ADVANCEMENT OF AGRICULTURAL ACTIVITY ON NATURAL VEGETATION AREAS IN NATIONAL AGRIBUSINESS CAPITAL

JUSSARA GIARETTA[1]
DANIELLE STORCK-TONON[2]
JOSELAINE SOUTO HALL SILVA[3]
MANOEL DOS SANTOS FILHO[4]
DIONEI JOSÉ DA SILVA[5]

1 Introduction

The economy of Mato Grosso, Brazil, is focused on primary activity, especially grain cultivation and the development of livestock (CUNHA, 2006). The agricultural sector accounts for approximately 30% of the gross domestic product (GDP), and grain production is responsible for 23% of this total (MATO GROSSO, 2012). Mato Grosso is currently a leader in national grain production, with over 13.7 million hectares cultivated per year in the first crop (CONAB, 2016).

The northern, northeastern and southeastern mesoregions cultivate 9.2 million hectares of soybeans, corn, beans and cotton, which is 70% of grains grown in the first crop in the state (CONAB, 2016). This production has increased in the northern region of Mato Grosso since the 2000s, focusing on high-tech mechanized agriculture, based on monoculture (GIARETTA; SILVA, 2017). The region also has large estates, high population growth, high urbanization rates and little labor in the countryside (CUNHA, 2006; ELIAS, 2011). This economic and population growth

1. Master in Environment and Agricultural Production Systems from the State University of Mato Grosso – UNEMAT. Professor at UNIC-Sorriso/MT. E-mail: jussaragiaretta@yahoo.com.br. Orcid: https://orcid.org/0000-0002-8413-3876

2. PhD in Biological Sciences (entomology) from the National Institute of Amazonian Research – INPA. Visiting professor in ecology and collaborator of the postgraduate program in Environment and Agricultural Production Systems at the State University of Mato Grosso – UNEMAT. E-mail: danistorck@gmail.com. Orcid: http://orcid.org/0000-0002-4402-0607.

3. Master and PhD student in Environmental Sciences from the State University of Mato Grosso-UNEMAT. Professor in health policies at UNEMAT. E-mail: joselaineshs@unemat.br. Orcid: http://orcid.org/0000-0001-5667-8871

4. PhD in Biological Sciences (Ecology) from the National Institute of Amazonian Research – INPA. Professor at the Faculty of Agrarian and Biological Sciences and in the postgraduate programs in Environmental Sciences and Ecology and Conservation at the State University of Mato Grosso – UNEMAT. E-mail: msantosfilho@gmail.com. Orcid: https://orcid.org/0000-0002-9784-7114.

5. PhD in Biological Sciences (Ecology) from the National Institute of Amazonian Research – INPA. Professor at the Faculty of Agrarian and Biological Sciences and in the postgraduate programs in Environment Sciences and Environment and Agricultural Production Systems at the State University of Mato Grosso – UNEMAT. E-mail: dioneijs@unema.br. Orcid: http://orcid.org/0000-0002-6189-9756.

has affected the natural vegetation, with increasing deforestation rates (FERREIRA; COELHO, 2015).

The occupation of the north region of Mato Grosso began in the 1970s. It grew in the following decade with the advance of corporate agriculture focused on large-scale grain production and focused on the export of agricultural commodities, mainly soy and corn (MATOS; PESSÔA, 2012; GIARETTA; SILVA, 2017). This intense occupation was part of the process of integrating the midwest economy into the national economy, where the federal government promotes regional development (MONTAGNHANI; LIMA, 2011). The expansion of grain culture in the region meant that important ecological areas of the Cerrado and Amazon biomes had their natural landscapes transformed into large areas of monocultures (FEARNSIDE, 2001).

The city of Sorriso is located to the north of Mato Grosso and was colonized by farmers from the southern region of the country in the 1970s (MATO GROSSO, 2015). These farmers acquired large tracts of land and suppressed the original vegetation, starting the cultivation of rice and later soybeans (CUNHA, 2011). The municipality of Sorriso is currently the largest soybean producer in Brazil and is among the largest grain producers in the country, accounting for 3% of national production and 17% of state production (CONAB, 2016; IBGE, 2016; GIARETTA; SILVA, 2017).

As a result of the expansion of agricultural activities, large tracts of native vegetation were replaced by annual monocultures. This substitution, caused by deforestation, causes problems in the environment, including soil erosion, the pollution of water resources, and the loss of fauna and flora species (FEARNSIDE, 2001). Agribusiness consolidation, however, as described by Brum et al. (2009), has resulted in economic and social improvements to the municipalities and consequent improvements in the population's quality of life. Sorriso, as Brazil's largest soybean producer also reaps these benefits, as it has had great population growth, and in 2016 had a population of 82,792 inhabitants (IBGE, 2016).

