FORMATION OF BABASSU IN DEGRADED AREAS BY HUMAN ACTION IN SOUTHEAST PARÁ, BRAZIL: ITS IMPORTANCE FOR RECOVERY OF LEGAL RESERVE AREAS

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Summary

The Babassu palm Forest landscape also includes the history of abandoned managed pasture areas, that accounts for the infestation by the Babassu palm (Attalea speciosa Mart. ex Spreng.), which is a palm tree with spontaneous and abundant regeneration. In these areas fire is the most common form of management to eliminate invaders but, however, it has a contrary effect on Babassu palm, because after the pasture burning it is precisely the "pindovas" (young Babassu palm individuals) that resist the impact (Mitja & Ferraz, 2001). Thus, these plants are the first to appear as secondary vegetation mainly at edges of small rivers (igarapés) after felling or burning of original forest, invading wet, highly degraded places where they sprout vigorously. According to Barot et al. (2005) Babassu palm tree has an enormous reproductive plasticity that favors its proliferation in pasture areas. This study describes spatial and temporal changes in Benfica Settlement Project landscape of Southeast Para Sate, Brazil, using techniques of GIS, data TM/Landsat of 1987, 1992, 1996, 2001 and 2005 and information from field. There has been identified and characterized 10 landscape components that represent the patterns of use and vegetation cover: Forest Remnant, Riparian forest, swamps, High fallow, Fallow with Solanum, Low fallow, Pasture with woody, Pasture with Babassu palm, Babassu Forest and Clean Pasture. The Forest Remnant showed 60% of its deforested area in the period 1987-2005. In the same period areas of pasture and poultry showed a corresponding expansion to 30%, respectively. There has also been identified and characterized six types of landscapes: Forest, Agricultural Mosaic, Agricultural Mosaic with Pasture, Large Pastures, Large Pasture with Babassu, and Babassu palm Forest. Results indicated that the dynamic process was the conversion of forest to pasture, especially the landscapes of Large Pastures, Large Pastures with Babassu and Babassu Forest. From 1987 until 1996 the dominance of Forest Landscape amounted to almost 80%. The expansion of pasture in the period 1996-2001 reflected the increase in areas of Babassu palm and Pasture with Babassu palm components. In 2001 the area occupied by these components dominated the Large Pasture with Babassu and Babassu palm Forest landscapes. However, in the period 2001-2005 predominated the Landscapes Agricultural Mosaic, Agricultural Mosaic with Pastures and Large Pastures. From obtained results it was found that over time, the simplification inherent in the system can cripple livestock production and reproduction of local family farms, as it runs out areas for implantation of new crops. In field invasion of Babassu palm is favored when the plot is abandoned, being still possible to became into a Babassu palm Forest. In the pasture Babassu palm can either slowly invade the area or be almost eliminated when palm trees are felled and "pindovas" killed with herbicide.

1. Introduction

Currently the environmental question in areas of the pioneer front of the Southeastern Pará, Eastern Amazonia has become a great challenge in the search for viable alternatives to conciliate natural resource protection and conservation with sustainable development.

Since the 1960s the occupation process in this region has been fomented by development policies through large projects. In the 1970s the National Integration Program (NIP) influenced the opening of highways and large hydroelectric projects and mineral exploitation (Homma, 2000). This infrastructure supported new migration flows (Homma 2003) and the occupation process culminated with deforestation of large areas for implantation of livestock systems as the basis of economic sustainment of families (Pasquis et al.,2005; Piketty et al., 2005).

In the case of Itupiranga-PA municipality, Incra data total of settlements corresponds to 5148 families in a total area of 368,197 ha, equivalent to 46.72% of municipal area, where Benfica Settlement Project (Benfica SP) is included. In this settlement, landscape do not represent a homogeneous whole, but involves differentiations that portray in an integrated way, a mosaic of anthropological and natural features, referent to the forest remnants, small areas of family agriculture, large pasture areas and babassu palm forests. This simplification of landscape has made original plant structure unstable, from the point of view of biodiversity. (Sampaio, 2008).

Study on the plant coverage dynamic and on land use, with use of remote sensing, integrating field information allows the definition of parameters that control the spatial and temporal changes which are occurring very quickly in the landscape. Several authors have used this technique to show this process in the Amazon region (including Adams et al., 1995; Roberts et al., 1998; Cochrane and Souza, 1998; Souza and Barreto, 2000; Sampaio et al., 2000; Thalles et al., 2002; Monteiro et al., 2003; Souza Jr. et al., 2003; Watrin, 2005).

