An outline of the use of agrochemicals in southwestern Paraná (2011-2016)

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Abstract

This article presents data and maps on the use of agrochemicals in the 27 municipalities that constitute the 8th Regional Health Authority of Paraná state, which is located in its Central-Southwestern region. To this end, the work draws on data from SIAGRO, the Monitoring System of Agrochemicals Trade and Use in Paraná, which is controlled by the Agricultural Defense Agency of Paraná (ADAPAR). Since SIAGRO was established in 2011, the article discusses information obtained between 2011 and 2016. Data on the sales volume of pesticides for each municipality of the studied area were mapped and analyzed. Also charts on the main active ingredients commercialized and classification of the use and volume destined for crops are presented. Based on this, it was observed that the production of commodities such as soybean, corn and wheat has accounted for an exorbitant consumption of pesticides in the 27 municipalities in question, so that the main active ingredients used trigger high risks of environmental contamination and also for the human health.

Keywords: Agrochemicals. Southwest of Paraná. Monitoring System of Agrochemicals Trade and Use in Paraná (SIAGRO).

Perfil del Uso de Pesticidas en Suroeste de Paraná (2011 - 2016)

Resumen

Este artículo presenta datos y mapas sobre el uso de pesticidas en los 27 municipios que componen la Octava Regional de Salud del Paraná, la cual está ubicada en la Mesorregión Suroeste del estado. Para ello, se utilizaron datos del Sistema de Monitoreo del Comercio y Uso de Pesticidas en Paraná (SIAGRO), que es administrado por la Agencia de Defensa Agropecuaria del Paraná (ADAPAR). El SIAGRO fue instituido en 2011, de modo que el artículo discute las informaciones obtenidas entre los años 2011 y 2016. Fueron mapeados y analizados datos sobre el volumen comercializado de pesticidas en cada municipio de la referida área de estudio, además de la presentación de gráficos sobre los principales ingredientes activos comercializados, clasificación de uso y volumen destinado por cultivo. A partir de eso, se observó que la producción de *commodities* como soja, maíz y trigo ha sido responsable por el consumo exorbitante de pesticidas en los 27 municipios en cuestión, de modo que los principales ingredientes activos utilizados desencadenan un alto riesgo de contaminación ambiental y también para la salud humana.

Palabras-clave: Pesticidas; suroeste del Paraná; Sistema de Monitoreo del Comercio y Uso de Pesticidas en Paraná (SIAGRO).

Perfil do uso de agrotóxicos no Sudoeste do Paraná (2011-2016)

Resumo

Esse artigo apresenta dados e mapas sobre o uso de agrotóxicos nos 27 municípios que compõem a Oitava Regional de Saúde do Paraná, a qual está localizada na Mesorregião Sudoeste do estado. Para tanto, foram utilizados dados do Sistema de Monitoramento do Comércio e Uso de Agrotóxicos no Paraná (SIAGRO), que é gerenciado pela Agência de Defesa Agropecuária do Paraná (ADAPAR). O SIAGRO foi instituído em 2011, de modo que o artigo discute as informações obtidas entre os anos de 2011 e 2016. Foram mapeados e analisados dados sobre o volume comercializado de agrotóxicos em cada município da referida área de estudo, além da apresentação de gráficos sobre os principais ingredientes ativos comercializados, classificação de uso e volume destinado por cultura. A partir disso, observou-se que a produção de *commodities* como soja, milho e trigo tem sido responsável pelo consumo exorbitante de agrotóxicos nos 27 municípios em questão, de modo que os principais ingredientes ativos utilizados desencadeiam alto risco de contaminação ambiental e também para a saúde humana.

Palavras-chave: Agrotóxicos; sudoeste do Paraná; Sistema de Monitoramento do Comércio e Uso de Agrotóxicos no Paraná (SIAGRO).

Introduction

Brazil is among the major exporting countries for agricultural commodities, especially concerning grains and meat. This enables a strong economic and political influence from agribusiness, which has been exerted by large transnational corporations that dominate the sector. Among the technologies used by the global agribusiness, the expansion of the cultivation of genetically modified organisms (GMOs) and, mainly, the wide and growing use of chemical inputs, especially fertilizers and agrochemicals.

The country also draws the attention of the agribusiness focused on global trade and on the production of agricultural commodities, due to the availability of arable areas. This process has led to an enormous growth in the use of agrochemicals in Brazil and governmental incentives to this are part of a world policy prescribed by the central countries, according to their political and economic interests. Thus, there is a historical and growing process of exploitation of natural resources and of the labor force of peripheral countries.

Government incentives for the acquisition of agrochemicals and reduction of costs via tax exemptions and rural credit lines for purchase of agricultural inputs have been significant in Brazil since the 1970s, the period of implementation of the Green Revolution in the country. Furthermore, another factor that ended up favoring this exponential expansion was the approximation and merger of companies from the agricultural and the chemical sectors, such as the soybean seed resistant to glyphosate herbicide (PORTO, 2013). The central objective is economic, while the negative socio-environmental consequences of this process are usually ignored and neglected.

Such economistic conception, intrinsic to Brazilian agribusiness, favors the intentionalities of the large transnational corporations and some sectors of the national elite. The expansion of agribusiness has led to a loss of the essential value of human food, transforming it into a commodity and reducing its nutritional quality. The corresponding indiscriminate use of agrochemicals and chemical fertilizers in Brazilian crops result in socioenvironmental impacts such as the reduction of biological and ecosystem diversity, the contamination of water, soil and human beings, especially rural workers (CARNEIRO et al., 2015).

Despite the emphasis on the economic “benefits” of agrochemicals and the intense propaganda process aimed at minimizing the negative social and environmental consequences of their use, there is a social mobilization that challenges it and stands up against the liberation and expansion of the use of pesticides in Brazil. This movement is manifested mainly by means of the National Campaign against the use of pesticides. The evidence that Brazil is the world’s major consumer of agrochemicals since 2008 is the central element in this debate.

Although plentiful scientific evidence on the negative consequences of the use of agrochemicals and GMOs has been published, partially compiled in a Dossier by the Brazilian Association of Collective Health (ABRASCO) (CARNEIRO *et al*., 2015) and in a book organized by Ferment *et al*. (2015), the political pressure for the liberalization of the use of both GMOs and agrochemicals has increased[1], indicating a clash between the rural sector and institutions of health and the environment protection.

In monocultures, terrestrial and aerial spraying of agrochemicals are commonly applied, with dire consequences for both the environment and human health. Some of the pesticides that are used in plantations affect the whole ecosystem and the food chain, since wind, rain and other factors may spread them beyond the plantation, contaminating the soil, water tables and river waters, not to mention that those more persistent organic pollutants are biologically accumulated in the food chain and, consequently, in human beings (PIGNATI, 2007; CONSEA, 2014). Moreover, pesticides affect not only the crops in which they are used, but also the workers who use them directly (THOMAZ JÚNIOR, 2014) and the consumers of the food products (CONSEA, 2014). The segments of population exposed to agrochemicals are composed of people who live in or near the contaminated areas or who have direct contact with these products at the time of production, such as farmers and their families; as well as consumers of food and water in urban areas.

[1] Candiotto *et al*. (2017) offer a systematic review of the Brazilian legislation on pesticides, considering the monitoring of residues of pesticides in water bodies, as well as the process of liberalization of these products in Brazil.

