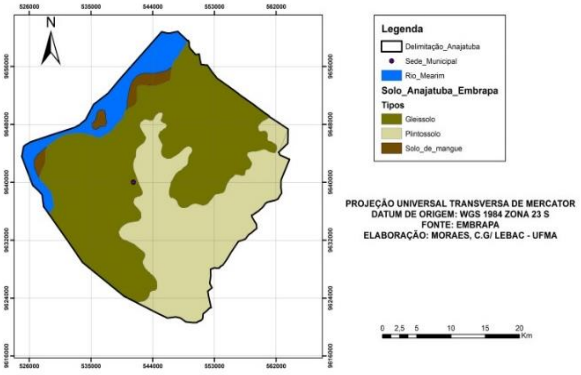


Figure 1 - Map of location (A) and geology (B) of the Municipality of Anajatuba, MA.

a)



b)

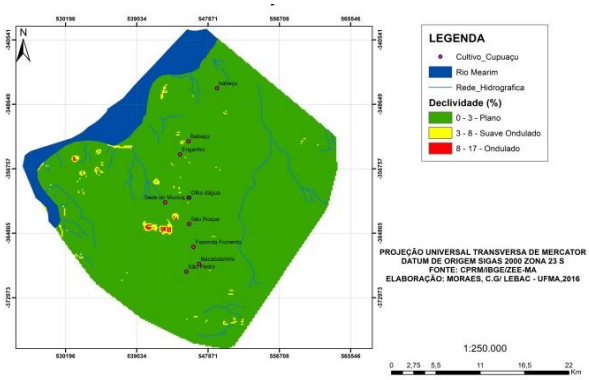


Figure 2 - Soil maps (A) and cupuaçu plantation locations (B) in the Municipality of Anajatuba, MA.

Characterization of plantations

In the last three decades, with the increase in demand, the exploitation of cupuaçu tree went from extractive to the cultivated form and, as a consequence, the cultivation expansion to other Brazilian regions occurred (SOUZA et al., 2002). However, there are many problems related to cupuaçu cultivation, such as high susceptibility to witches' broom disease (*Crinipellis perniciosa*) and short shelf life.

Research institutions in the North region have carried out breeding programs emphasizing the selection of materials with characteristics of high fruit yield, pulp yield and resistance to witches' broom, the main disease of the crop.

Extractive exploitation of native fruits, especially the species under this study, generates seasonality in production, low fruit quality and productivity, besides the difficulties to meet current and potential demand, due to the small volume of production. Therefore, possible solutions to such difficulties necessarily involve the viability of rational cultivation and also better and efficient ways of using this fruit. For this, further knowledge about the species of interest is needed, especially in relation to management.

The current challenge of cupuaçu agribusiness in the region studied is to overcome technological limits, using superior genetic material and improving management techniques, such as balanced shading with adequate spacing for all species in the consortium; crown with controlled height and branches with good emission of lateral branches led by successive pruning; sufficient

and balanced fertilization; provision of water; systematic control of weeds and pests, as well as daily harvests.

CONCLUSION

Cupuaçu tree plantations were generally found in backyards of family farms over areas generally covered by “Plintossolos”, indicating the potential of these areas to plant the cultivar Carimbó. The methodology developed will allow the same procedure to be performed in regions with similar environmental characteristics to the studied areas.

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