The landscape is considered an applicable scale by researchers from different disciplines to know and assess dynamics of the pioneering fronts in regions with difficult access and fast evolution (Venturieri, 2004). So, the objective is to analyze the expansion of babassu palm (*Atalea speciosa* Mart. ex Spreng.), in the landscape scale overg eighteen years and its importance for recovery of Legal Reserve Area (LRA) and Permanent Preservation Area (APP) in Benfica SP.

2. Study area

The area of Benfica-SP is located in the southeastern of Pará State, Itupiranga municipality, between coordinates 05º12'20" and 05º20'40" South latitude and 49º56'40" and 49 º 48'00" west longitude, at 70 kilometers from the Transamazon Highway and covers an area of 10,026.00 hectares (Figure 1).

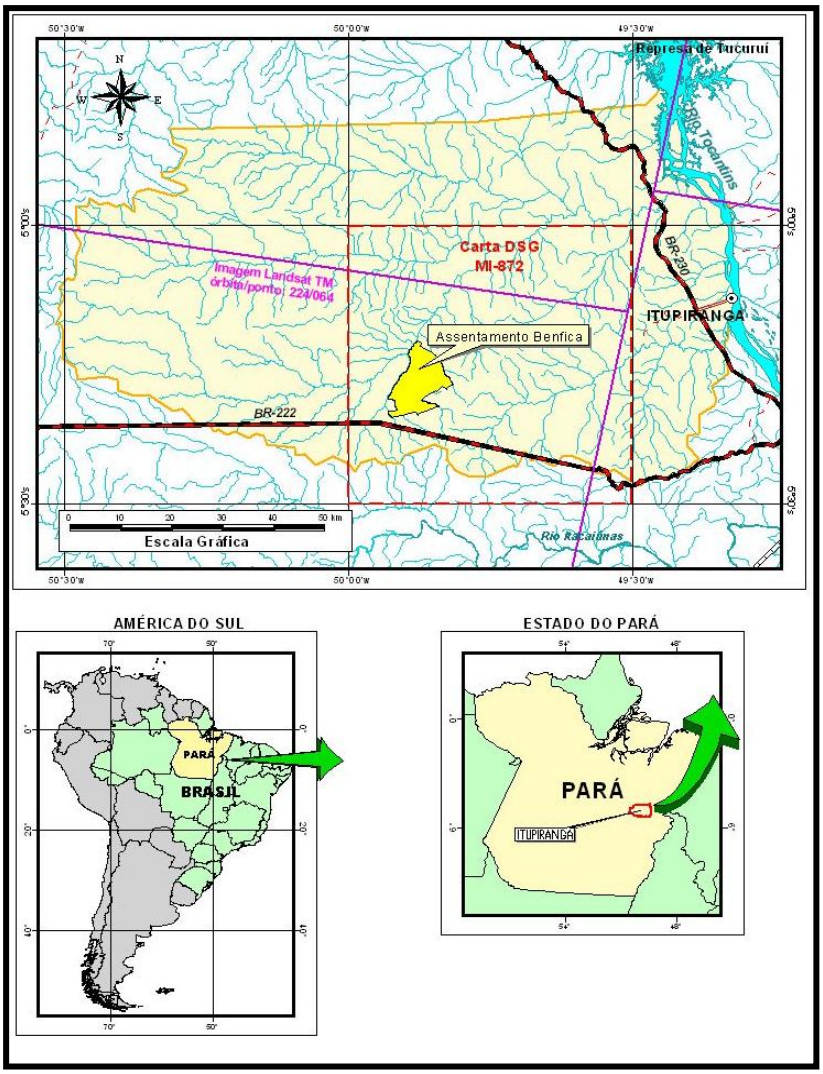


Figure 1. Location of the area of SP-Benfica, southeastern of Pará State, Itupiranga municipality, Brazil.

Benfica-SP is divided into two areas called Benfica I (north of settlement) and Benfica II (south of settlement) forming a total of 183 lots occupied since 1994 and have different histories of occupation and uses (Dosso et al., 2005). Its population is estimated at 1000 inhabitants (Biri Kassoum and Maître d'Hotel, 2002).

