


# Land for planting, harvesting and sickness? Agricultural production, pesticides and disease in Goiás, Brazil (2000 to 2013)

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## **Abstract**

This article discusses the expansion of agribusiness in the state of Goiás, Brazil, the use of toxic agrochemicals or pesticides, and the resulting ailments contracted by the local population between 2000 and 2013, with emphasis on five municipalities located in the microregion of Ceres (Goianesia, Itapaci, Uruana, Rialma and Barro Alto). The approach employed in this study consisted of bibliographical research, an exploratory analysis of the data, and a non-parametric descriptive and statistical analysis. The findings reveal marked urban expansion in the aforementioned municipalities in the state of Goiás from 2000 to 2013, a shrinking Cerrado biome, and augmented agricultural productivity of sugarcane, corn and soy, accompanied by an increase in the number of poisoning victims, suicide attempts using pesticides, neoplasms and congenital malformations, according to data recorded in public health information systems.

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## INTRODUCTION

Brazil's agribusiness production chain has become dependent on the intensive use of agrochemicals that contaminate the environment and impair the health of living beings, causing sickness among humans, the extinction of animal and plant species, and increasing pesticide resistance (ABREU; ALONZO, 2016; CARNEIRO et al., 2015; JOBIM, 2010; PORTO; SOARES, 2012; SILVA, 2005; STOPPELLI, 2005).

According to Albuquerque et al. (2015), Brazilian agribusiness generated 8.8 billion dollars for the national trade balance in 1991, and 79.4 billion dollars in 2012. From 2000 to 2008, the global pesticide market showed a growth of 45.4%, while the domestic pesticide market increased by 176.0%. Since then, Brazil has become one of the world's 10 largest pesticide consumer markets, thereby increasing the health risks of the population exposed to toxic agrochemicals.

Agribusiness is one of the main economic development activities in Goiás. Its territorialization in the state was heterogeneous and it was organized considering the region's topography and abundance of water resources, among other factors (MATOS, 2013). This model of agricultural production has expanded in the state, especially that of soybean, corn and sugarcane.

According to the Mauro Borges Institute of Statistics and Socioeconomic Studies (IMB), the productivity of the three aforementioned crops increased between 2000 and 2013, indicating an intensification in the use of agrochemical products (IMB, 2018). According to the Health Surveillance Report of Populations Exposed to Pesticides in the State of Goiás (BRASIL, 2016), these products include toxic chemicals such as pesticides and herbicides, which contributed directly or indirectly to increase sickness due to acute or chronic toxicity.

The harmful effects of pesticides on human health have therefore been the focus of research not only by the national (ABREU; ALONZO, 2016; CORCINO, 2019; JOBIM, 2010; PORTO; SOARES, 2012; SILVA, 2005; STOPPELLI, 2005) and international scientific community (ACQUAVELLA, 1998; ALAVANJA et al., 2003; 2004; DOULL; LEVINE, 1993; EATON, 2008; LEVINE; DOULL, 1992), but also by national institutions (Fórum Estadual de Combate aos Impactos dos Agrotóxicos do Estado do Rio de Janeiro, Associação Brasileira de Saúde Coletiva,

Conselho Nacional de Segurança Alimentar e Nutricional, Fundação Oswaldo Cruz and Instituto Nacional de Cancer José de Alencar Gomes da Silva) and international agencies (International Agency for Research on Cancer; Human Rights Watch). It should be noted that the topics discussed here include those that correlate chronic and congenital diseases with the use of pesticides, especially in areas where agribusiness is territorialized.

In this context, this article discusses the expansion of agribusiness in the state of Goiás, the use of pesticides and illnesses in the population in the years 2000 to 2013, with emphasis on five municipalities located in the microregion of Ceres, state of Goiás, Brazil, namely: Goianésia, Itapaci, Uruana, Rialma and Barro Alto.

We sought to answer the following questions: from 2000 to 2013, was there an increase in the production of sugarcane, corn and soybeans, allied to an increase in the use of pesticides in the municipalities surveyed? During those same years, did cases of diseases such as cancer, congenital malformation and pesticide poisoning increase in the municipalities surveyed? To what types of pesticide is the population of those municipalities exposed?

These questions were answered based on data available in the following information systems: Mauro Borges Institute, Center for Toxicological Information of Goiás (CIT/GO); National Toxicology and Pharmacology Information System (SINITOX); State of Goiás Health Information System; Cancer Information System (SISCAN); Mortality Information System (SIM), Information System for Notifiable Diseases (SINAN); Ministry of Agriculture, Livestock and Food Supply (MAPA), and Goiás Agricultural Defense Agency (AGRODEFESA).

The methodological procedure used in this study also consisted of exploratory data analysis, aimed at examining the data before applying any statistical technique in order, whenever possible, to understand and compile the data garnered from the various information systems and physical files and then make a descriptive and non-parametric statistical analysis. The research sampling criterion was the total resident population of the municipalities studied in the microregion of Ceres, in the state of Goiás, Brazil.

## AGRIBUSINESS – POLICIES, UTILIZATION AND POISONING

In the 1970s, agribusiness led to the restructuring of Brazil's territory, with a "strong presence of the State in the articulation between agents involved in modern production networks, bringing about a closer relationship and interdependence between agriculture and industry" (CASTILHO, 2007, p.35). In Goiás, this restructuring took place through a project aimed at integrating the Northeast with the Amazon region and the Brazilian Highlands (Planalto Central), which invested resources in the construction of highways, airports and telecommunications networks for economic expansion.