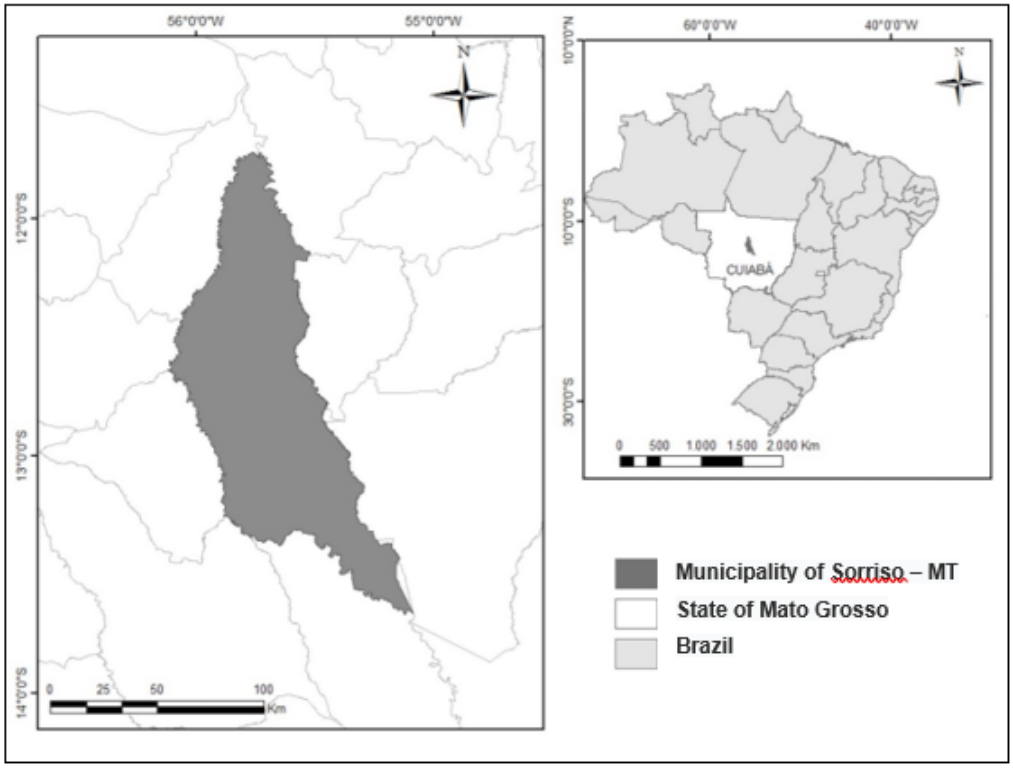
This study analyzed the growth of agriculture in the municipality of Sorriso-MT and the reduction in areas of natural vegetation, as well as relate the growth of production to aspects of municipal economic and social development.

2 Material and methods

2.1 *Study area*

The municipality of Sorriso-MT is located on the banks of BR 163, 412 km from the capital, Cuiabá, (Figure 1) and has a total area of 932,960.30 hectares. Geographically it is in the mid-north portion of the state and politically in the northern Mato Grosso mesoregion, in an ecotone area between the Cerrado and Amazon biomes (IBGE, 2016; MATO GROSSO, 2015).

Figure 1 - Municipality of Sorriso in the national, Mato Grosso and regional context.



Source: Self-elaboration (2017)

2.2 *Methodological procedures*

2.2.1 Survey of socioeconomic data

Data on the cultivated area, yield and productivity of the main crops was obtained from the Rural Assistance and Extension Research Company (EMPAER, MT) for 1985 and 1986; the Mato Grosso State Secretariat of Planning (SEPLAN-MT) website, 1987 to 1989 and the Brazilian Institute of Geography and Statistics (IBGE), for 1990 to 2014. Data on the livestock (animal unit) for 1987 to 2014 was obtained from the IBGE website, and transformed into pasture areas, considering 1.39 head/ha.

Percentages of annual and cumulative growth were calculated from the absolute values, for the period from 1985 to 2014. With these results, combined figures were elaborated, to represent the extension of the cultivated areas of each culture in hectares, and of production in tons.

Socioeconomic data for the period from 1995 to 2016 was obtained from the Annual Budget Law (LOA), which estimates revenue and sets the expenses of the municipality.

Information on urbanization rate, Municipal Human Development Index (MHDI) and Gini Index was obtained from IBGE and the Atlas of Human Development in Brazil.

The Human Development Index (HDI), which ranges from 0 to 1, aims to indicate social improvements, and focuses on three basic aspects: education, measured by years of schooling; longevity, which consists of life expectancy at birth; and per capita income. Values above 0.80 are very high human development; increased from 0.70 to 0.79; 0.5 to 0.69, and low when less than 0.5 (UNITED NATIONS DEVELOPMENT PROGRAM, 2015).

The Gini Index is an instrument for measuring the degree of income concentration of a given place. Numerically the values range from 0 to 1, where zero is equivalent to equal income distribution and 1 to total income concentration, which means total inequality (ATLAS BRASIL, 2013).

2.2.2 Temporal analysis of land use and occupation

Land use and occupation maps were elaborated from satellite images to verify the temporal transformations in the landscape, which allowed the occupation gradient of native vegetation areas to be observed over time. Landsat 5, TM sensor (Thematic Mapper) satellite images from 1985, 1990, 1995, 2000, 2005 and 2010 were acquired and Landsat 8, Operational Land Imager (OLI) sensor data for 2015. These images are available on the National Institute for Space Research - INPE site, and the American Geological Survey – USGS site, corresponding to orbits/points 226/68; 226/69; 227/68 and 227/69, with 30m resolution for the respective years. We chose images between May and September due to the low amount of cloud. Bands 5, 4 and 3 (Landsat 5) and 6, 5 and 4 (Landsat 8) and red green and blue (RGB) color composition were used.

Georeferencing was performed using Spring software. Images in GeoTiff format were used for Landsat 5 Geocover and 30 control points were obtained per image, considering the distribution of the points on the entire surface of the image. This procedure was performed for the four images from 1985, 1990, 1995, 2000, 2005 and 2010, and were used as the basis for the 2015 images that were georeferenced. A pixel error was established for each scene that was less than 0.5 pixels in order to determine georeferencing reliability.

Landsat 8 sensor Operational Land Imager (OLI) images did not go through this procedure as they are georeferenced. The georeferenced images were cropped, mosaiced, and exported to the ArcGis software, which processed the study area through the municipality's shapefile as a mask.

Four classes were used for the supervised classification: i) natural vegetation, ii) agricultural use, iii) urban use and iv) water. The quantifications of the categories and the elaboration of the map layouts of each year were again performed in ArcGis.