The original vegetation corresponds to primary forest areas classified according to IBGE (1992) as dense ombrophilous forests and secondary vegetation areas, whose pioneer specie development stages specie vary according to time of abandonment.

Land use consists of acquiring and specializing in cattle raising that causes a progressive substitution of forest by pasture (Reynal et al., 1995) and a period with family agriculture.

3. Methods

Benfica-SP landscape is a continuous amount of space, segmented in two levels of spatial understanding, perceived in a complimentary and ascendant way: from components (a representative of constituent elements of landscape types) for landscape types, where proportion of areas they occupy is associated to the organization of the community, reflecting its differences and similarities.

The landscape components are compulsory levels in the identification of the plant coverage, image classification, in recognition of the land reality and in the identification of landscape type organization related to description of occupation and use of the land. Its physiognomy informs its function, based on the following criteria: a) nature, based on its image within the landscape structure, considering its fragmentation; b) proportion (extension), related to representation of the component in terms of the occupied area in the landscape; c) organization in space, according to its shape (regular/ irregular/fragmented) and its distribution (aggregated/disperse, continuous/discontinuous, close/distant), emphasizing the intrinsic organization and interdependence among the components in the system (Sampaio, 2008; Laques, 2009).

Landscape type is a combination of components, representative of a portion of the homogeneous space and coherent in relation to the physiognomy of the places (existence of a natural similarity, arrangement and frequency of the constituent elements), both for social and economic use and for ecological operation in the origin of its production.

The study included fieldwork, remote sensing products and techniques, geo-processing and theoretical models. Digital TM-Landsat images were used, orbit/point 224/064, TM3 spectral bands (red), TM4 (close infrared), TM5 (medium infrared) and R5G4B3 colored composition.

Images were selected for periods 1987 and 1992 (before occupation of the area), 1996 (after occupation of the area), 2001 (after the release of credit from the National

Family Agriculture Program (PRONAF), time of greatest pasture area expansion) and 2005 (before the field surveys started in the second semester of 2005 and first and second semester of 2006).

The analysis of dynamic of Benfica-SP landscape types refer to periods: 1987-1992, 1992-1996, 1996-2001 and 2001-2005. TM/Landsat data were processed on the SPRING (Sistema de Processamento de Informações Georreferenciadas) for Windows version 4.1.1, developed by the Brazilian Space Research Institute (INPE). The classification method supervised by regions associated the image resulting from the process of image segmentation for fragmentation into homogeneous units.

The most appropriated threshold in the image segmentation values were 8 for similarity and 10 for area (they were selected to define the most suitable limits), whose degree is determined by a parameter t, represented by the Euclidean distance between the vectors associated with each segment. These values were obtained after several approaches until a level of fragmentation considered appropriate for the study.

In classification for areas was used the same limit for analysis of the samples (99.9%), aiming the lowest rejection index, first in the most recent image (2005) and then in images of 1987, 1992, 1996 and 2001.

In the field, aspects present in the images were correlated with patterns of plant cover and land use. The identified types of correspond to the nature, proportion and organization spatial of its components. The differences in typology established an own configuration, representative of the spatial relationships between different ecosystems or present elements in addition to interactions and natural or anthropic processes (physical, ecological, technical and cultural, etc.).

Representative graphic models of the organization of the landscapes in the field were built, combining components with the productive activities to portray the local and temporal dynamic and to help in the analysis of the landscape changes. Beringuier et al. (1999) highlighted that these models endeavor to show the spatial organization of the constituent elements of the landscape, so that they are representative of a determined class or typology of the established landscape, by graphic representations.

The delimitation of landscape types in satellite images was based on criteria such as the area of the components, the size of the openings in the forest and their spatial organization.

4. Results

4.1. Landscape components

Ten landscape components were identified (Figure 2): Forest Remnant (LC1) referring to the remains of the original forest, that still present a great species diversity; Riparian Forest (LC2), forest areas on the banks of bodies of water, sometimes well conserved and other times disturbed; Swamp (LC3) secondary vegetation derived from degradation of Riparian Forests and presenting a great amount of secondary species such as *Typha sp., Ludwigia latifolia* (Benth.) H. Hara and *Panicum pilosum Sw*.