There is a persistent lack of data on the use of these products in Brazil and, according to Pignati *et al*. (2017), this has favored the concealment and invisibility of this major public health (and environmental) problem. Researchers, public institutions and society face difficulties in obtaining accurate data on the use of pesticides in certain regions.

The Agrochemicals Trade and Use Monitoring System (SIAGRO) in the state of Paraná, managed by the Agricultural Defense Agency of Paraná (ADAPAR), is currently the most consistent database in terms of quantification of the use of agrochemicals. SIAGRO began collecting data in 2011, but according to an ADAPAR official, the most consistent data were collected from 2012 on. Considering the existence of SIAGRO, this article seeks to demonstrate the spatial distribution of the use of pesticides in the 8th Regional Health Authority of the State of Paraná, between the years 2011 and 2016. This regional health authority is also known as the regional of Francisco Beltrão and is located in southwestern Parana. The knowledge about the spatial distribution of the use of agrochemicals can help to formulate hypotheses and future studies, serving as an alert and as a basis for demanding policies to reduce the use of pesticides.

Method

The methodological procedures for the elaboration of the present article were divided into the following stages: first, data collection was carried out from the official agencies of the state of Paraná, such as the *Instituto Paranaense de Desenvolvimento Econômico e Social* - IPARDES (Institute for Economic and Social Development of Parana State) and the *Agência de Defesa Agropecuária do Paraná* – ADAPAR (Agricultural Defense State Agency), which runs the SIAGRO.

Data on the volume of pesticides sold between the years 2011 and 2016 and the percentage allocated to each cultivation, kind of use and active components, for the years 2015 and 2016, were made available by SIAGRO / ADAPAR upon formal request. Data on area harvested from temporary crop between 2010 and 2015 were taken from databases of the Institute for Social and Economic Development of Paraná (IPARDES), in order to generate maps on the volume traded per hectare cultivated.

The information obtained from SIAGRO / ADAPAR was cross-checked against population estimates from the Brazilian Institute of Geography and Statistics (IBGE), to create maps on the per capita volume of agrochemicals sales. To this effect, a cartographic base was generated showing the 27 municipalities that comprise the 8th Regional Health Authority of Paraná, based on IBGE (2008), UTM coordinate, system SIRGAS 2000. The base map, with coordinates, north, scale and legend, was produced using Corel Draw®.

Other seven thematic maps were generated from the base map, also using Corel Draw®. The classes were defined according to specificities of each data set, so that to better express the quantitative information obtained. As the maps represent different information, different colors were used in each map, with shades ranging from the strongest for the most significant data (larger values) to weaker shades for the less significant quantitative data (smaller values), in accordance to standard methodological procedures for thematic mapping (MARTINELLI, 1991; DUARTE, 2002).

The charts were created in MS Excel®, based on calculations using the data provided by ADAPAR. To attain greater accuracy, data were treated, by converting relative or percentage values into absolute data for the analyzed situations. Thus, the percentage values referring to the municipalities were converted into volume of sales in tons of agrochemicals, according to their classification (herbicide, insecticide, fungicide, etc.). Following, absolute values by class of agrochemicals of each municipality were added, generating the total of each class for the 8th Regional Health Authority. Finally, the total of each class divided by the total volume of pesticides sales provides the percentage value presented in the data.

The percentage of the sales volume of pesticides per crop and the percentage of sales volume of pesticides per active ingredient were obtained in a similar way, although, in these cases, presented data refer to years 2015 and 2016 for the municipalities of the 8th Regional Health Authority of Paraná.

The 8th Regional Health Authority of Paraná comprises 27 municipalities of the Central-Southwestern region of Paraná state, namely: Ampére, Barracão, Bela Vista da Caroba, Boa Esperança do Iguaçu, Bom Jesus do Sul, Capanema, Cruzeiro do Iguaçu, Dois Vizinhos, Éneas Marques, Flor da Serra do Sul, Francisco Beltrão, Manfrinópolis, Marmeleiro, Nova Esperança do Sudoeste, Nova Prata do Iguaçu, Pérola D'Oeste, Pinhal de São Bento, Planalto, Pranchita, Realeza, Renascença, Salgado Filho, Salto do Lontra, Santa Izabel do Oeste, Santo Antônio do Sudoeste, São Jorge D'Oeste and Verê. According to IBGE's 2016 estimates, these municipalities have a total of 357,296 inhabitants.

Results

Paraná ranks third among the states that show he highest rates of agrochemicals sales in the country (accounting for 14% of total sales), just behind the states of Mato Grosso (20%) and São Paulo (15%). In 2016, according to Ibama (2018), the state of Paraná commercialized, legally, 72. 212 tons of agrochemicals.

Currently, according to data from IPARDES, agricultural production has a significant share in the composition of the Gross Domestic Product (GDP) of the municipalities that comprise the Southwest of Paraná. In 2010, agricultural activity generated the second largest GDP in approximately 80% of the municipalities, surpassing the industrial activity.

The economies of the 27 municipalities that comprise the 8th Regional Health Authority of Paraná are strongly based on the primary sector. Production specialization is also a prominent feature of these economies. In 12 of these municipalities, more than 50% of the population is engaged in agricultural activity (IBGE, 2016). In 2006, there were 34,385 agricultural establishments, 90% out of which carried out family farming, making up a total of 30,832 family farms. Corporate farms comprised only 3,553 establishments. However, these latter occupied 254,509 hectares of the total area. This demonstrates a degree of land concentration in these municipalities, since rural establishments classified as family farming hold, in average, 15 hectares of land, while corporate farms have in average 71 hectares. Table 1 shows the number of family farms and the total area occupied by these in the 27 municipalities of the 8th Regional Health Authority.

Table 1: Number of agricultural establishments and area of agricultural establishments (family and non-family farming) in 27 municipalities of the 8th Health Regional (2006)

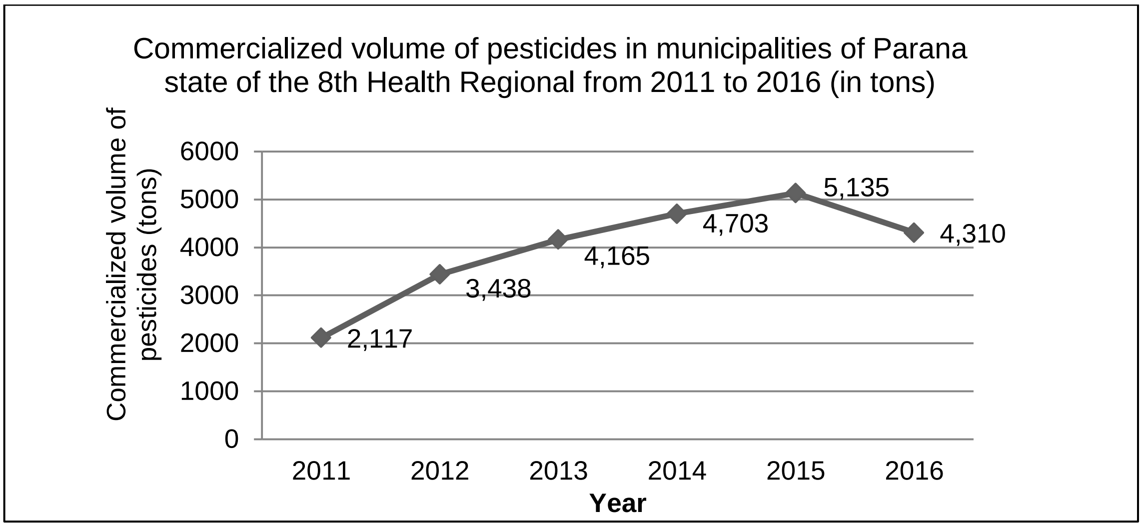
	Family Establishments	Non-Family Establishments
Number of establishments	30,832	3,553
Total area occupied by establishments	464,451	254,509

Source: IBGE (2006).