2.3 Statistical test

A Pearson Linear Correlation test was performed to determine the degree of correlation between the deforested area and area of agricultural use variables, as well as the

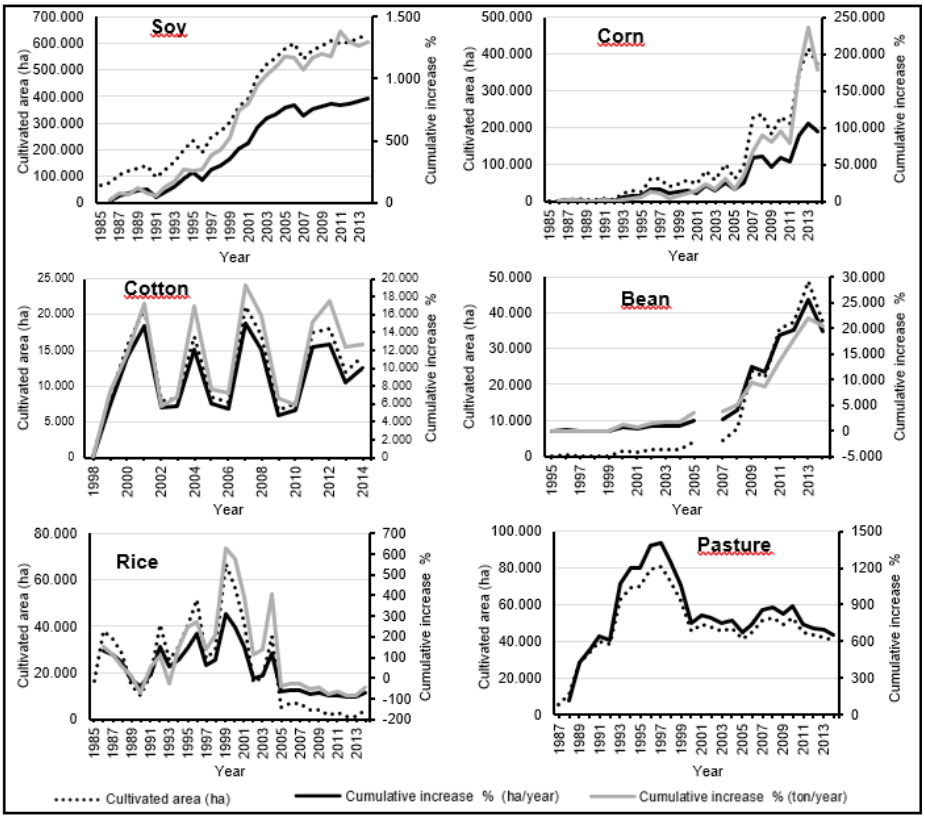
deforested area and soybean cultivated area,. The parametric test was chosen after testing the normality of the data. The Pearson's correlation scale ranges from -1 to 1, so the closer to 1, the greater the degree of correlation (positive or negative) between the variables.

3 Results and discussion

3.1 *Agricultural and livestock production*

The municipality of Sorriso stands out as the largest grain producer in Brazil, , and in 2014 the total cultivated area was 1,065,406 ha (IBGE, 2014). Of the main agricultural activities developed in the last 30 years, we highlight the cultivation of soybeans, corn and beans, all of which increased. Cotton cultivation has fluctuated over the years and there has been a reduction in areas cultivated for rice, as well as livestock activity (EMPAER, 2015; MATO GROSSO, 1987 to 1989) (Figure 2).

Figure 2 - Main agricultural activities developed in the municipality of Sorriso-MT, from 1985 to 2014.



Sources: Empaer (2015); MATO GROSSO (1987 to 1989); IBGE, Municipal agricultural production from 1990 to 2014. Self-elaboration (2017)

In 1985, the soybean acreage [*Glycine max* (L.) Merril] was 7.25% of the municipality's territorial extension (EMPAER, 2015). In 2014 it reached 68.06%, which corresponds to an accumulated growth in cultivated area of 842.75% and 1,301.10% in terms of production, constituting the main crop produced. There was growth in terms of cultivated area in the first five years and a reduction in 1991. From 1997 to 2006 there was an increase in area, with a significant increase in production, but in 2006, despite increased area, there was a reduction in production (Figure 2).

In 2007, there was a significant reduction in the soybean cultivation (9.18%) and production areas (7.11%), with growth returning in the following years. In 2010, even with an increase in the area cultivated, there was a decrease in production. In 2011 there was a slight decrease in the cultivated area, but the highest production of all time was recorded, with 2,088,540 tons harvested. In the following three years the planted area grew again, reaching 635,000 ha in 2014, but production decreased in 2012 and 2013 by 5.11% and 2.77%, respectively (Figure 2).

The expansion of the soybean cultivation area coincided with the replacement of the rice planting areas. This crop replacement is related to the appreciation of the product in each period, since the commodities are affected by market prices (FERREIRA; COELHO, 2015), in 2002 to 2004 the price of soybeans was high, and this encouraged the expansion of oilseed crops in new areas.

Soybean cultivation, the main agricultural activity in Sorriso, was the monoculture that presented the most regularity, in terms of planted area, from 1985 to 2014, and the municipality of Sorriso was the largest producer in Brazil, representing 2.30% of national production (IBGE, 2014). The high production of oilseeds is reflected in the economy, since the soy chain accounted for 65% of municipal ICMS (Tax on Circulation of Goods and Services) revenues in 2009 (BRUM et al., 2009) and 74.9% in 2014 (IBGE, 2014).

The area cultivated with maize (*Zea mays* L.) in Sorriso, which was 390 ha in 1985, had increased to 371,800 thousand hectares in 2014, which was an accumulated increase of 95,233%. Production growth was even higher for the same period. In 1985, 1,123 tons of maize were harvested and in 2014 this was 2,007,720, a cumulative increase of 178,682%. During this period there are two relevant peaks in planted area growth and production. The first was in 2007, when there was an increase of 139.86% in terms of planted area and 88.78% in production, compared to the previous year. The second in 2012 saw the planted area expand by 66.05% and production by 124.59% over the previous year (Figure 2).