In 1975, through the Cerrado Development Program (POLOCENTRO), which was established by Decree no. 75320 of 29 Jan 1975, investments were made in research, technical assistance, reforestation, financing of motorized patrols, and the expansion of support infrastructure (transport, energy and storage) and of rural credit.

According to Estevam (1997), the mechanism that capitalized agricultural activity in Goiás was rural credit, which subsidized inputs, machinery and equipment. Rural financing was the main factor responsible for mechanized agriculture and the growth of the agricultural machinery industry. Between 1970 and 1985, rural credit in Goiás showed a 7% higher growth rate than in Brazil's other states. According to three Censuses of Agriculture, conducted by Instituto Brasileiro de Geografia e Estatística (IBGE), the number of tractors in Goiás rose significantly from 5,692 units in 1970 to 33,548 units in 1985, reaching 43,313 units in 1995. The number of tractors in Goiás rose significantly, going from 5,692 units in 1970 to 33,548 units in 1985, and reaching 43,313 units in 1995 (IBGE, 1970; 1985; 1996).

In the 1980s, POLOCENTRO's public policy was replaced with the Brazil-Japan Cooperation Program for the Development of the Cerrado (PRODECER), whose main function was to transform the Cerrado region into a "producer of grains, soybeans, mainly products in short supply in the Japanese market" (INOCÊNCIO; CALAÇA, 2009, p.3).

According to Castilho (2007), Brazil's financial crisis in the 1980s led to privatization, concessions, reduction of subsidies and commercial opening. Starting in the 1990s, according to Silveira (2016), Brazil's government granted greater market freedom to agriculture to offset the economic crisis established in the 1980s. The author also points out that in Goiás:

Commodity production is established, attracting to its territory large multinational companies of the agricultural sector. This resulted in the industrialization of agriculture and in the process of creating the large conglomerates that command production (SILVEIRA, 2016, p. 122).

According to the IMB (2013), agriculture in the state of Goiás specializes in the production of commodities. In a bulletin, the IMB stated that (the production of foods such as rice and beans are negligible *vis-à-vis* the state's total agricultural volume. The document pointed out that Goiás was one of the country's largest rice producers, and that in 2013 its production volume was only 1.26% of the national volume, a finding that was confirmed at a national level

Currently, the total area on which rice, beans, wheat and cassava are grown corresponds to close to 8.5 million hectares, which is smaller than the total area covered by sugarcane. Moreover, the total area given over to growing these four crops plus sugarcane corresponds to about 17 million hectares, in other words, half the size of the area dedicated to soybean production (BOMBARDI, 2017, p.28).

The author also points out that the area dedicated to the production of the items that make up the staple foods basket (rice, beans, manioc flour and wheat) has decreased, while the area used for the production of soy and sugarcane has increased (BOMBARDI, 2017), and the same holds in the state of Goiás.

According to the IMB, at the beginning of the 2010s, the state of Goiás advanced in the ranking of national production, especially with soybeans, sugarcane and corn. "In the case of corn, the last survey of agricultural production identified the state of Goiás as the third largest national producer" (IMB, 2013). Moreover, regarding sugar and ethanol production, "The emergence of new sugarcane processing plants is boosting the production of ethanol and sugar in the state" (IMB, 2013), placing Goiás in third place in the national production of sugarcane.

According to data released by the IMB, production per ton of sugarcane, soybeans and corn increased in Goiás between 2000 and 2013. Sugarcane production increased by 682.64%; soybeans by 217.76% and corn by 210.05%. And the harvested area of sugarcane increased by 618%, soy by 197.70% and corn by 146.45% (IMB, 2013). According to AGRODEFESA (2018),

the use of agrochemicals for the production of the aforementioned crops has increased, including pesticides.

AGRODEFESA (2018) also reports that 38% of the pesticides used in sugarcane, soy and corn crops are extremely toxic, 18% highly toxic, 36% moderately toxic and 7% slightly toxic. Another relevant fact is that 793 pesticides are registered for use in Goiás and the most widely used are insecticides (26.35%), fungicides (21.56%) and herbicides (36.82%). The others are growth regulators, nematocides, adhesive spreaders, acaricides, synthetic pheromones, etc.

According to the Health Surveillance Report of Populations Exposed to Pesticides in the State of Goiás (BRASIL, 2016), published by the Ministry of Health, the use of pesticides in agricultural production has risen sharply in Goiás. In 2007, this increase represented 25,247,000 (kg) in a planted area of 3,955,025 (ha), and by 2012 this amount had increased to 110,497,804 (kg) of active ingredients on 5,282,270 ha of planted area (BRASIL, 2016, p.4). The information available in this report indicates an increase of 337% in the use of pesticides between 2007 and 2012, in contrast to a 33% increase in hectares of planted areas.

Also according to the National Health Surveillance Report of Populations Exposed to Pesticides (BRASIL, 2016, p. 72), approximately “95 million kilos, which represents 28.7% of the trade in the region [Central-West]” are sold in Goiás. The document also states that despite the decrease in pesticide sales in Goiás in 2012, in the following year

There was an increase in the incidence of pesticide poisoning, which may reflect the state’s work in raising the awareness of managers and health professionals to improve the processes of detection and notification of pesticide poisoning cases (BRASIL, 2016, p. 76).

The data provided by SINITOX (BRASIL, 2017) demonstrate the fluctuation and increase in the number of individual accidents, occupational accidents, and suicide attempts by intentional ingestion of pesticides in Goiás. A particular focus falls on the increase in attempted suicide in Goiás. In Brazil, according to the Ministry of Health, from 2007 to 2013, 32,369 (54.3%) of the 59,576 notifications of pesticide poisoning registered in SINAN pertain to attempted suicides (BRASIL, 2016). The Ministry of Health states that 1,435 suicide attempts by pesticide poisoning were notified

between 2007 and 2013, with 41 cases culminating in death (BRASIL, 2016).