Secondary forests present different successional stages, that depend on time of abandonment and on the history of use of the area, as: High Fallow (LC4) refers to the 8 to 15 year-old secondary forests, approximately; Fallow with Jurubeba (LC5), young fallow, average age 5 years, dominated by *Solanum rugosum* Dunal, commonly called Jurubeba; Low Fallow (LC6), young fallow, average age five years, without apparent dominance by any species and Babassu Palm (LC9), secondary forests dominated by babassu palm with age around 20 years old.

Babassu is the common name for several species of the genus Attalea (*A.speciosa A. brasiliensis*), pionner species of Amazon forest and of Cerrado biome. The most studied species in Brazil is *Attalea speciosa Mart. ex. Spreng* (May et al., 1985), found in isolation, in forests or in open areas, being more frequent in degraded areas, especially in old forest formations cleared in the process of colonization (Ribeiro and Walter, 1988).

The components Pasture with Woody Species (LC7), Pasture with Babassu Palm (LC8) and Clean Pasture (LC10) consist mainly of species such as *Brachiaria brizantha* (Hochst. ex A. Rich.) Stapf. and *Panicum* sp. The Clean Pasture corresponds to recently implanted or well-managed areas, with a low degree of invaders; the Pasture with Woody Species presents invaders of various species, but still sustains pasture activity and Pasture with Babassu Palm is dominated by young Babassu palm individuals.

Those components were observed for 18 years in four different periods, 1987-1992, 1992-1996, 1996-2001 and 2001-2005, being verified increasing reduction in natural formations (Forest Remnant, Riparian Forest) due to expansion of anthropic formations. In areas of secondary formations (High Fallow, Fallow with Jurubeba, Low Fallow, Babassu Palm Forest), was observed increase mainly in the pasture (Clean Pasture, Pasture with Woody Species and Pasture with Babassu Palm (Table 1)).