The increase in the area for corn cultivation throughout the country was an alternative option to planting a second crop, succeeding the soybean crop.. This is a viable economic alternative for farmers, with the anticipation of sowing of soybeans and a reduction in its cultivation cycle (KAPPES, 2013), thus making it possible to increase production in the same area by having two cultivation cycles in the same year. Maize cultivation is currently the second largest agricultural activity in Sorriso, which makes the municipality the largest producer of grain in the country, with the cultivated area still expanding (IBGE, 2014).

Another crop that has shown growth in the municipality of Sorriso is beans (*Phaseolus vulgaris* L.). Cultivation of this crop began in the municipality in 1995 and until

2014, there was a cumulative increase of 19,478.95% in terms of cultivated area and 20,381.36% in relation to production (IBGE, 1995 to 2014). Bean cultivation showed small oscillations in growth between 1995 and 2008, with a considerable increase in planted area in 2009, 2011 and 2013. In 2014, there was a reduction of 23.59% in planted area compared to 2013 and 7.53% in production (Figure 2).

The increase in the bean crop in Sorriso was due to the cultivation of the second crop (dry season) and winter (irrigated), which consists of the second and third crop (EMBRAPA, 2011). The large increase in the bean crop in 2008 was driven by the increase in the minimum commercialization price established by the federal government that remained for the next six years and reduced in 2014 with the fall in prices (IBGE, 2009, 2013, 2014). In this period, Smile became the second largest bean producer in the country. Also included in this increase was the inclusion of a new cultivated species, the cowpea [*Vigna unguiculata* (L.) Walp.]. This species presents characteristics of grain rusticity, resistance to diseases, lower water requirements, low production cost and of the potential for growth in low fertility soils (IBGE, 2009). The growth of cowpea cultivated areas in Sorriso and in the midwest region has been due to medium- and large-scale rural entrepreneurs who practice highly technical production (EMBRAPA, 2011).

The cotton crop (*Gossypinum hirsutum* L.) showed the highest variation in the studied period, with production corresponding to the variation of the cultivated area. The largest extensions in cultivated areas was in 2001 and 2007, with more than 20,000 ha of cultivated area and respective production of 65,678 and 73,115 tons. In 2014 there was a reduction in cultivated area and production compared to 2001, of 67.04% and 70.40% respectively (Figure 2).

The large fluctuation in cotton production is related to market demand and product price, however, the fall in 2009 was caused by the high cost of production (IBGE, 2009). The rise in the price of cotton at the beginning of 2014 again encouraged farmers to opt for cotton instead of corn as the second option, as both crops compete for area (IBGE, 2014).

Rice cultivation (*Oryza sativa* L.) was the second largest agricultural activity in Sorriso in 1985. It expanded from 1995 to 2000, but drastically reduced from 2005. There was little recovery in 2014. with a cultivation of 4,300 ha, but the fall in activity corresponded to 73.60% in terms of planted area and 43.43% in production when compared to 1985 (Figure 2).

Rice cultivation was the first major agricultural activity in the municipality. It presented successive reductions over the years, affected by falling prices and/or the appreciation of other crops and, so producers opted for those that offered better economic results. In Sorriso and in the state of Mato Grosso, rice has lost ground to soybean cultivation. According to Cunha et al. (2008), rice was the main agricultural activity developed from 1977 to 1983, and represented 65% of grain production in the state, but was surpassed by soybeans the following year.

Compared to other agricultural activities, livestock is of little relevance in the municipality today. In 1987, the area under grazing was 5,358 ha, with upward growth until 1997, when it reached 80,856 ha. In the following years, the pasture area reduced

to 40,286 ha in 2014 (Figure 2). From 1993 to 1999, livestock activity was more intense, coinciding with a period of higher deforestation in the municipality of Sorriso, because in general the first agricultural activity practiced after deforestation is raising cattle and then pastures are replaced by grain crops (DOMINGUES et al., 2014). From the 2000s on, livestock activity decreased and yielded areas to grain production, with the consequent displacement of cattle husbandry to other regions, following the pattern of other municipalities in the state with high production of soybean, corn and cotton (DOMINGUES; BERMANN, 2012).

Although some crops have reduced in cultivated areas over the years in Sorriso, this does not directly imply a reduction of areas used for agriculture and the consequent possible recovery of native vegetation. In practice, the deforested areas are still cultivated by one crop or another, which varies according to the size of each crop, according to market demand and prices. In addition, the occupation of pasture areas by soybean cultivation continues to contribute to deforestation, since according to Brandão et al. (2006), new forest areas are then cleared for pasture.

In 30 years of political-administrative emancipation, Smile stands out among the largest grain producing municipalities in the country, and as the largest soy producer. This is due to its privileged location on the margins of the BR 163 highway, which facilitates the arrival of inputs and production flow (CHRISTIAN, 2014), allied to the flat or slightly undulating features that facilitate mechanization. The area also has a favorable water regime, with two well-defined climatic seasons, one rainy and one dry (MATOS; PESSÔA, 2012).

Encouraging the use of midwest and northern Brazil was fundamental for the economic development, not only of this region, but of the country as a whole. However, economic activity based on agriculture exerted direct pressure on the environment and over the years, important areas of the Mato Grosso Cerrado and ecotonal areas were replaced by monocultures (SILVA; SATO, 2012). The demand for production, associated with the productive potential of the region, has stimulated this relationship between economic gains and environmental losses, which causes concern not only for Brazilian society, but also for the countries consuming the results of this production (BRUM et al., 2009), which charge social and environmental commitments.