In Goiás, according to Tejerina (2018), from 2011 to 2012, 54.52% of the cases of pesticide poisoning were the result of attempted suicide and occurred more frequently among males of working age (20 to 39 years old). Another point raised by the author is that the number of notifications was higher in the urban area.

The intentional ingestion of lethal pesticides may be attributed to their ready availability and wide variety in the market. Easy access to harmful chemical products may influence the victim’s decision to commit suicide; hence, reducing access may be a preventive strategy (TEJERINA, 2018, p.243).

In addition to cases of attempted suicides, discussions about the harm caused to human health by the use of pesticides have been the subject of much research. One that stands out is the report published in 2018 by the international organization Human Rights Watch, “You Don’t Want to Breathe Poison Anymore,” which presents a study on failures to protect rural communities exposed to pesticides. The document states that:

The Human Rights Watch surveyed in Brazil for several reasons, including the significant amount of pesticides used in the country compared to worldwide consumption, and found that many of the pesticides used in Brazil are highly dangerous, and that there is intense political pressure to further weaken Brazil’s regulatory system for pesticides (HRW, 2018, p.34).

The document contains statements by people affected by aerial spraying, including reports by people from the rural school community in Rio Verde, Goiás, who were affected by aerial spraying of pesticides in 2013. According to the technical report contained in the aforementioned document, the pesticide sprayed from the airplane was not released for use in airplanes. The event caused acute poisoning in 42 people, and 29 were hospitalized with vomiting, dizziness and headaches.

According to the Health Surveillance Report of Populations Exposed to Pesticides in the State of Goiás (BRASIL, 2016), cases of pesticide poisoning in Goiás grew 87% between 2007 and 2012. This report stated that the rate of pesticide poisoning per 100,000 inhabitants was 4.02 in 2007; 4.24 in 2008; 6.56 in 2009; 7.38 in 2010;



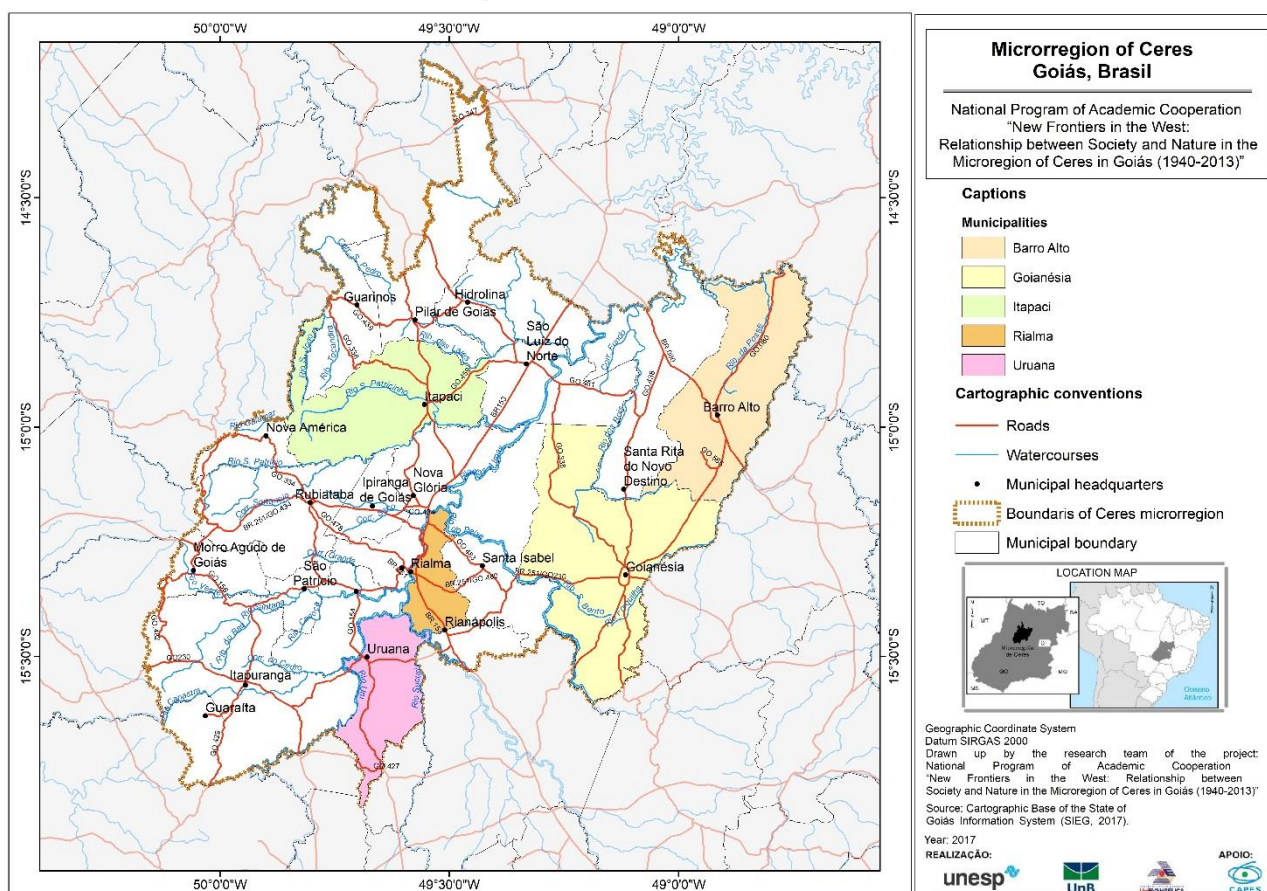
and then decreased to 5.54 in 2011 and 7.52 in 2012.