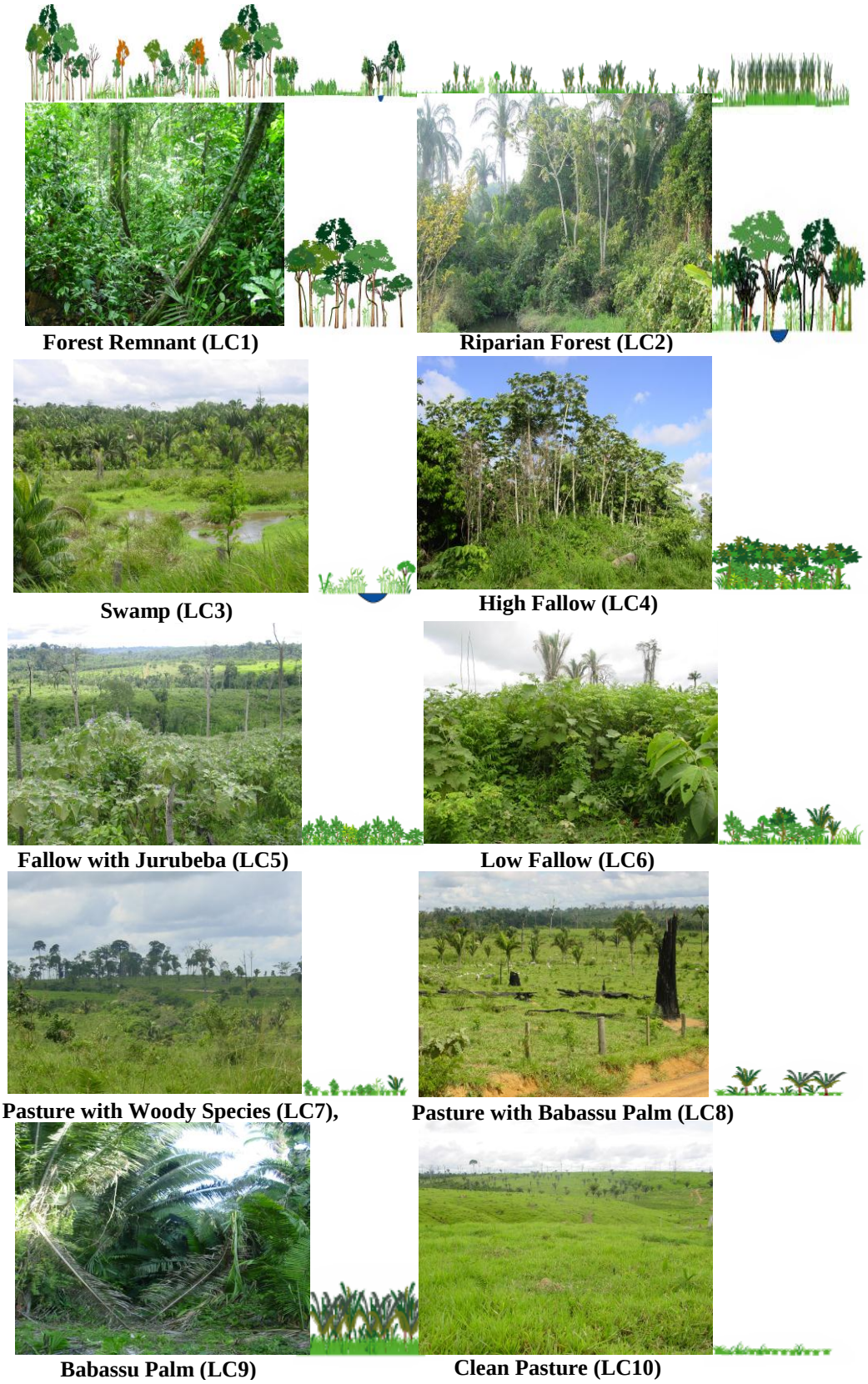


Figure 2. Landscape components of the SP-Benfica, southeastern of Pará State, Itupiranga municipality, Brazil.

TABLE 1. Quantification of areas the Landscape Components of the SP-Benfica, southeastern of Pará State, Itupiranga municipality, Brazil for years 1987, 1992, 1996, 2001 and 2005.

Components Landscape	1987		1992		1996		2001		2005	
	ha	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**
(LC1)	8605,4	85,83	7810,87	77,91	6709,19	66,92	3772,10	37,62	2486,62	24,80
(LC2)	211,59	2,11	200,86	2,00	326,97	3,26	134,61	1,34	83,72	0,84
LC3)	36,17	0,36	14,56	0,15	49,60	0,49	21,80	0,22	98,08	0,98
LC4)	321,89	3,21	520,90	5,20	788,08	7,86	1586,04	15,82	1009,81	10,07
(LC5)	1,76	0,02	149,82	1,49	60,02	0,60	441,55	4,40	519,77	5,18
(LC6)	193,96	1,93	323,03	3,22	543,36	5,42	1219,25	12,16	1465,38	14,62
(LC7)	217,90	2,17	137,18	1,37	212,24	2,12	704,05	7,02	1536,23	15,32
(LC8)	55,53	0,55	383,23	3,82	484,55	4,83	786,73	7,85	1165,62	11,63
(LC9)	36,81	0,37	157,56	1,57	427,23	4,26	536,31	5,35	831,53	8,29
(LC10)	265,00	2,64	326,02	3,25	306,98	3,06	606,99	6,05	775,49	7,73
Other: Water	0,00	0,00	0,00	0,00	26,96	0,87	6,91	0,07	3,68	0,04
Exposed Soil	58,43	0,58	1,97	0,02	90,82	0,31	209,65	2,09	50,06	0,50
Burned	21,54	0,21	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
TOTAL	**10026,**	**100,0**	**10026,0**	**100,0**	**10026,0**	**100,0**	**10026,0**	**100,0**	**10026,0**	**100,0**

4.2. Landscape types

There have been identified six landscape types as: Forest Landscape (LT0), Agricultural Mosaic Landscape (LT1), Agricultural Mosaic with Pasture (LT2) Large Pastures Landscape (LT3), Babassu Palm Forest Landscape (LT4) and Large Pastures with Babassu Palm (LT5).

In the landscape (LT0), the Forest Remnant component (LC1) occupies the landscape in an almost continuous way and in the Agricultural Mosaic (LT1) very small portions of land are organized in a heterogeneous manner, generally rice, corn and cassava fields or rice with pasture consortium. These practices occur shortly after felling and burning the forest, with the surroundings areas occupied by High Fallow (LC4) and Low Fallow (LC6) components.

The Agricultural Mosaic with Pasture Landscape (LT2) presents a large area of forest close to anthropic areas, diversity of components and the agricultural production systems are giving place to areas occupied by fallow because of abandonment of fields and pasture.