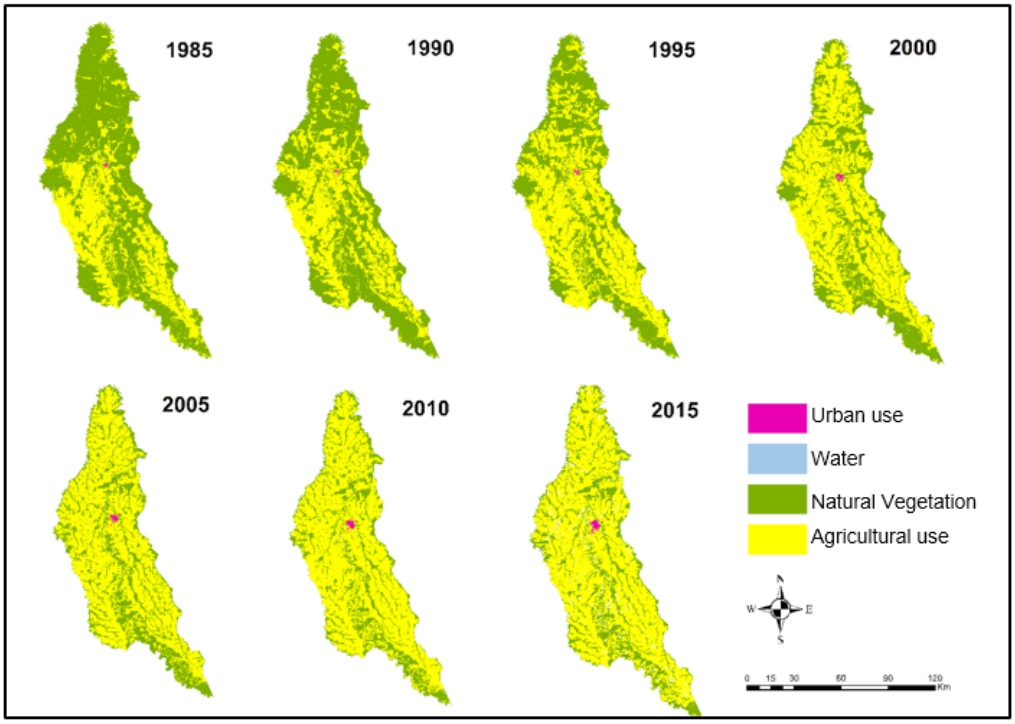
3.2 *Land use and occupation from 1985 to 2015 and the impact on the environment*

The advance of agricultural activities in the region of Sorriso has caused a severe transformation in land use and occupation in just 30 years. In 1985, the natural vegetation area was 63.06% of the 927,932.54 ha of the municipality. Agricultural activities occupied 36.61%, water depth 0.26%, urban use, 0.04%, and other uses 0.03% of the area. Over the next 30 years, the extent of deforestation more than doubled, and in 2015 the area used for agricultural activities reached 74.35% of the municipality's territorial extension while natural vegetation was reduced to 24.97% of the municipal area (Figure 3).

The main economic activity of the agricultural use class is the cultivation of soy. In 1985, 67,356 ha cultivated in this area , representing 19.82% of this class. In 2014,

soybean cultivation occupied 635,000 ha, corresponding to 92.02% of the agricultural use class and 68% of deforested areas. Brum et al. (2009) argue that soybean cultivation was responsible for an important extension of the deforested area in Sorriso, although livestock has also contributed to this, because after deforestation the first activity was generally livestock grazing before grain cultivation (DOMINGUES et al., 2014).

Figure 3 - Distribution of the classes of use and occupation of the soil in the municipality of Sorriso-MT, in the years of 1985, 1990, 1995, 2000, 2005, 2010 and 2015.



Source: Self-elaboration (2017)

While there has been a significant increase in agricultural production in the municipality of Sorriso, there has been a corresponding reduction in native vegetation areas. The expansion of soybean cultivation has thus been seen as a major issue in the set of threats to biodiversity in regions such as Sorriso (FEARNSIDE, 2001; QUEIROZ, 2009). Delmon et al. (2013) show that in 1988 the deforested area in the municipality corresponded to less than half that of the current area, 36.7%. This suggests that in 30 years there was an increase of 99.77% in deforestation in the municipality, and the remaining 24.97% of native areas today do not meet the percentages of areas to be conserved by Brazilian law.

The increase in agricultural activities over time in the municipality of Sorriso corroborate the study by Schwenk and Cruz (2008), who argued that the municipalities that have most of the territorial extension with soy cultivation find consolidated for this

economic activity. However, they have no more possibilities of expanding new areas, because only small fragments of natural vegetation remain, reflecting a modified and degraded landscape. This condition is a major concern regarding biodiversity conservation, as studies have shown that fragmentation processes cause serious changes in the dynamics of animal and plant populations, which pose a serious threat to biological diversity (LAURANCE; PERES, 2006; PERES et al., 2010).

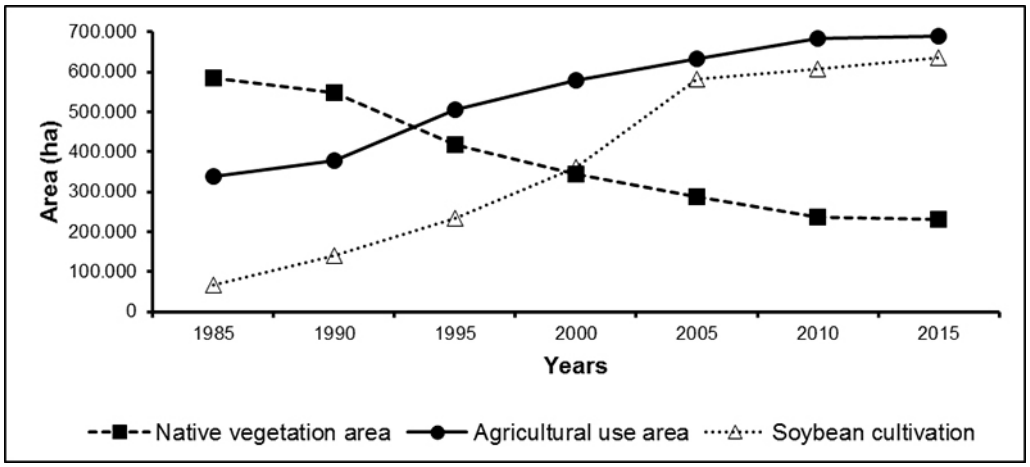
Within 30 years, 353,485 ha were deforested, corresponding to 38% of the natural vegetation in the municipality of Sorriso. The highest intensity deforestation occurred from 1991 to 1995, when 128,880 hectares of natural vegetation were suppressed, which represented 36.46% of the deforested area in three decades. There was also high deforestation recorded from 1996 to 2000, and the next five years, corresponding, respectively, to 20.79% and 16.06% of the three decades studied.