The Goiás State Department of Health (GOIÁS, 2016) reported that the rate of consumption of pesticides in the state is 16.96 (Kg/ha), ranking fifth in the country in terms of pesticide-related health risks to the population. According to the agency, 4,671 pesticide poisonings were reported in Goiás between 2007 and 2015.

## MICROREGION OF CERES – POISONING AND SICKNESS

The microregion of Ceres (Map 01) is located in the center of the state of Goiás, and comprises 22 municipalities, with a total population of 231,239, of which 38,668 live in rural areas and 192,571 in urban areas, according to the IBGE Demographic Census (2010).

**Map 1** – Delimitation of the microregion of Ceres and location of the municipalities of Barro Alto, Goianésia, Itapaci, Rialma and Uruana, Goiás, Brazil.



Source: Cartographic Base of the State of Goiás Information System (SIEG, 2017).

Ceres microregion was occupied before the region's actual expansion began,

With the arrival of squatters on land not yet allocated by the government, who stood out for their non-capitalist production. The second phase – the pioneer front – was confirmed by the rapid growth of the population and by the expansion of cultivated areas in the region, with government support from the Vargas administration, through the March to the West and the creation of National

Agricultural Colonies (CAN), aimed at settling people on small farms engaged in the production of agricultural goods on a capitalist scale (RODRIGUES, 2013, p.81).

The microregion was originally occupied as a result of the National Agricultural Colonies project (FREITAS; MELLO, 2014) and intensified upon the implementation of the National Fuel Alcohol Program (PROÁLCOOL), which consolidated agricultural dynamics based on the sugarcane agroindustry. Proálcool intensified the production of sugarcane through

taxincentives and bank loans with interest rates below the market rate for producers. This policy led to the construction of power plants in the 1970s and 1980s in the Ceres microregion. However,

The first sugar mills in the Ceres microregion date back to the 1960s and 1970s. The pioneering projects were: the Sociedade Açucareira Monteiro de Barros, in the municipality of Goianésia, in 1968, which was purchased in 1989 by the Matari Group from Pernambuco, which changed its name to Usina Goianésia; the Pite S/A sugar mill installed in Itapuranga in 1979, which operated until 1990 and was then reopened in 2007 by the Farias Group from Pernambuco, which is currently called Vale Verde Empreendimentos Agrícolas [...]. and the company Jalles Machado (in Goianésia), the Devale Group sugar mill (in Itapaci), and the Cooperativa Agroindustrial in the municipality of Rubiataba (Cooper Rubi), established in 1980, 1982 and 1984, respectively (FERREIRA; DEUS, 2012, p.69).

Starting in the 1960s, the establishment of the sugar mills reorganized the agricultural landscape of the Ceres microregion. Table 01 presents data on land cover and use between 1975 and 2013.

**Table 01.** Land cover and use in the microregion of Ceres, Goiás.

| Area/Year              | 1975   | 1985   | 1995   | 2013   |
|------------------------|--------|--------|--------|--------|
| <b>Classes</b>         |        | (%)    |        |        |
| Dense Cerrado          | 54.08  | 26.66  | 26,25  | 25,02  |
| Low grassy groundcover | 39.90  | 33.63  | 29.03  | 27.03  |
| Drainage               | 0.89   | 0.45   | 0.52   | 0.78   |
| Pastureland            | 5.06   | 35.34  | 27.28  | 24.32  |
| Farmland               | 0.0    | 1.78   | 16.51  | 21.95  |
| Irrigated farmland     | 0.00   | 0.00   | 0.22   | 0.47   |
| Urban area             | 0.08   | 0.15   | 0.20   | 0.43   |
| Total                  | 100.00 | 100.00 | 100.00 | 100.00 |

Source: BARBALHO, 2018.

According to Barbalho (2018), natural areas shrank while urban areas, and especially agricultural areas, expanded. According to the State of Goiás Ethanol Manufacturing Union and the State of Goiás Sugar Manufacturing Union (SIFAEG, 2018), which demonstrate the advance of agribusiness, the microregion has seven sugar and alcohol mills, six of which are in operation and one has suspended its operation.

The area's natural resources have been negatively affected by agricultural expansion. In the Ceres microregion, "a large part of the forest cover has been cleared due to the expansion of the agricultural frontier, not only for agricultural occupation [and cattle ranching] but also for the expansion of urbanization" (DUTRA SILVA; BARBALHO; FRANCO, 2013, p. 232).

Another relevant fact about the process of occupation of the territory by agribusiness, according to SINAN (2018), was the number of cases of pesticide poisoning in the microregion of Ceres, which increased by 1,930% between 2001 and 2013.

Five municipalities in the Ceres Microregion were selected for this research, namely, Barro Alto, Goianésia, Itapaci, Rialma and Uruana, because they produce sugarcane, corn and soybeans, and from 2000 to 2013, expanded the areas under cultivation of these crops. Moreover, according to Porto and Soares (2012), these are the areas where pesticides are the most widely used to boost production and productivity, thereby exposing the population to health risks. These municipalities also have a high concentration of center pivot irrigation systems in their territories, except for Rialma.

It should be noted that the production of sugarcane, soy and corn in these municipalities grew between 2000 and 2013, accompanied by an expansion in farmland area and a corresponding decrease in untouched areas of the Cerrado biome, in some cases taking over areas of other crops.