The Large Pasture Landscape (LT3) corresponds to a matrix of pasture consisted of Clean Pasture (LC10) and/or Pasture with Woody Species (LC7), where direct

substitution of forest by pasture is executed. The isolated and distant remnants are substituted by new pasture, during a new agricultural cycle. When the cover is not totally formed by pasture, there is dominance of Low Fallow (LC6) component. Signaling management of the area, rarely is observed the presence of adult and young babassu palm trees or taboa (*Typha* sp.), a species that prefers wet places such as swamp and whose presence becomes problematic for farmers for being very competitive.

The Babassu Palm Forest Landscape (LT4) is characterized by a matrix where the Babassu Palm Forest (LC9) and High Fallow (LC4) components predominate, indicating abandonment of old pasture, and the Large Pasture with Babassu Palm Landscape (LT5), reflects the expansion of the component Pasture with Babassu Palm (LC8).

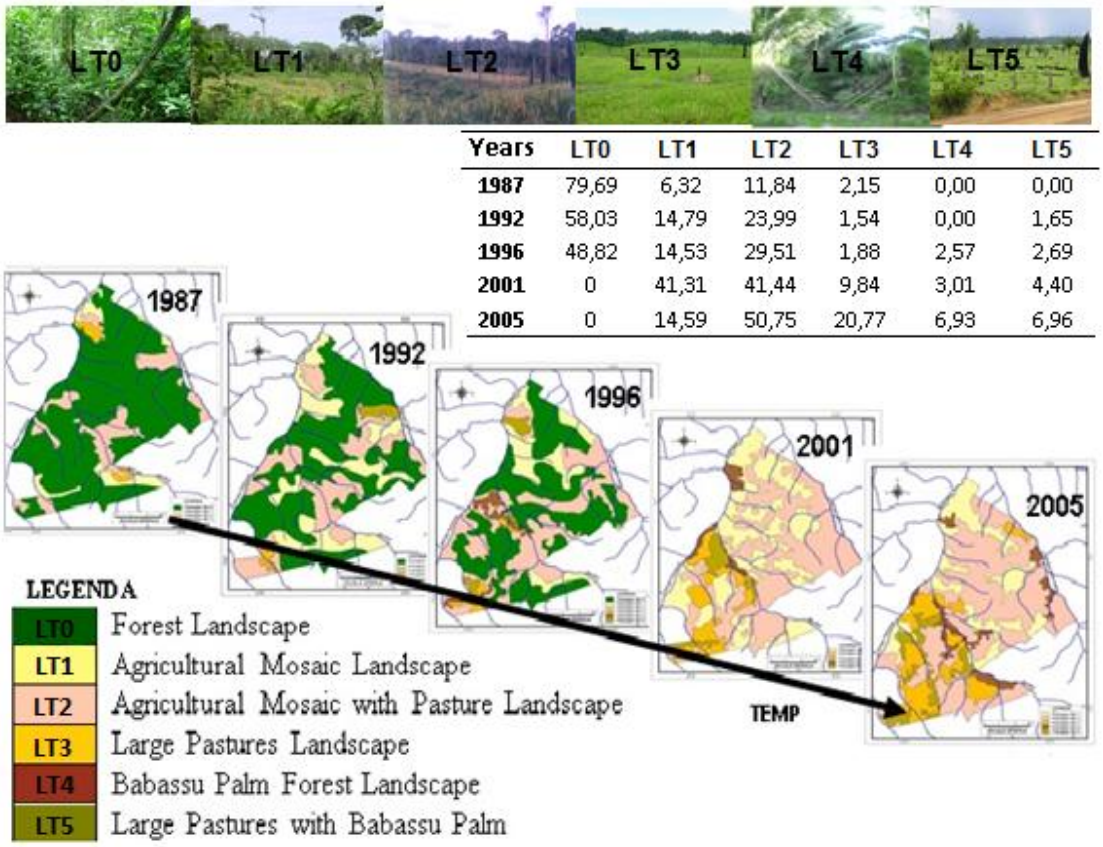
4.4. Landscape dynamics

In dynamics of landscape types (Figure 3), the Forest Landscape (LT0) predominated between 1987 and 1992 with reduction starting in 1996 of almost 80% to 58% in relation to the total area of Benfica-SP.