In the 1990s and early 2000s local producers received large amounts of funding directed to the development of agricultural activities. It was also during this period that the largest number of forest burnings was recorded in the municipality, due to the burning of felled areas (AZEVEDO; PASQUIS, 2007). As a result, 73.4% of the territorial extension of the municipality of Sorriso was already deforested in 2004, with a corresponding environmental liability. This direct relationship between the granting of agricultural credit and increased deforestation is also described by Ferreira and Coelho (2015) and Camargo (2017), who pointed out that there was a significant increase in deforestation in areas of the Legal Amazon states, with the economic stability resulting from the Real Plan in 1994 and later 2004 with the rise in agricultural commodity prices.

It is possible to note a strong correlation between the increase in areas for agricultural use and the deforested area ($r = 0.99$; $p = 0.00$); that is, increasing the deforested area the agricultural activity increases in practically the same proportion. The same was equivalence was noted for deforested versus soybean acreage ($r = 0.97$; $p = 0.002$) (Figure 4). It is clear from this figure that from 2005 the deforested area is used for soybean cultivation at the time as rice plantations and pasture are reduced (Figure 2).

Deforestation continued to increase from 1985 to 2010 in the municipality of Sorriso and then reduced and stabilized from 2011 to 2015. This reduction is mainly due to the scarcity of natural areas available for exploitation, as 73.32% of the entire territory was already used for agricultural activities in 2010.The current 24.97% of native vegetation area in the municipality does not even meet the established by the current environmental legislation, since Sorriso is in the Legal Amazon area. Legislation does not clearly specify preservation percentages for ecotone areas such as Sorriso. Article 12 of Law No. 12,651 of 2012, however, states that in the Cerrado biome the legal reserves (RL) must represent at least 35% of the area and in the Amazon biome it must be 80% (BRASIL, 2012). In this case if we apply the Cerrado condition, there is a minimum environmental liability of 4.3%, while if we apply the Amazon Forest condition the liability reaches 55.3%. In addition to these percentages, Permanent Preservation Areas should also be considered as watercourse. The extent of preserved areas in the municipality of Sorriso is in fact below the legal limit.

Figure 4 - Graphical relationship of native vegetation area, agricultural use and soybean cultivation in the municipality of Sorriso-MT, in the period from 1985 to 2015.



Source: Self-elaboration (2017)

The maintenance of the RL areas, as established by Law 12,651/2012 (BRASIL, 2012) has the function of ensuring the sustainable economic use of natural resources, as well as assisting in the conservation and rehabilitation of ecological processes, promoting the conservation of genetic diversity and serving as a refuge and protection for wildlife and native flora. In the case of the Municipality of Sorriso, these fundamental principles are undermined, by the small extent of the conserved areas and their distribution in small isolated vegetation units in a fragment mosaic, as shown in Figure 3.

3.3 *Socioeconomic aspect*

The increase in agricultural production, and especially grain production, in the municipality of Sorriso was responsible for an increase in tax collection, reflecting the social improvements to the municipality, which promoted migration and the consequent growth of the local population. In 1991 Sorriso had 16,107 inhabitants, but then experienced growth of 414% in the next 25 years, and in 2016 had 82,792 inhabitants. During the 1990s and early 2000s the cities that developed under agribusiness in the Alto Teles Pires region north of Mato Grosso, such as Sorriso, had an annual population growth of 7% to 9% above rates for the state and country (FREDERICO, 2011; VOLOCHKO, 2015).

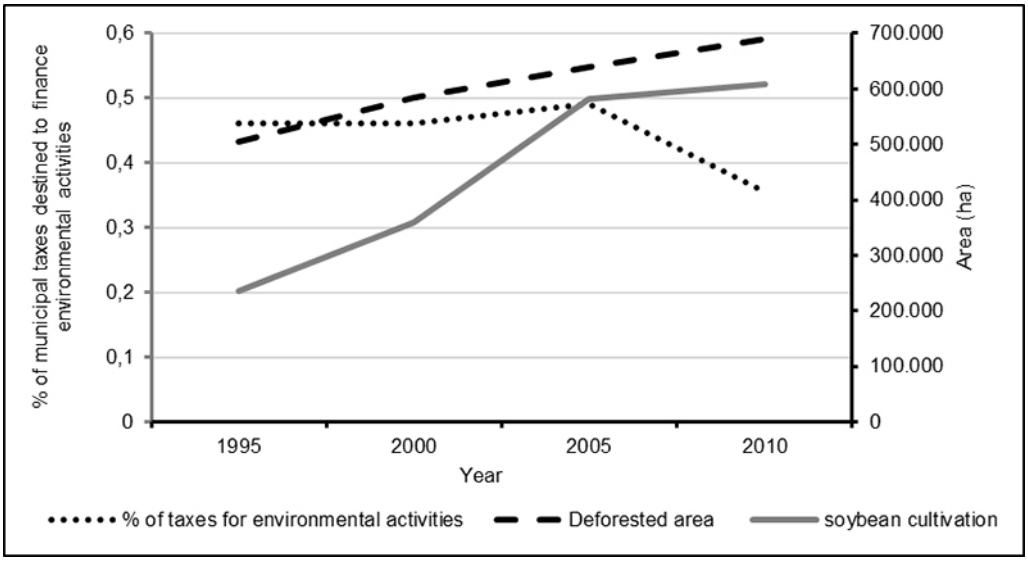
According to data released by the IBGE (2011), there was also growth in the urbanization rate of the municipality, from 72.92% in 1991 to 87.74% in 2010. The high urbanization rate of Sorriso is typical of cities that developed with the expansion of the agricultural frontier, resulting from the rural exodus, migratory processes (CAMARGO, 2017) and the centralization of trade and specialized services involving the agricultural production chain (ELIAS, 2011). As a result, it has urbanization rates above 80%, such as in Lucas do Rio Verde and Nova Mutum in the state of Mato Grosso and the muni-

cipality of Luiz Eduardo Magalhães in Bahia, which reached 91% (FREDERICO, 2011; VOLOCHKO; 2015).