In the five municipalities of this study, there was an expansion of the areas used for soybean, corn and sugarcane production, with the latter showing the most significant increase. In the Ceres microregion, the municipalities that stand out as the largest producers of sugarcane, corn and soybeans are, respectively, Goianésia, Uruana and Barro Alto. The data indicate variations in tons per hectare, but in general, there was an increase in the planted areas and in agricultural productivity in these municipalities (IMB, 2018). Noteworthy was the increase in sugarcane production in all five municipalities.

Stabenow (2014) states that the Ceres microregion brings to light the disparity of the production system, illustrated, on the one hand, by the paucity of municipalities with augmented revenue and improved economic and infrastructure indicators, which was the case of Goianésia and Barro Alto between 2007 and 2013 (Cf. IMB, 2018). On the other hand are the municipalities that were disadvantaged and

That are highly dependent on public policies, have reduced agricultural activities, a significant rural exodus, stagnation of formal jobs and of the economy [...], constituting 72.73% of the municipalities in the Ceres microregion, i.e., 16 municipalities among a total of 22, which also corresponds to 70% of the area of the microregion (STABENOW, 2014, p.67).

The author claims that they have become mere suppliers of sugarcane and suffer from economic stagnation and rural exodus. Among them are Uruana, Rialma and Itapaci (Cf. IMB, 2018).

The statistics published in the IMB information system (2018) also reveal that sugarcane production in these municipalities has caused the diversity of agricultural production and rural properties to dwindle, inhibiting other forms of agricultural crops, especially those that hold families on the land and produce food, and that the microregion has been given over to another form and function.

In general, according to IBGE census data, the population of these municipalities gradually migrated from the countryside to the city, following a national trend of migration (IBGE, 1980; 1991; 2000; 2010).

Goianésia stands out as the municipality with the highest population growth, and is the location of two large sugar mills that export sugar to countries in North America, Europe, the Middle East and Africa. According to Alves (2012), the presence of other industrial and commercial establishments and institutions of higher education also attracts interregional and intraregional migration, in addition to circular and seasonal migration. Ferreira (2010) states that during the harvest season there are about 4,030 workers in Goianésia and in the off-season about 2,666, which are numbers that indicate seasonal migration.

The urban population in these municipalities is larger than the rural one, and most of the population ranges in age from 20 to 69 years old. According to the Demographic Censuses (IBGE, 2000; 2010), the municipalities of Itapaci, Goianésia and Barro Alto underwent a population growth, while the population in the municipalities of Rialma and Uruana remained unchanged.

These municipalities have a high Municipal Human Development Index (PNUD, 2013). But when one considers education separately, according to data from the IMB (2018), most of

the population has a primary education, and only 5% to 8% have a higher level of education.

Moreover, according to the 2010 Demographic Census (IBGE, 2010), although most of the population lives in cities, they are employed in rural activities (cattle ranching, farming and livestock production). In fact, in terms of the economically active population working in the agricultural sector, this corresponds to 16.26% of the population of Barro Alto, 13.19% of that of Goianésia, 27.41% of Itapaci, 7.37% of Rialma, and 35.52% of Uruana.

The people living and working in these municipalities are exposed to severe health risks due to poisoning from extremely toxic pesticides used on crops to increase productivity.

In general, between 2007 and 2013, SINAN (2018) registered a 295% increase in cases of poisoning (Medicines, 43%; Pesticides, 19%; Rodenticides, 13%, Others, 25%), while cases specifically of agricultural pesticide poisoning increased by 160%.

According to the Núcleo de Vigilância Epidemiológica do Vale de São Patrício (NVEVSP, 2018), the main pesticides responsible for poisoning are herbicides (Glyphosate, Volcane, Integrity and Tordon) and insecticides (Barrage, Furadan, Lannate, Confidor, Baygon, and Diazitop). The Goiás State Department of Health reports the occurrence of 2 to 20 cases of pesticide poisoning per year in the municipalities of Goianésia, Uruana, Rialma and Itapaci, while the number reported in the municipality of Barro Alto exceeds 20 cases.

These municipalities also reported an increase in death due to cancer, with emphasis on the municipality of Goianésia, where the number increased by 156.5% between 2000 and 2013. In 2000, Rialma reported an increase of 171% and Uruana and increase of 180% of cancer-related deaths. Such deaths increased 100% in Itapaci and Barro Alto (SIM, 2018; SINAN, 2018).

The SIM (2018) reported an annual increase in the number of cancer deaths in these municipalities, with a higher number of deaths among semi-illiterate males, browns and blacks (SIM, 2018). According to SINAN (2018), the most recurrent types of cancer that led to death were: malignant neoplasm of eye, brain and other parts of the central nervous system; of hematopoietic, lymphatic and correlated tissues; of respiratory system and intrathoracic organs, of male genital organ, and of digestive organs. A higher incidence of the last three types of neoplasm were reported in the abovementioned municipalities.



Among females, higher death rates due to malignant neoplasm were recorded at the ages of 40 to 49 and 50 to 59 years, brown or black. The three main causes of death, according to information provided by the SIM, were malignant neoplasms of digestive organs; respiratory and intrathoracic organs, and female genital organs (SIM, 2018).

Other relevant data contained in the records of SINAN (2018) have to do with the increase in cases of congenital malformation, i.e., birth defects of any organ or set of organs that impose a structural morphological anomaly at birth due to a genetic, environmental or mixed cause. Among live births between 2000 and 2013, the most frequently reported congenital malformations were: a) nervous system; b) cleft lip and palate; c) feet, and d) congenital musculoskeletal deformities, the latter two reported more frequently. SINAN (2018) reported that cases of congenital malformations increased by 7.60% in the municipality of Barro Alto, by 5.96% in Goianésia, 1.93% in Itapaci, 5.39% in Rialma and by 5.33% in Uruana from 2000 to 2013 (SINAN, 2018).