Between 2011 and 2015, the total sales of agrochemicals in the municipalities comprising the 8th Regional Health Authority of Paraná increased annually. Between 2011 and 2013, this volume has almost doubled. The years 2014 and 2015 also registered an increase in the volume traded. In 2011, 2,117 tons of agrochemicals were legally sold, while in 2015, the sales reached 5,135 tons. However, as shown in Chart 1, official figures show a decrease in this volume in 2016. A possible explanation for this fall in official data may be supply through smuggling, since the study area is close to the Brazilian border with Paraguay. According to Horii (2015), the acquisition of these inputs in Paraguay is related to a significant difference in prices as compared to Brazil.

Other hypotheses for such reduction are related to: (1) a possible reduction in agricultural production in 2016. However, data on produce were not analyzed to test this hypothesis; (2) an effort to reduce the use of agrochemicals in the region, by means of more appropriate management techniques. However, it was not possible to obtain information on this hypothesis either; (3) a possible inconsistency in data collected by SIAGRO in 2016.

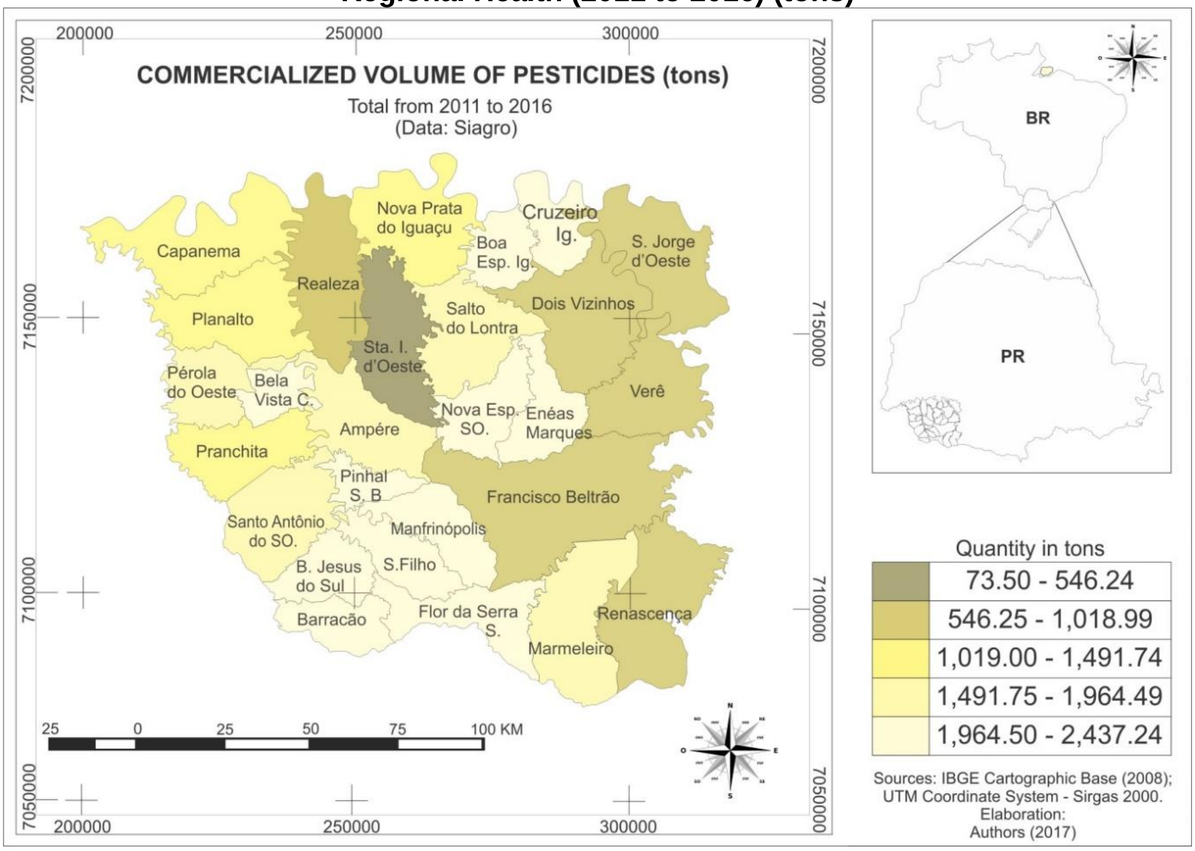
Graph 1: Total volume of pesticides commercialized per year (2011 to 2016)



Source: ADAPAR (2017).

Total sales by municipality for this same period can be observed on Map 1.

Map 1: Total volume of agrochemicals marketed in the municipalities of the 8th Regional Health (2011 to 2016) (tons)