Economically, the municipality of Sorriso's budget was R$ 18 million in 1995. It increased 1,361% and reached R$ 263 million in 2016. The municipality's expenditures on statutory obligations such as education and health were above the legal minimum limits, reaching 31 and 22% respectively. However, the proportion of resources earmarked for the environment was proportionally reduced, even with the increase in revenue from increased production and the consequent expansion of environmental impacts caused by deforestation.

Municipal revenue grew steadily throughout the period, however, when we analyze the allocations towards the environment, it can be noted that there was a decrease in investments from 2005 (Figure 5). In terms of absolute value, there was an increase, but the increase proportional to the total amount of municipal revenue was decreasing, reflecting public administration's neglect of environmental issues. Ideally, environmental allocations should also be expanded to provide environmental control, education, mitigation, recomposition and compensation measures for a highly anthropized region.

Figure 5 - Graphical demonstration of the percentage of taxes of Sorriso-MT destined to the financing of environmental activities; expansion of deforested areas and soybean production in the Municipality.



Source: Self-elaboration (2017)

Faced with economic growth, there was an increase in the Municipal Human Development Index (MHDI) in Sorriso, which went from 0.51 in 1991 to 0.66 in 2000 and 0.74 in 2010. Both first values were classified by the United Nations Development Program (2015) as medium and the third as high. The fastest growing dimension was

education, followed by longevity and per capita income (ATLAS BRASIL, 2013). The high HDI, above both the state and country averages, was found in municipalities with an economic basis in soybean and cotton production (AZEVEDO; PASQUIS, 2007), as is the case for Sorriso and Tapurah, also in Mato Thick.

Frederico (2011) notes that agribusiness municipalities in Brazil have high social disparities, however, even though they have higher HDI indices and per capita income than other cities. These municipalities also have other problems, such as high unemployment, which contributes to the growth of the peripheries and triggers various social problems. A high housing deficit is also common, and the index of households without a water supply is still high (ELIAS; PEQUENO, 2007). Cunha (2006) argues that economic activities related to cattle ranching and soy cultivation imply rural depopulation and swelling of cities. These agricultural activities take place on large tracts of land, but require little labor, and the population tends to migrate to urban centers (CAMARGO, 2017).

An analysis of the Gini Index for Smile shows that the municipality had increased income concentration in the 1990s, with records of 0.55 in 1991 and 0.62 in 2000. Inequality decreased in the following years with a value of 0.54 in 2010, however it was just enough to return to the levels of the previous decade. This result is within the averages for the state of Mato Grosso and Brazil, which were, respectively, 0.62 and 0.60 in 2000, and 0.55 and 0.52 in 2010 (ATLAS BRASIL, 2013, IBGE, 2010). These values are very high and place Brazil among the countries with the greatest social inequality in the world. Similarly, the index recorded for Sorriso is high, and shows that although the municipality has a high HDI, income concentration is still a socioeconomic problem, as it is for the whole country, especially in a place where the economy has been growing in recent decades. A similar condition is reported by Aguiar and Monteiro (2005) for the municipality of Uruçuí in Piauí, where soybean production contributed to local economic growth, but did not have a positive impact on income distribution or the improvement of the population's living conditions.

Given this reality, it is noted that the municipalities with an economic basis for agricultural activities (monocultures and intensive livestock) have a GDP and MHDI value that is often higher than the other municipalities, but they do not necessarily have any improvement in the quality of life. This is clear when we analyze income distribution through the Gini Index. These municipalities have the highest concentrations of income, which shows, according to Silva and Sato (2012), that this model of agro-export economic development does not take account of the entire local population, economically, as expected.

Income concentration in the municipality of Sorriso, and certainly in other areas with similar economic activities, is also related to land concentration. Brandão et al. (2006) and Camargo (2017) note that the concentration of land in the country is the result of government incentive programs for land occupation and the intensification of agricultural modernization, which also contributed to environmental degradation, precarious work and increased socioeconomic inequalities.

The Smile region, which prior to the 1970s was considered a "demographic void," was never effectively unpopulated. It was inhabited by traditional populations and small

farmers who were not taken into consideration and lost their land and sociocultural identity when they were expelled or relocated to other regions (SILVA; SATO, 2012). When displaced, it was left up to this population to migrate to urban centers or to move deeper into the forest and clear new areas by intensifying logging (FEARNSIDE, 2001; ROS-TONEN, 2007). These "voids" are currently concentrated in the hands of the few investors who practice intensive agriculture, whose high production technology reduces the need for labor (BUAINAIN; DEDECCA, 2008; QUEIROZ, 2009) and they are instead characterized as devoid of people, and full of commodities.

Although intensive agriculture forms the basis of the Smile economy, whose generated taxes are fundamental for the development of municipal obligations (BRUM et al., 2009), authors such as Custódio (2005), Cunha (2011), Domingues and Bermann (2012) and Santos (2012) reflect that this agro-export economic development model, which exists in regions such as Sorriso, has a negative social impact. The main problems are related to the reduction of employment in the countryside, with consequent rural exodus. This promotes a reduction in production capacity and traditional and diversified food, which compromises the food security of the local population.