## FINAL CONSIDERATIONS

Today, the state of Goiás is consolidating its position as one of the country's main producers of food grains and sugarcane, with agro-industrial enterprises operating in its various microregions. Starting in the 1960s, the economy of the microregion of Ceres has focused on increasing agricultural production, especially sugarcane, with the establishment of the first sugar mills.

The territorial configuration of the Ceres microregion has gradually been altered in response to economic demands. The consequences thereof have materialized in the form of unequal urban expansion, loss of biodiversity, social inequalities, and as evidenced by the data, sickening of the population manifested through cancer and congenital malformations. The latter have occurred hand-in-hand with the increasing use of pesticides, aimed at boosting the agricultural productivity of sugarcane, corn and soybeans.

An analysis of the interface between agribusiness, agricultural chemicals and disease leads to the proposal of an agenda for interdisciplinary and interinstitutional discussion about land use in the state of Goiás and severe health problems in its population. These health problems are linked to the

transformations and forms of land use in the territory, since it is clear that, directly or indirectly, the processes involved in agricultural crop production in the region are closely associated with human health and a variety of diseases, including acute or severe pesticide poisoning.

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## REFERENCES

- ABREU, P. H. B. de; ALONZO, H. G. A. O agricultor familiar e o uso (in) seguro de agrotóxicos no município de Lavras/MG. **Revista Brasileira Saúde Ocupacional**, v.41, p.1-12, 2016. <https://doi.org/10.1590/2317-6369000130015>
- ACQUAVELLA, J. et al. Cancer among farmers: a meta-analysis. **Annals of Epidemiology**, v. 8, p. 64-74, 1998. [https://doi.org/10.1016/S1047-2797\(97\)00120-8](https://doi.org/10.1016/S1047-2797(97)00120-8)
- AGRODEFESA. Agência Goiana de Defesa Agropecuária. **Agrotóxicos**. Available in: <<http://www.agrodefesa.go.gov.br/post/ver/186586/agrotoxicos>>. Accessed: February 03, 2018.
- ALAVANJA, M. C. et al. Use of Agricultural Pesticides and Prostate Cancer Risk in the Agricultural Health Study Cohort. **American Journal of Epidemiology**, v. 157, p. 800-814, 2003. <https://doi.org/10.1093/aje/kwg040>
- ALAVANJA, M. C. et al. Pesticides and lung cancer risk in the agricultural health study cohort. **American Journal of Epidemiology**, v. 160, p. 876-85, 2004. <https://doi.org/10.1093/aje/kwh290>
- ALBUQUERQUE, P.C. C. de et al. . Sistemas de informação em saúde e as intoxicações por agrotóxicos em Pernambuco. **Revista Brasileira Epidemiologia**, v. 18, p. 666-678, 2015. <https://doi.org/10.1590/1980-5497201500030012>
- ALVES, G. L. F. **Expansão canavieira e seus**