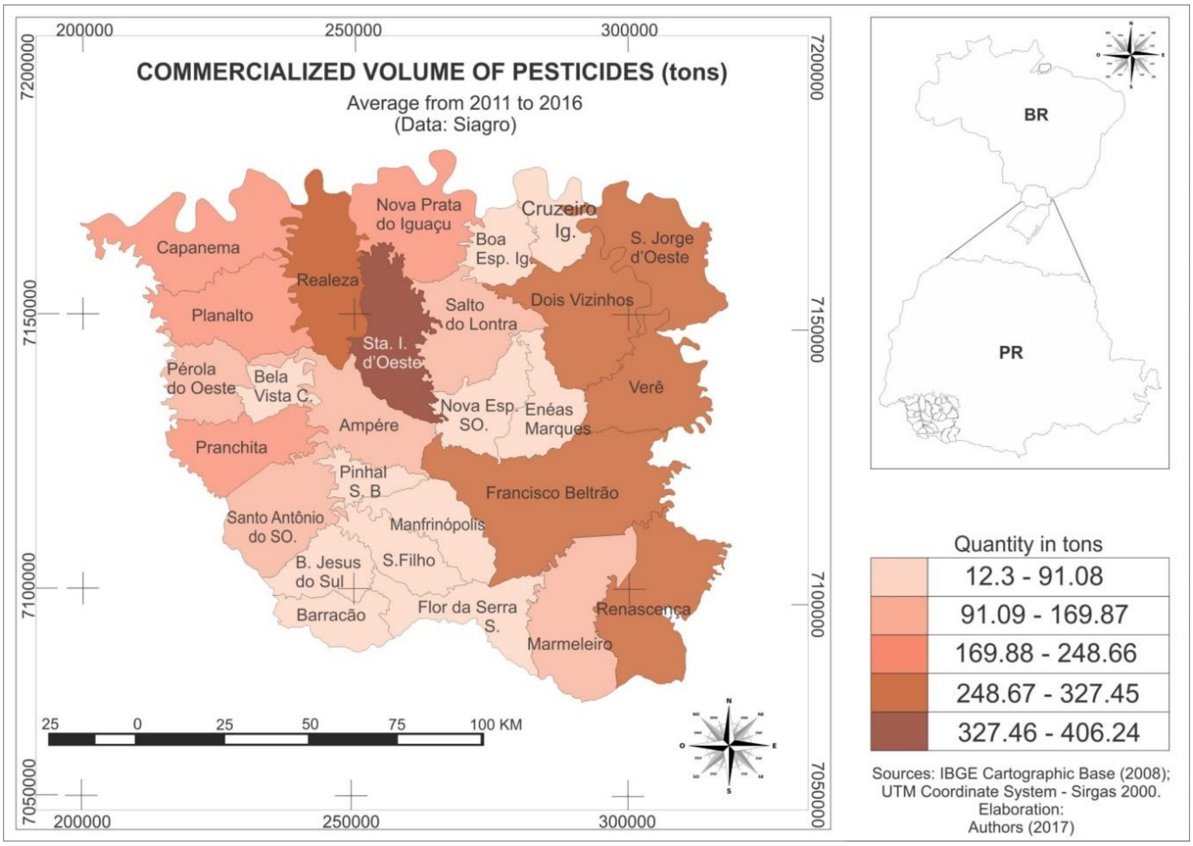


The municipality of Santa Izabel do Oeste stands out in relation to the sales quantity between 2011 and 2016, in a total of 2,437.24 tons. In the next stratum, between 1,491.75 and 1,964.49 tons, are the municipalities of Renascença (1,834.90 tons), São Jorge do Oeste (1,801.90 tons), Realeza (1,754,20 tons), Verê (1,660.30 tons) ton), Dois Vizinhos (1,587.40 tons) and Francisco Beltrão (1,556.90 tons). Among the 27 municipalities, these were those were agrochemicals sales exceeded 1,500 tons in a period of only six years.

Map 2 presents the annual average of sales volume by municipality, between 2011 to 2016. The municipality with highest volumes of pesticides sales was Santa Izabel do Oeste, with an annual average of 406.2 tons per year, followed by a second stratum comprising the municipalities of Renascença (305.8 tons), São Jorge do Oeste (300.3 tons), Realeza (292.4 tons), Verê (276.7 tons), Dois Vizinhos (264.6 tons) and Francisco Beltrão (259.5 tons).

Some aspects may contribute to explain these high values in the above municipalities. The first is the fact that these municipalities have flat lands, located in levelled grounds or in the bottom of large river valleys, such as Iguaçu and Chopim. Consequently, these types of relief are suitable for mechanization and agricultural monocultures and large crops. Another aspect concerns the total area of these municipalities, which are among those with greater territorial extension in the Central-Southwestern region of Paraná.

Map 2: Average volume of agrochemicals traded between 2011 and 2016 (tons)

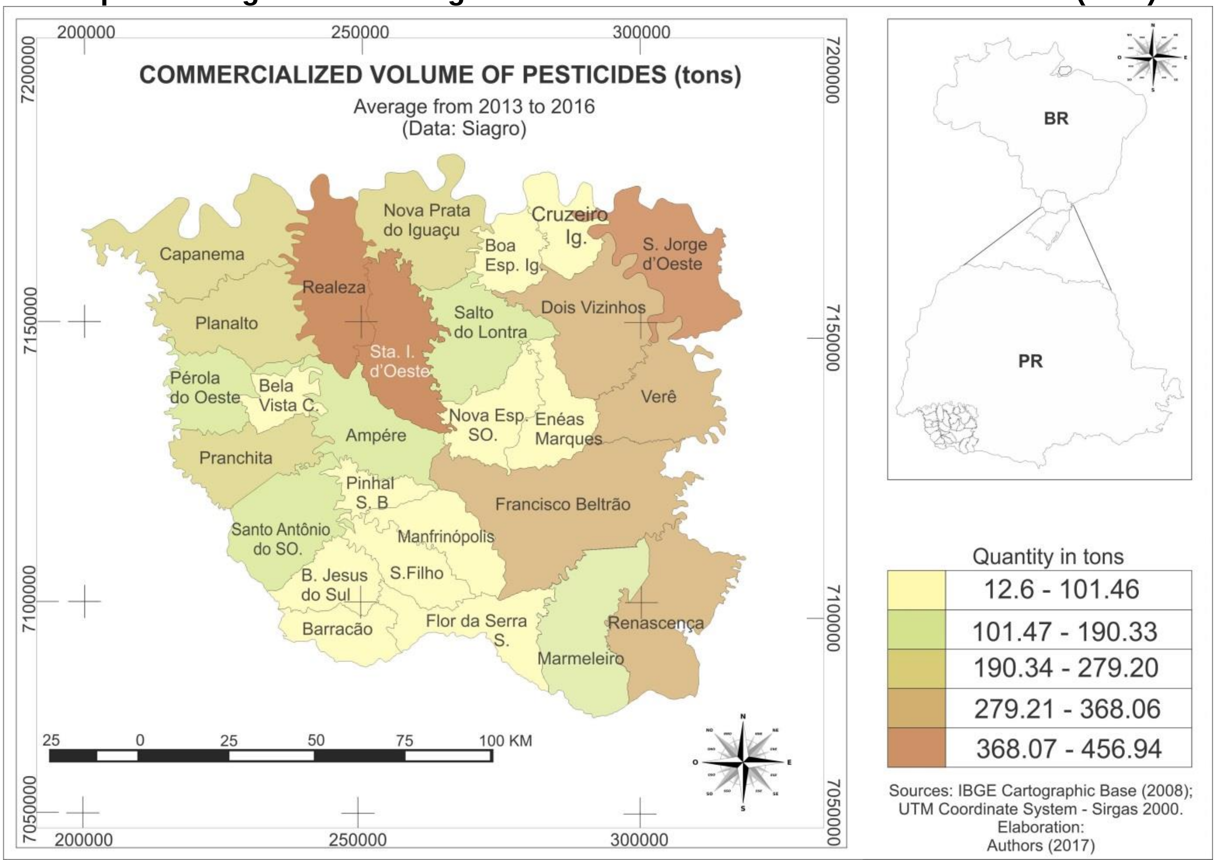


The third stratum of municipalities with highest sales volumes of agrochemicals includes Capanema (228.6 tons), Pranchita (194.2 tons), Nova Prata do Iguaçu (176.7 tons) and Planalto (172.4 tons). The fourth stratum includes the municipalities of Marmeleiro (160.2 tons), Santo Antônio do Sudoeste (145.8 tons), Salto do Lontra (145.6 tons), Pérola d'Oeste (122.0 tons) and Ampére (105.9 ton).

The remaining municipalities were classified in the stratum of those with least volumes of pesticides sales between 2011 and 2016, showing the following annual averages: Cruzeiro do Iguaçu (71.7 tons), Flor da Serra do Sul (63.6 tons), Boa Esperança (59.3 tons), Bela Vista da Caroba (45.2 tons), Enéas Marques (43.1 tons), Pinhal de São Bento (34.2 tons), Nova Esperança do Sudoeste (30.0 tons) , Salgado Filho (23.4 tons), Barracão (19.2 tons), Bom Jesus do Sul (17.4 tons) and Manfrinópolis (12.3 tons).

Map 3 shows the annual average volume of pesticides sales between 2013 and 2016. It is observed that in the first stratum, Santa Izabel do Oeste (456.9 tons), Realeza (371.1 tons) and São Jorge do Oeste (370.0 tons) stand out in comparison with the other municipalities, since they used, on average, more than 370 tons of pesticides per year.

Map 3: Average volume of agrochemicals traded between 2013 and 2016 (tons)



In the second stratum are Renascença (338.4 tons), Verê (314.1 tons), Dois Vizinhos (309.1 tons) and Francisco Beltrão (294.5 tons). These municipalities are followed by the third stratum of those with the highest volumes of agrochemicals sales from 2013 to

2016: Capanema (258.1 tons), Pranchita (215.0 tons), Nova Prata do Iguaçu (206.4 tons) and Planalto (202.2 tons).