It also follows that the low employability of the local workforce, the concentration of income and the high environmental cost will have medium and long term effects, which, according to Milani (2008) will be more strongly felt by the population that did not generate them. Although social improvements have been made in many respects, the environmental cost of the agro-export production model has directly impacted the environment, transforming the natural landscape into large areas cultivated with grain, and as Fearnside (2001) and Queiroz (2009) certainly show, brought large losses of biodiversity.

5 Conclusion

The municipality of Sorriso is an important hub of regional and national agricultural production, especially soybean, corn, cotton, beans and rice. Advances in agribusiness has meant that the greater territorial extension of the municipality, consisting of an ecotone between the Cerrado and Amazon biomes, has been deforested, compromising an important portion of biodiversity and future generations.

Except for rare areas of pasture, there is no more land available in the municipality for the horizontal expansion of agricultural production. It is thus necessary to invest in productivity, using technologies that enable greater and better production in areas already cultivated. We need to focus on a land-saving biological model to maintain municipal economic growth, dependent on commodity production. Another means of doing so is to diversify the economy, encouraging the industrialization of production through public policies, in order to strengthen the local economy with added value for products and contributing to the generation of new jobs.

The economic growth of the municipality has contributed to social improvements such as health and education, and is reflected in high HDI indices, however, this index is unmasked when analyzing the Gini Index, which reflects the high income concentration.

As much as the municipality shows high economic growth, there is no accompanying income distribution.

In these circumstances it is important to raise awareness and encourage the collective participation of producers and civil society in the municipality, in order to create economic growth in an environmentally viable and socially fair manner. It is important to identify and recover environmental liabilities in both the Legal Reserve and Permanent Preservation Areas, so that there are no major problems in the future.

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Submitted on: 11/05/2017
Accepted on: 24/08/2019
http://dx.doi.org/10.1590/1809-4422asoc0139r2vu19L4AO
2019;22:e01392
Original Article

ADVANCEMENT OF AGRICULTURAL ACTIVITY ON NATURAL VEGETATION AREAS IN NATIONAL AGRIBUSINESS CAPITAL

JUSSARA GIARETTA
DANIELLE STORCK-TONON
JOSELAINE SOUTO HALL SILVA
MANOEL DOS SANTOS FILHO
DIONEI JOSÉ DA SILVA

ADVANCEMENT OF AGRICULTURAL ACTIVITY ON NATURAL VEGETATION AREAS IN NATIONAL AGRIBUSINESS CAPITAL

Abstract: The municipality of Sorriso-MT has become the largest grain producer in the country in the last 40 years, which has caused important economic, social and local changes. Thus, we seek to analyze and understand the dynamics of these transformations. We evaluate the growth of agricultural activity in the Municipality, the reduction of areas of natural vegetation and relate the growth of production with aspects of economic and social development. In order to verify the temporal transformations in the landscape, maps of soil occupation were elaborated from satellite images, in a five-year time scale (1985 to 2015). In 2015, 24.97% of the area of the Municipality covered by natural vegetation. Soy is the main crop, present in 68.6% of the area of the Municipality. If, on the one hand, agricultural activities generate taxes that are fundamental to municipal obligations, on the other hand, they also generate relevant socioenvironmental impacts.

Keywords: Sorriso - MT, Agricultural Production, Soybean, Natural Vegetation, Geotechnologies.

AVANÇO DA ATIVIDADE AGROPECUÁRIA SOBRE AS ÁREAS DE VEGETAÇÃO NATURAL NA CAPITAL NACIONAL DO AGRONEGÓCIO

Resumo: O município de Sorriso-MT tornou-se o maior produtor de grãos do País nos últimos 40 anos, o que provocou importantes transformações econômicas, sociais e na paisagem local. Assim, buscamos analisar e compreender a dinâmica destas transformações. Avaliamos o crescimento da atividade agropecuária no Município, a diminuição das áreas de vegetação natural e relacionamos o crescimento da produção com aspectos de desenvolvimento econômico e social**.** Para verificar as transformações temporais na

paisagem, foram elaborados mapas de ocupação do solo a partir de imagens de satélite, em escala temporal de cinco anos (1985 a 2015). Em 2015, restavam 24,97% da área do Município coberta por vegetação natural. A soja é a principal cultura, estando presente em 68,6% da área do Município. Se, por um lado, as atividades agrícolas geram impostos fundamentais para as obrigações municipais, por outro geram impactos sociais e ambientais relevantes.

***Palavras-chave*:** Sorriso-MT, Produção Agrícola, Soja, Vegetação Natural, Geotecnologias.

AVANCE DE LA ACTIVIDAD AGRÍCOLA EN LAS ÁREAS DE VEGETACIÓN NATURAL EN LA CAPITAL NACIONAL DEL AGRONEGOCIO

Resumen: El municipio de Sorriso-MT se ha convertido en el mayor productor de granos del país en los últimos 40 años, lo que ha provocado importantes cambios económicos, sociales y en el paisaje local. Así buscamos analizar y comprender la dinámica de estos cambios. Evaluamos el crecimiento de la actividad agropecuaria en el Municipio y la disminución de las áreas de vegetación natural y relacionamos el crecimiento de la producción con aspectos del desarrollo económico y social. Para verificar las transformaciones temporales en el paisaje, elaboramos mapas de ocupación del suelo a partir de imágenes de satélite, a temporal de cinco años (1985-2015). En 2015, quedaban 24,97% del área del Municipio con vegetación natural. La soja es la principal cultura, presente en el 68,6% del área del Municipio. Por un lado, las actividades agrícolas generan impuestos básicos para las obligaciones municipales, por el otro generan significativos impactos sociales y ambientales.

Palabras clave: Sorriso – MT, Producción Agrícola, Soja, Vegetación Natural, Geotecnología.