In the period, the Agricultural Mosaic Landscape (LT1) increased from 6.32% to 14.79% giving room for Agricultural Mosaic with Pasture Landscape (LT2) that increased from 11.84% to 23.99%. The course of this landscape (LT2) to the Large Pasture Landscape (LT3) in the 1987-1992 period presented a reduction in the area from 2.15% to 1.54%, and may be associated to abandonment of management in these areas and to increase in the area of Agricultural Mosaic with Pasture Landscape (LT2).

From 1992 to 1996 the area of Forest Landscape (LT0) reduced 19% contributing to the expansion of the Large Pasture Landscape (LT3) and Large Pasture with Babassu Palm Landscape (LT5) and to the appearance of Babassu Palm Landscape (LT4).

In period 1996-2001, the largest changes were registered in landscape types. In addition to disappearance of the Forest Landscape (LT0), the Agricultural Mosaic Landscape (LT1), the Agricultural Mosaic with Pasture Landscape (LT2) and Large Pasture Landscape (LT3) increased by over 80%, 70% and 174%, respectively. In this period the Babassu Palm Forest Landscape (LT4) increased by almost 20% and the Babassu Palm component (LC9) dominated more than 65% of its area.



Years	LT0	LT1	LT2	LT3	LT4	LT5
1987	79,69	6,32	11,84	2,15	0,00	0,00
1992	58,03	14,79	23,99	1,54	0,00	1,65
1996	48,82	14,53	29,51	1,88	2,57	2,69
2001	0	41,31	41,44	9,84	3,01	4,40
2005	0	14,59	50,75	20,77	6,93	6,96

Figure 3. Dynamics of landscape types in SP-Benfica, southeastern of Pará State, Itupiranga municipality, Brazil.

From 2000 to 2005, Agricultural Mosaic with Pasture Landscape (LT2) predominance exceeded 50% of Benfica-SP area, in detriment to Agricultural Mosaic Landscape (LT1), whose area decreased almost 55%. In the period, the Large Pasture Landscape (LT3), Babassu Palm Landscape (LT4) and Large Pastures with Babassu Palm (LT5) grew by about 60%, 55% and over 100%, respectively.

5. Discussion

In Southeast of Pará, the expansion of agricultural frontier was followed by pasture implantation starting from periodic deforestation, followed by successive burning**.** For Santana and Homma (1997), Piketty et al. (2005), Poccard-Chapuis et al. (2005) e Sartre et al. (2005) the importance of livestock is unquestionable in the regional economy. In this context, Silva et al. (2009) highlights that, traditionally, the

first action taken by the settlers is disorderly withdrawal of forest resources for fuel wood, charcoal, poles, stakes and sticks, making it the first source of their subsistence.

In the period 1987-2005, Benfica-SP was marked by many trajectories of evolution that coincided with the productive activities in the process of occupation for pioneer fronts. The arrival of farmer in this period is represented by the absence of capital investment and by a spatial and temporal organization with predominance of Forest Landscape type (TP0).

For Mitja and Robert (2003) these Pioneer fronts consist of a space in formation, where evolutions are very fast and radical. In this context, Piketty et al. (2005) says that the farmer's productive strategies, based on their culture, traditions and on how they have access to credit and to public policies, were determinant in the organization and dynamic of the landscape.

The great interest of producers by cattle raising in Benfica-SP was established even before their incorporation into land reform. In the period 2001-2005 the expansion of grazing areas with funds from the National Family Agriculture Program (PRONAF), caused environmental and social impacts, with significant reductions in diversity and in areas of forests. Over time, this favored changes in the types of landscapes, from interactions of its components which established ever more or minus, according to conditions and chances of maintaining or not productive systems.

In the context of family agriculture, the expansion of livestock raising system at the cost of using the forest remnants, with time has brought difficulties to maintenance of other productive systems and especially it has brought abandonment and occupation of new areas (Silva et al., 2007).

Still because of the action of man and his control of pasture, abandonment or possible alternations between the abandonment and use of these managed areas, giving rise to secondary forests of babassu palm (Atalea speciosa Mart. Ex Spreng.) also known as Babassu Palm Forest Landscape (LT4). In this process it is included the financial conditions for labor recruiting.

Babassu palm already present in the forest has spontaneous and abundant regeneration being one of the first palm trees that emerge as the secondary vegetation, mainly along the banks of streams or after withdrawal or burning of original forest, invading damp places, highly degraded, where re-grows vigorously.