The municipalities that form the fourth stratum of pesticide sales in the 8th Regional Health Authority of Paraná between 2013 and 2016 are Salto do Lontra (175.4 tons), Marmeleiro (166.1 tons), Santo Antônio do Sudoeste (162.2 tons) ton), Pérola d'Oeste (139.2 tons) and Ampére (120.5 tons). The other municipalities showed sales volumes below 100 tons during this period.

While, in 2011, the national average of environmental, occupational and food exposure to pesticides was 5.2 liters per person, in 2014 the average indirect consumption per inhabitant in Brazil was already 7.3 liters[2] (ABRASCO, 2015). This figure has been questioned by the defenders of this agricultural model, because the calculation is the result of the division between the volume of pesticides sales and the number of inhabitants of the country. However, it must be considered that, although this quantity was not actually consumed by the population and not all plantations using agrochemicals are food crops (eg. cotton), the Brazilian population is highly susceptible to pesticide exposure. As this average is the result of the division of the total amount of pesticides legally sold by the total Brazilian population, there is an assumption that these products are indirectly consumed, and that there are environmental, occupational and food exposure to them. Such exposure is certainly relative, being greater for rural workers – who suffer a more direct exposure – than for people living in the cities. This figure also reveals a high environmental and occupational exposure.

Data provided by ADAPAR (2017) are expressed in kilograms and show that, in many municipalities of the 8th Regional Health Authority of Paraná, the average volume sold in kilos per inhabitant is well above the national average, as can be observed in Map 4.

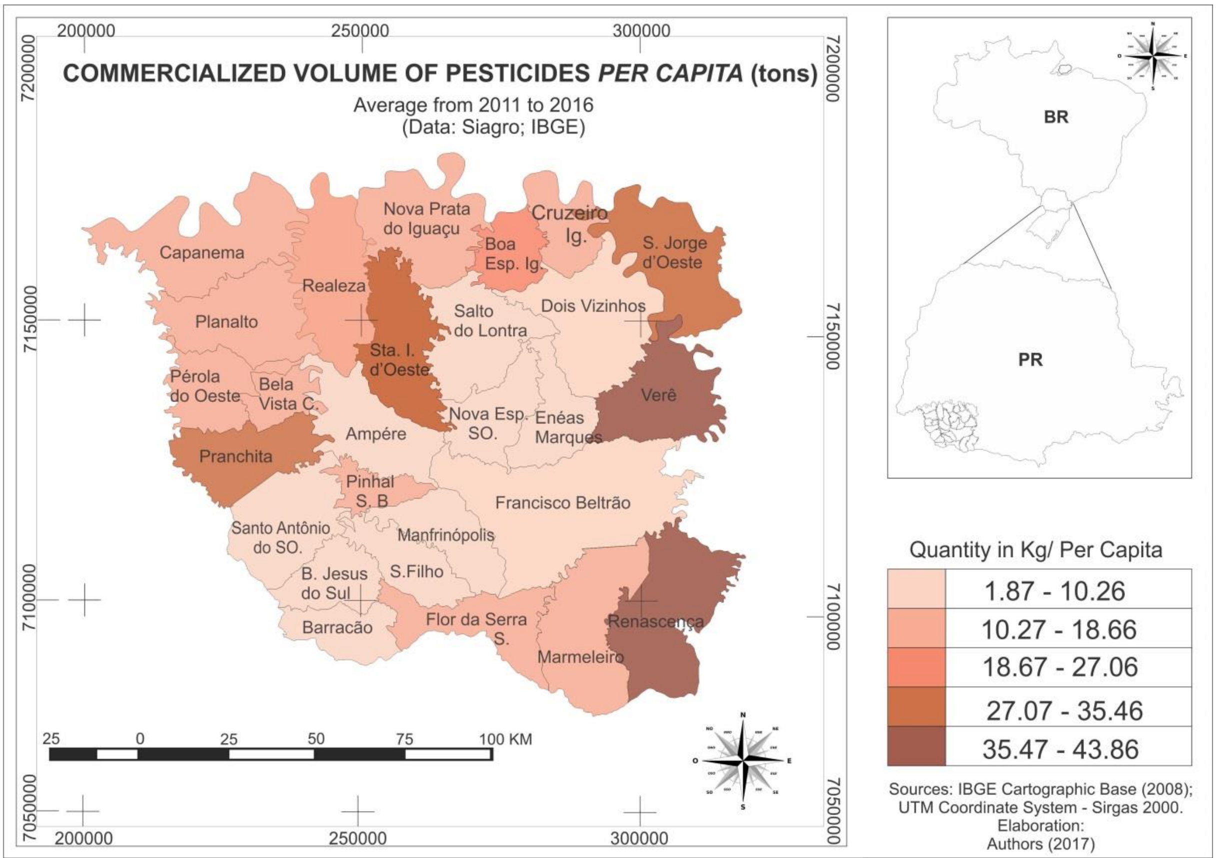
Between 2011 and 2016, the municipalities with the highest environmental, occupational and food exposure were Renascença (43.8 kg/inhab.) and Verê (35.7 kg/inhab.). In the second stratum are the municipalities of Pranchita (35.2 kg/inhab.), São Jorge do Oeste (32.3 kg/inhab.) and Santa Izabel do Oeste (28.4 kg/inhab.). In the third stratum of municipalities with the highest sales of pesticides per inhabitant, there is only Boa Esperança do Iguaçu (22.0 kg/inhab.).

In the fourth stratum are the municipalities of Pérola d'Oeste (18.1 kg/inhab.), Realeza (17.1 kg/inhab.), Nova Prata do Iguaçu (16.4 kg/hab.), Cruzeiro do Iguaçu 16.3 kg/inhab.), Flor da Serra do Sul (13.2 kg/inhab.), Pinhal de São Bento (12.4 kg/inhabit.), Planalto (12.4 kg/inhab.) Bela Vista de Caroba (11.8 kg/inhab.), Capanema (11.8 kg/inhab.) and Marmeleiro (11.0 kg/hab.).

[2]<https://www.abrasco.org.br/site/noticias/movimentos-sociais/aumenta-a-quantidade-de-agrotoxicos-consumido-por-cada-brasileiro-73-litros/10304>.

As to the municipalities with the lowest average sales volume per capita, they are: Salto do Lontra (10.0 kg/inhab.), Santo Antônio do Sudoeste (7.2 kg/inhab.), Enéas Marques (6.9 kg/inhab.), Dois Vizinhos (6.7 kg/inhab), Nova Esperança do Sudoeste (5.7 kg/inhab), Salgado Filho (5.7 kg/inhab.), Ampére (5.6 kg/inhab.), Bom Jesus do Sul (4.6 kg/inhab.), Manfrinópolis (4.2 kg/inhab.), Francisco Beltrão (2.9 kg/inhab.) and Barracão (1.8 kg/inhab.). However, even in the lower strata, the municipality of Salto do Lontra shows values higher than the national average, indicating that 17 of the 27 municipalities in question have per capita consumption values higher than the Brazilian average (7.3 liters/ha) [3].