- efeitos na violência em Goianésia**, 2012. 189 f. Thesis (MasterDegree in Agronomy). Universidade Federal de Goiás, Goiânia, 2012.
- BARBALHO, M. G. **Relatório de Pós-doutoramento**. Brasília: UnB, 2018, 65p.
- BOMBARDI, L. M. Atlas: Geografia do Uso de Agrotóxicos no Brasil e na Europa. Available in: <<https://www.larissabombardi.blog.br/atlas2017>> Accessed: November 20, 2017.
- BRASIL Ministério da Saúde. **Protocolo de Atenção à Saúde dos Trabalhadores Expostos a agrotóxicos**, 2013. Available in: <[http://bvsms.saude.gov.br/bvs/publicacoes/protocolo\\_atencao\\_saude\\_trab\\_exp\\_agrotoxicos.pdf](http://bvsms.saude.gov.br/bvs/publicacoes/protocolo_atencao_saude_trab_exp_agrotoxicos.pdf)> Accessed: December 09, 2017.
- BRASIL. Ministério da Saúde. **Relatório Vigilância em Saúde de Populações Expostas a Agrotóxicos no Estado de Goiás**. 2016. Available in: <<http://portalquivos2.saude.gov.br/images/pdf/2015/julho/08/Relat--rio-Goi--s.pdf>>. Accessed: January 01, 2018
- BRASIL. Ministério da Saúde Sistema Nacional de Informações Tóxico-Farmacológicas **Casos registrados de intoxicação humana e envenenamento**: região Centro Oeste. 2017. Available in: <<http://www.fiocruz.br/sinitox>>. Accessed: June 20, 2017
- CARNEIRO, F. F. et al. **Dossiê**: Um alerta sobre os impactos dos agrotóxicos na saúde. Rio de Janeiro: EPSJV; São Paulo: Expressão Popular, 2015.
- CASTILHO, D. **A dinâmica socioespacial de Ceres e Rialma-GO no âmbito da modernização de Goiás**: território em movimento, paisagens em transição, 2007. 198 f. Thesis (Doctorate Degree in Geography) - Universidade Federal de Goiás, Goiânia, 2007.
- CORCINO, C. O. et al. Avaliação do efeito do uso de agrotóxicos sobre a saúde de trabalhadores rurais da fruticultura irrigada. **Ciência Saúde Coletiva**, v. 24, p.38-51, 2019. <https://doi.org/10.1590/1413-81232018248.14422017>
- DAYRELL, E. G. **Colônia Agrícola Nacional de Goiás**: análise de uma política de colonização. 1974. 243f. Thesis (Master Degree in History) – Universidade Federal de Goiás, Goiânia, 1974.
- DOULL, J.; LEVIEN, R. S. Global estimates of acute pesticide morbidity and mortality. **Reviews of Environmental Contamination and Toxicology**, v. 129, p.29-44, 1993. [https://doi.org/10.1007/978-1-4684-7106-9\\_3](https://doi.org/10.1007/978-1-4684-7106-9_3)
- DUTRA SILVA, S.D; BARBALHO, M.G.; FRANCO, J.L. A Expansão sucroalcooleira e a devastação ambiental nas matas de São Patrício, Microrregião de Ceres, Goiás. **História, histórias**, v. 01, p. 230-247, 2013. <https://doi.org/10.26512/hh.v1i2.10735>
- EATON, D. L. et al Review of the Toxicology of Chlorpyrifos with an Emphasis on Human Exposure and Neurodevelopment. **Critical Reviews in Toxicology**, v.2, p.118-125, 2008. <https://doi.org/10.1080/10408440802272158>
- ESTEVA, L. **O tempo da transformação**: estrutura e dinâmica na formação econômica de Goiás. 1997. 245f. Thesis (Doctorate Degree in Geography) Universidade Estadual de Campinas, Campinas, 1997.
- FREITAS, W. A. de; MELLO, M. de. A Colônia Agrícola Nacional de Goiás e a redefinição nos usos do território. **Sociedade & Natureza**. v. 26, p. 471-482, 2014. <https://doi.org/10.1590/1982-451320140306>.
- FERREIRA, L. C. G. **A evolução do setor sucroalcooleiro na microrregião Ceres (GO)**: dinâmica espacial e impactos socioeconômicos. 2010. 212 f. Thesis (Master's in Geography) – Universidade Federal de Goiás, Goiânia, 2010.
- FERREIRA, L. C. G.; DEUS, J. B. de. O uso do território e as redes na microrregião de Ceres (GO): o caso das agroindústrias sucroalcooleiras. **Boletim Goiano de Geografia**, v. 30, p.67-80, 2012, <https://doi.org/10.5216/bgg.v30i2.13795>
- GOIÁS. Secretaria de Saúde do Estado de Goiás. **Uso de agrotóxicos na RS Central**. Notificação de intoxicações por agrotóxicos em Goiás. 2016. Available in: <<http://www.sgc.goias.gov.br/upload/arquivos/2016-06/uso-de-agrotoxicos-na-rs-central.pdf>>. Accessed: March 02, 2018.
- HRW - Human Rights Watch. **“Você não quer mais respirar veneno”** as falhas do Brasil na proteção das comunidades rurais expostas à dispersão de agrotóxicos, 2018. Available in: <<https://www.hrw.org/pt/report/2018/07/20/320417>> Accessed: July 28, 2018.
- IBGE – Instituto Brasileira de Geografia e Estatística. **Censo Agropecuário**. 1970. Available in: <[https://biblioteca.ibge.gov.br/visualizacao/periodicos/45/ca\\_1970\\_v3\\_t23\\_go.pdf](https://biblioteca.ibge.gov.br/visualizacao/periodicos/45/ca_1970_v3_t23_go.pdf)> Accessed: October 03, 2018.
- \_\_\_\_\_. **Censo Agropecuário**. 1985. Available in: <<https://biblioteca.ibge.gov.br/visualizacao/per>