The babassu palm tree has an enormous reproductive plasticity that favors its proliferation in pasture areas (Barot et al., 2005). In these areas, fire is the most

common form of management to eliminate the invaders but it has a contrary effect on the babaçu palm, because after burning the pasture it is precisely the `pindovas´ (young babassu palm individuals) that resist the impact (Mitja and Ferraz, 2001).

The capitalized producers that have conditions to pay for labor influence land use and pasture remains through management for a longer period preventing faster changes. However, technological conquests present uncertainties from economic point of view, because the high cost of agricultural chemicals elevates cost of recovering the pasture, a fact that often makes the activity of small producers unfeasible (Veiga et al., 2004).

In areas of small producers, the babassu palm that normally does not receive crop treatment mixes with the High Fallow (LC4) component and in others the babassu palm spreads dominating old pasture areas. In this process, it forms very often and spontaneously, very dense and dark homogeneous groups, due to the proximity between large palm trees, giving rise to a true Babassu Palm Landscape (LT4).

In turn, in Large Pastures with Babassu Palm Landscape (LT5), where capitalized producers are set down, sometimes the pasture is not abandoned and the babassu palm trees are preserved by proprietor's own will, seeking shade for cattle during the hot hours of the day.

The two examples above is required to comply with environmental laws that determine the use of properties aiming environmental preservation, conservation of natural resources and to ensure a good life quality. Thus, the forests of babassu palm have great importance inside environmental strategies, and provide new economic opportunities as extractivist product.

In the context of environmental management, Homma (2005) states that the reduction of deforestation and burnings in the Amazon region depends on the development of appropriate economically viable agricultural activities in deforested areas, and the babassu palm is quite suitable for this. According to the Institute of Geography Brazil (IBGE) data, the babassu palm in 2007 was the first in the list of non-timber extractive species contributing significantly to economies of some states in the country.

Thus, Babassu palm has potential for multiple uses and can support the sustainability of family farming systems and the recovery of Legal Reserve Area (LRA) and Permanent Preservation Areas (PPA) in Benfica SP.

6. Conclusion

In Benfica-SP, the intensity of use of agricultural systems favored, in time, to strong reactions of Types of Landscape to changes of their components, reflecting different dynamics. This way, recognizing, that both, change is inevitable and the delayed effects that characterize processes in landscape level, the sustainability of the depends on public consistent policies of medium and long term and on the establishment of goals in the management of it.

In the area of Benfica SP, the implantation of agroforestry systems are maintained in the planning, implementation and evaluation of future initiatives certainly would change current scenery of the landscape.

The association of babassu palm with other native species of commercial value rural property would be an alternative to administration of challenges found in pasture management or in the establishment of other cultures, considering the lack of financial resources, and cost reduction and risks for the establishment of exotic species.

The incentive for this activity as a form capable to make changes in the current picture of environment degradation, goes through understanding of lapses found in current productive systems in Benfica-SP and by valorization of a new form of production and handling techniques that meet as much social, economic, political, cultural and ethically, as ecological and environmental principles.

This system could be both made viable in landscapes Babassu Palm Forest(LT4) and Large Pastures with Babassu Palm (LT5) formed by abandonment of pasture where predominates the natural regeneration of babassu palm, as in landscape Large Extensions Pasture (LT3) where the babassu palm is suppressed during pasture management.

However, the establishment of agroforestry systems depends heavily on the commercialization opportunities that vary according with each linked culture. In the case of babassu palm, the use of its full potential, in consortium with other native species as Brazil nuts (*Bertholletia excelsa*), Copaiba (*Copaifera multijuga Hayne*), *Acai (Euterpe oleracea Mart.) and others could increase food and family incomes generating additional profits.*

In addition, the local processing of these species would add value to rural properties and improve social and economic family life. For that, it would be necessary to count on important support policy, mainly for technical assistance, investment

credits, processing and commercialization, technology research and industrialization of production beyond expansion of infrastructure and organization of farmers.

In ecological and environmental context, sustainable use of babassu in agroforestry systems could contribute to recovery actions of the Legal Reserve Areas (LRA) and Permanent Preservation Areas (PPA), which are a priority for the mitigation of environmental liabilities and thus, would meet the requirements of the New Forest Code from now on recovery.

Although the New Forest Code establish restrictions on use of Legal Reserve (shallow cutting, land use alteration and exploitation for commercial purposes, with some exceptions), it makes possible the exploration through sustainable management plans.

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