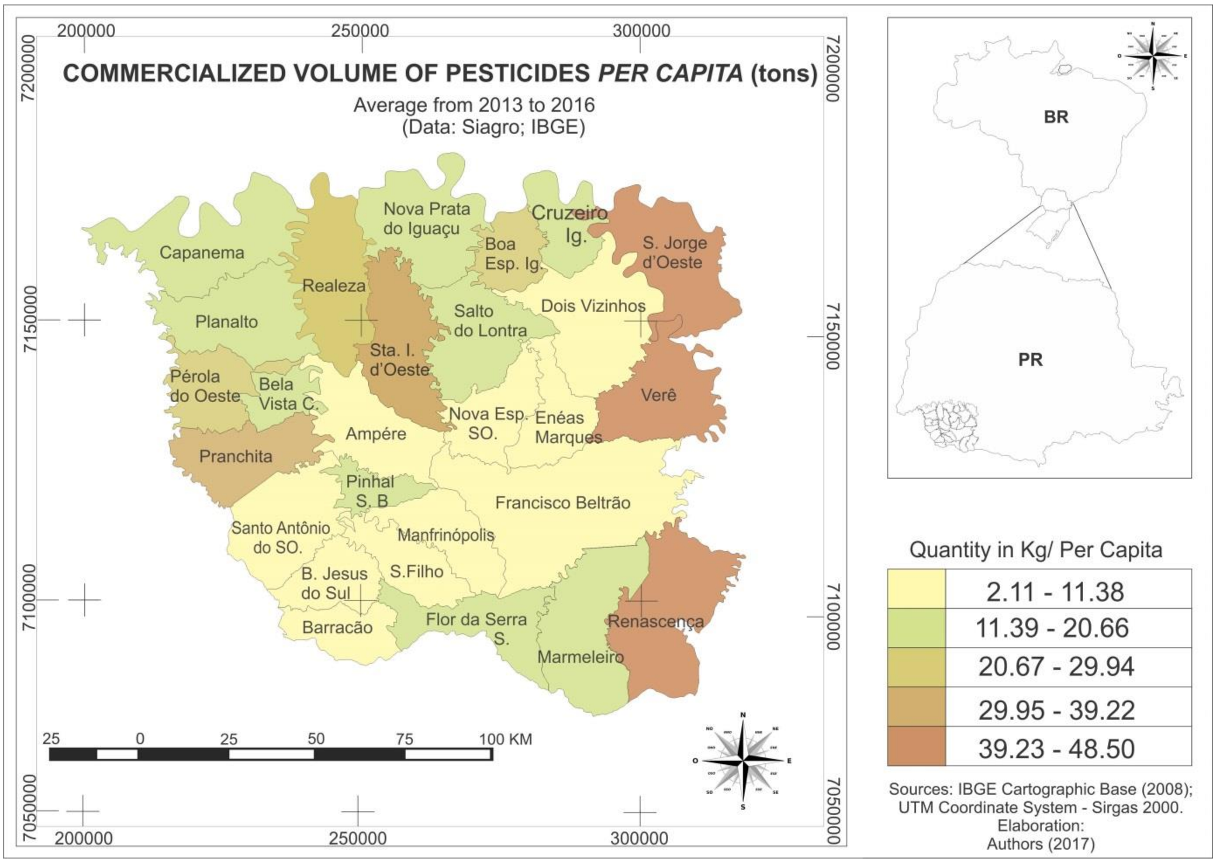
Map 4: Average volume of agrochemicals traded per capita (2011 to 2016) (kg)



These same data are more alarming when the average is calculated between 2013 and 2016 (Map 5).

[3]. It is must be taken into account that 1 liter is not necessarily equivalent to 1 kilo, since the density of the liquid is determinant to gauge its weight. However, if we consider the density of water, for example, for which 1 liter equals 1 kilo, we can say that 1 liter of pesticide weighs at least 1 kilo. Thus, in order to compare the national average with the average of the 27 municipalities in question, it was decided to equate 1 liter to 1 kilo. However, this value may be higher, since the density of pesticides is probably higher than that of water.

Map 5: Average volume of agrochemicals traded per capita (2013 to 2016) (kg)



The municipalities with the highest average volume of agrochemicals sales per capita between 2013 and 2016 are: Renascença (48.5 kg/inhab.), Verê (40.6 kg/inhab.) and São Jorge do Oeste (39.8 kg/inhab). The second stratum is composed of Pranchita (38.9 kg/inhab.) and Santa Izabel do Oeste (32 kg/inhab.).

In the third stratum of municipalities with the highest sales volume of pesticides per inhabitant from 2013 to 2016, there are Boa Esperança do Iguaçu (26.9 kg/inhab.), Realeza (21.7 kg/inhab.) and Pérola d'Oeste (20,7 kg/inhab.).

The fourth stratum presents the municipalities of Cruzeiro do Iguaçu (20.4 kg/inhab.), Nova Prata do Iguaçu (19.2 kg/inhab.), Planalto (14.5 kg/inhab.), Flor da Serra do Sul (13.4 kg/inhab.), Pinhal de São Bento (13.3 kg/inhab.), Bela Vista da Caroba (12.9 kg/inhab.), Salto do Lontra (12 kg/inhab.) and Marmeleiro (11.5 kg / hab.).

As to the municipalities with the lowest average volume sold per inhabitant are: Santo Antônio do Sudoeste (8.1 kg/inhab.), Dois Vizinhos (7.8 kg/inhab.), Enéas Marques (7.5 kg/inhab.), Salgado Filho (6.8 kg/inhab.), Nova Esperança do Sudoeste (6.4 kg/inhab.), Ampére (6.4 kg/inhab.), Bom Jesus do Sul (5.3 kg/inhab), Manfrinópolis (4.3 kg/inhab.), Francisco Beltrão (3.4 kg/hab.) and Barracão (2.1 kg/inhab.). It is worth noting that Francisco Beltrão is the municipality with the highest population concentration, what means that its average per capita consumption is considerably reduced.

Data from 2013 to 2016 indicate that only seven out of the 27 municipalities present values below the national average (7.3 liters/inhabitant), in terms of per capita consumption.

The growing consumption of agrochemicals in these 27 municipalities located in the Southwest of Paraná is proportional to the increase of monocultures and transgenic crops, especially soybean and corn. This type of agriculture is highly dependent on chemical inputs. According to IPARDES data, between 2010 and 2015, the trinomial soybean, corn and wheat accounted for 95% of the area harvested from the main grains produce in this studied region (Chart 2).

Graph 2: Percentage of the harvested area in hectares in temporary crops (average from 2010 to 2015)