- iodicos/47/ca\_1985\_n27\_go.pdf>. Accessed: October 03, 2018.
- \_\_\_\_\_. **Censo Agropecuário**. 1996. Available in: <[https://biblioteca.ibge.gov.br/visualizacao/periodicos/48/agro\\_1995\\_1996\\_n25\\_go.pdf](https://biblioteca.ibge.gov.br/visualizacao/periodicos/48/agro_1995_1996_n25_go.pdf)>. Accessed: October 03, 2018.
- \_\_\_\_\_. **Censo Demográfico**. 1980. Available in: <[https://biblioteca.ibge.gov.br/visualizacao/periodicos/72/cd\\_1980\\_v1\\_t4\\_n25\\_go.pdf](https://biblioteca.ibge.gov.br/visualizacao/periodicos/72/cd_1980_v1_t4_n25_go.pdf)>. Accessed: October 03, 2018.
- \_\_\_\_\_. **Censo Demográfico**. 1991. Available in: <[https://biblioteca.ibge.gov.br/visualizacao/periodicos/82/cd\\_1991\\_n27\\_caracteristicas\\_populacao\\_domicilios\\_go.pdf](https://biblioteca.ibge.gov.br/visualizacao/periodicos/82/cd_1991_n27_caracteristicas_populacao_domicilios_go.pdf)>. Accessed: October 03, 2018.
- \_\_\_\_\_. **Censo Demográfico**. 2000. Available in: <[https://biblioteca.ibge.gov.br/visualizacao/periodicos/83/cd\\_2000\\_caracteristicas\\_populacao\\_amostra.pdf](https://biblioteca.ibge.gov.br/visualizacao/periodicos/83/cd_2000_caracteristicas_populacao_amostra.pdf)>. Accessed October 03, 2018.
- \_\_\_\_\_. **Censo Demográfico**, 2010. Available in: <<https://censo2010.ibge.gov.br/resultados.html>>. Accessed: October 03, 2018.
- IMB - Instituto Mauro Borges. **Dados sobre Goiás**. 2018. Available in: <[http://www.imb.go.gov.br/index.php?option=com\\_content&view=category&layout=blog&id=19&Itemid=151](http://www.imb.go.gov.br/index.php?option=com_content&view=category&layout=blog&id=19&Itemid=151)>. Accessed: January 18, 2018.
- \_\_\_\_\_. Conjuntura Econômica Goiana. **Boletim Trimestral SEGPLAN**, n. 24, p.1-102, 2013. Available in: <<http://wwwold.imb.go.gov.br/down/conjuntura24.pdf>>. Accessed: March 20, 2018.
- INOCÊNCIO, M. E. CALAÇA, M. Cerrado: fronteira da produção capitalista do século XX. In: ENCONTRO NACIONAL DE GEOGRAFIA AGRARIA, 19.,2009, São Paulo, **Anais**[...] São Paulo: USP, p. 1- 16.
- INOCÊNCIO, M. E. **O PROCEDER**: as tramas do poder na territorialização do capital no Cerrado. 2010. 271f Thesis ( Doctorate in Geography)- Universidade Federal de Goiás, Goiânia, 2010.
- JOBIM, P. F. C. et al . Existe uma associação entre mortalidade por câncer e uso de agrotóxicos?: Uma contribuição ao debate. **Ciência Saúde Coletiva**, v. 15, p. 277-288, 2010. <https://doi.org/10.1590/S1413-81232010000100033>
- LEVINE, R.S.; DOULL, J. Global estimates of acute pesticide morbidity and mortality. **Environ Contm Toxicol**, v. 129, p. 29-50, 1992. [https://doi.org/10.1007/978-1-4684-7106-9\\_3](https://doi.org/10.1007/978-1-4684-7106-9_3)
- MATOS, P. F. de. Agronegócio no sudeste goiano e as disputas pelo uso do território. **ACTA Geográfica**, v.4, p.153-165, 2013 <https://doi.org/10.5654/actageo2013.0003.0008>
- \_\_\_\_\_. **As tramas do agronegócio nas “terras” do Sudeste Goiano**. 2011. 357f. Thesis (Doctorate Degree in Geography)- Universidade Federal de Uberlândia, Uberlândia, 2011.
- NVEVSP – Núcleo de Vigilância Epidemiológica do Vale de São Patrício. 2018. Available in: <<https://www.saude.go.gov.br/vigilancia-em-saude/vigilancia-epidemiologica>> Accessed: September 06, 2018.
- PNUD – Programa das Nações Unidas para o Desenvolvimento. **Atlas do Desenvolvimento Humano**. 2013. Available in: <<http://atlasbrasil.org.br/2013/>> Accessed: August10, 2017.
- PORTO, M.F.; SOARES, W.L. Modelo de desenvolvimento, agrotóxicos e saúde: um panorama da realidade agrícola brasileira e propostas para uma agenda de pesquisa inovadora. **Revista Brasileira Saúde Ocupacional**, v. 37, p.17-31, 2012. <https://doi.org/10.1590/S0303-76572012000100004>
- RODRIGUES, D. M. T. **Sustentabilidade do setor sucroalcooleiro na Microrregião de Ceres – GO**. 2008. 281f. Thesis ( Doctorate Degree in Environmental Sciences)- Universidade Federal de Goiás, Goiânia, 2013.
- SIEG. Sistema Estadual de Geoinformação. **Base Cartográfica do Sistema de Informação do Estado de Goiás**. Available in: <<http://www.sieg.go.gov.br/siegmapias/mapa.php>>. Accessed: December 20, 2017.
- SIFAEG. Sindicato da Indústria de Fabricação de Etanol do Estado de Goiás. **Cana de Açúcar**. Available in: <<http://www.sifaeg.com.br/cana-de-acucar/>> Accessed: October 20, 2018.
- SILVA, J. M. da et al. Agrotóxico e trabalho: uma combinação perigosa para a saúde do trabalhador rural. **Ciência Saúde Coletiva**, v. 10, p. 891-903, 2005. <http://dx.doi.org/10.1590/S1413-8123200500040001>
- SILVEIRA, M. R. da. **A dinâmica do agronegócio no estado de Goiás e a centralidade do município de Rio Verde**. 2016 Thesis (Doctorate Degree in Geography)

- Universidade de Brasília: Brasília, 2016.
- SIM: **Sistema de Informação sobre Mortalidade**. Brasil, 2018. Available in: <<http://tabnet.datasus.gov.br/cgi/defctohtm.exe?sim/cnv/obt10uf.def>>. Accessed: October 18, 2018.
- SINAN: **Sistema de Informação de Agravos de Notificação**. Brasil, 2018. Available in: <<http://www2.datasus.gov.br/DATASUS/index.php?area=0203&id=29878153>> Accessed: October 18, 2018.
- STABENOW, P. **Levantamento de indicadores e as dimensões de sustentabilidade: a expansão do setor agropecuário e sua relação com a saúde pública na Microrregião de Ceres (município de Itapuranga) – GO**. 2014. 132f. Thesis (Master's Dissertation in Ecology). Universidade Pontifícia de Goiás, Goiânia, 2014
- STOPPELLI, I. M. de B. S. **Agricultura, ambiente e saúde: uma abordagem sobre o risco de contato com os agrotóxicos a partir de um registro hospitalar de referência regional**. Thesis (Doctorado Degree in Health) - São Paulo: USP, 2005.
- TEJERINA, G. R. de L. **Intoxicações e óbitos por agrotóxicos no Estado de Goiás, Brasil e Inovações Legislativas Caderno Ibero-Americanos de Direito Sanitário**. v. 7, p. 01-21, 2018. <https://doi.org/10.17566/ciads.v7i1.471>