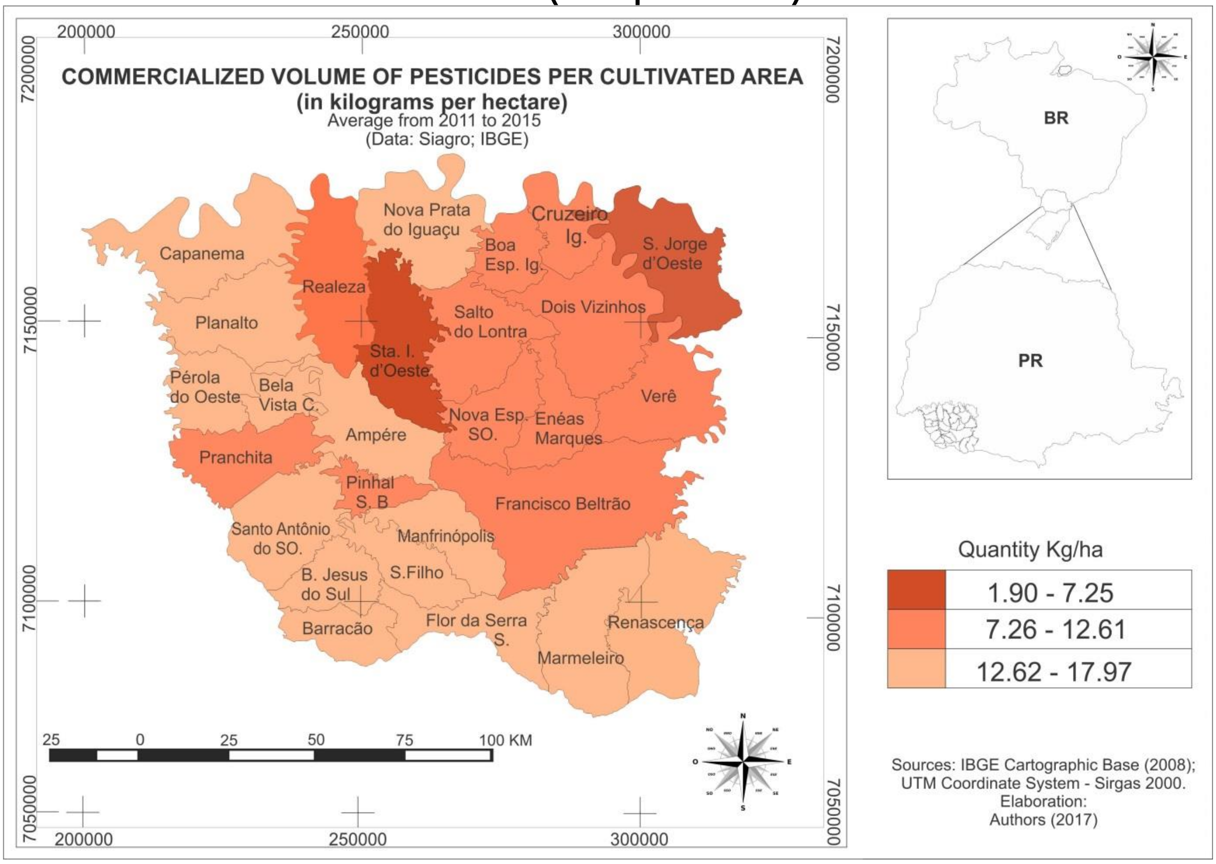
Source: IPARDES (2017).

Monoculture has also made the use of pesticides per cultivated hectare grow every year. In Brazil, in 2001, the average use of pesticides per hectare cultivated was 2.7 kg. In 2010, this average reached about 5 kg/ ha. The growth was due to increased cultivation of transgenic crops. This relationship arises from the fact that the plants were genetically modified to receive agrochemicals, without harming their development (NODARI, 2007).

In the 27 analyzed municipalities, the volume of pesticides commercialized in relation to the harvested area of both temporary and permanent crops increased considerably between 2011 and 2015. Two municipalities stood out in this regard: 1) São Jorge do Oeste, which increased from 9 kg per hectare in 2011 to 25 kg per hectare in 2015; and 2) Santa Izabel do Oeste, which raised from 8.3 kg per hectare in 2011 to 23.4 kg per hectare in 2015.

In Brazil, according to IBGE, the commercialization of pesticides per cultivated area was 6.7 kg per hectare in 2014. Nevertheless, when the 27 municipalities that comprise the 8th Regional Health Authority of Paraná are considered separately, more than half of them show average sales volume of pesticides per cultivated area, between 2011 and 2015, higher than the national average indicated by the IBGE in 2014, reaching up to 18 kg per hectare, as indicated in Map 6.

Map 6: Average volume of agrochemicals marketed per cultivated area between 2011 and 2015 (kilos per hectare)



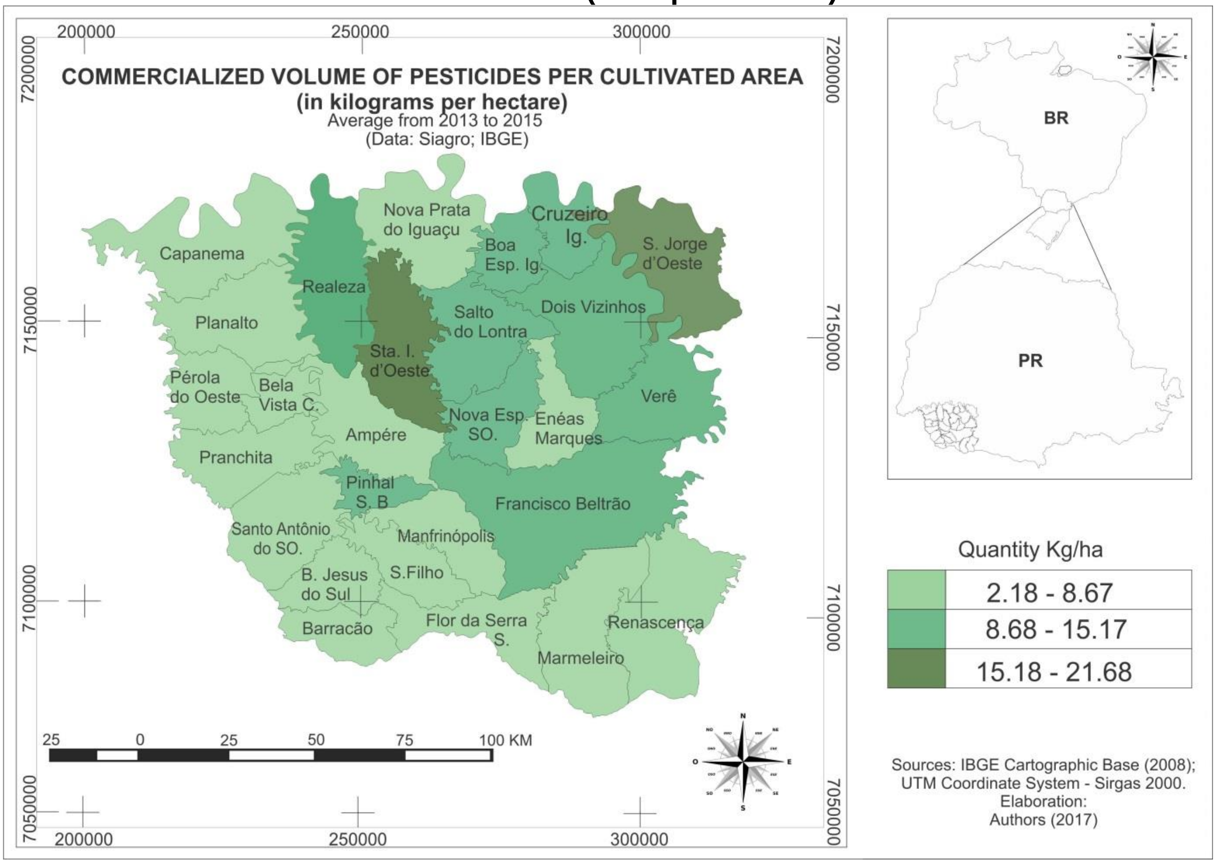
In the first stratum of the municipalities with highest average of agrochemicals sales volume per agricultural area cultivated, between 2011 and 2015, are São Jorge do Oeste (17 kg/ha) and Santa Izabel do Oeste (18 kg/ha).

The second stratum includes Pinhal de São Bento (10.4 kg/ha), Cruzeiro do Iguaçu (9.3 kg/ha), Realeza (8.9 kg/ha), Francisco Beltrão (8.9 kg/ha), Verê (8.5 kg/ha), Dois Vizinhos (8.4 kg/ha), Boa Esperança do Iguaçu (7.6 kg/ha), Pranchita (7.4 kg/ha), Enéas Marques (7.4 kg/ha), Nova Esperança do Sudoeste (7.4 kg/ha) and Salto do Lontra (7.3 kg/ha).

In the stratum of those that consumed less than 7.25 kg per cultivated hectare are Ampére (7.1 kg/ha), Planalto (6.9 kg/ha), Marmeleiro (6.8 kg/ha), Renascença (6.7 kg/ha), Capanema (6.5 kg/ha), Santo Antônio do Sudoeste (6.4 kg/ha), Pérola d'Oeste (6.4 kg/ha), Nova Prata do Iguaçu (5.6 kg/ha), Bela Vista da Caroba (5.1 kg/ha), Flor da Serra do Sul (4.6 kg/ha), Manfrinópolis (3.6 kg/ha), Barracão (2.7 kg/ha), Salgado Filho (2.5 kg/ha) and Bom Jesus do Sul (1.9 kg/ha).

Considering the average volume of pesticides sold per cultivated area between 2013 and 2015, increase is observed in all municipalities (Map 7). In the first stratum are the municipalities of São Jorge do Oeste (21.6 kg/ha) and Santa Izabel do Oeste (21.4 kg/ha). The two contrast markedly with the others, because they show values over 20 kilos per hectare.

Map 7: Average volume of agrochemicals traded per area under cultivation between 2013 and 2015 (kilos per hectare)

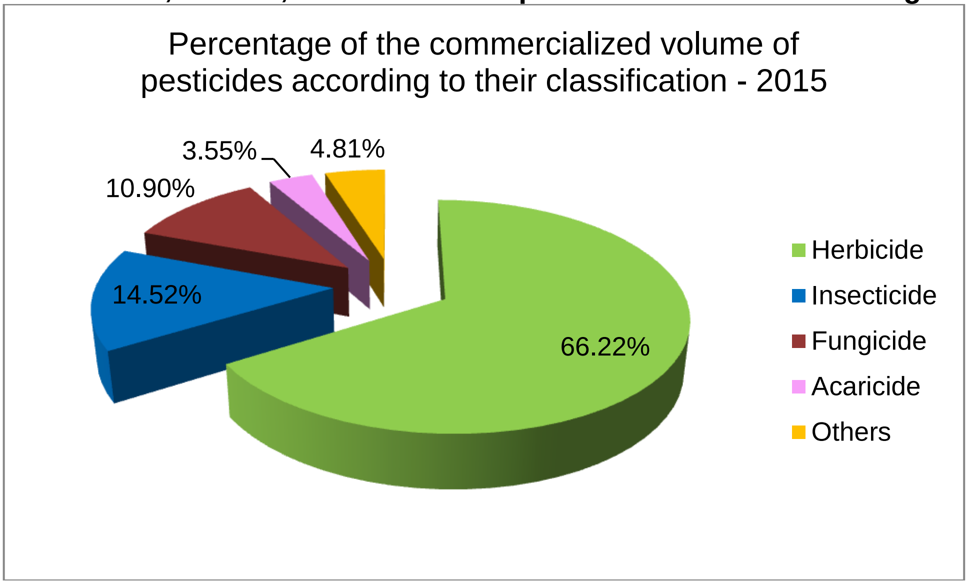


The third stratum comprises Ampére (8.4 kg/ha), Pranchita (8.3 kg/ha), Planalto (8.3 kg/ha), Capanema (7.5 kg/ha), Enéas Marques (7.5 kg/ha), Renascença (7.2 kg/ha), Pérola do Oeste (7.2 kg/ha), Santo Antônio do Sudoeste (7.0 kg / ha), Marmeleiro (6.6 kg/ha), Nova Prata do Iguaçu (6.6 kg/ha), Bela Vista da Caroba (5.3 kg/ha), Flor da Serra do Sul (5.0 kg/ha), Manfrinópolis (3.8 kg/ha), Barracão (3.2 kg/ha), Salgado Filho (3.0 kg/ha) and Bom Jesus do Sul (2.2 kg/ha). The proximity of some of these municipalities of the third stratum with Paraguay and Argentina casts doubt on the actual amount of pesticides used, since the official data do not take into account the products smuggled from these neighboring countries to Brazil.

According to Silva and Fay (2004), pesticides cover a large number of chemical molecules, with different pesticidal activity and toxicity, being divided into three main classes: insecticides, fungicides and herbicides. Insecticides have action against insects and larvae. Fungicides act to prevent fungus, while herbicides kill or control unwanted plants, such as weeds.

In the 27 analyzed municipalities, the commercialized volume of pesticides, according to the classification of use, shows that, in 2015, the use of herbicides was the most significant, reaching the mark of 66.2%, followed by insecticides (14.5%), fungicides (10.9%), acaricides (3.6%) and others[4] (4.8%) (Chart 3).

Graph 3: Percentage of the commercialized volume of pesticides according to their classification, in 2015, in the 27 municipalities of the 8th Health Regional



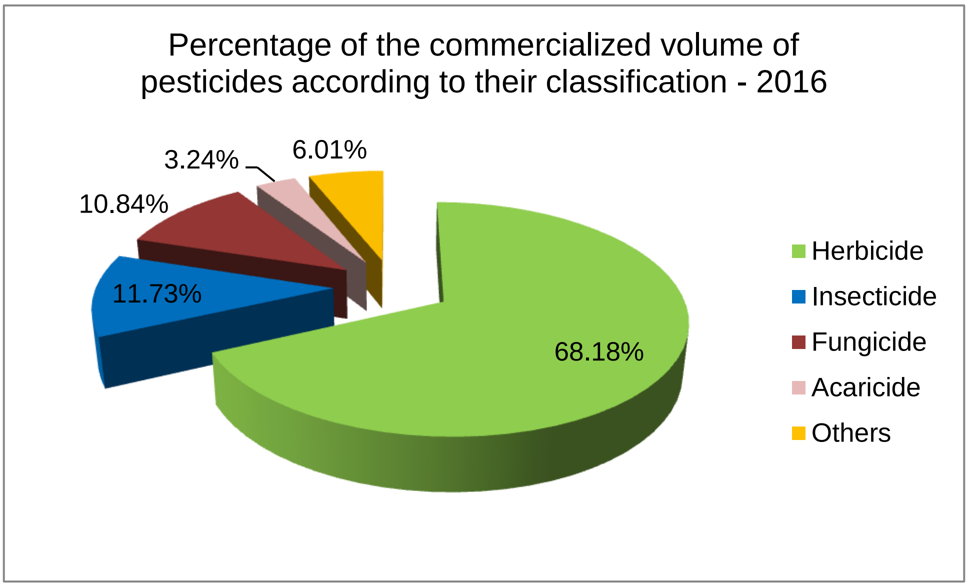
Source: ADAPAR (2017).

This data is close to those reported at the national level. In Brazil, in 2014, according to IBGE, the percentage of the commercialized amount of pesticides by class was as follows: 58% were herbicides, 10.6% fungicides, 12.3% insecticides, 1% acaricides and 18.1% other pesticide products.

In 2016, the percentage of sales volume for agrochemicals by type of use in the 27 analyzed municipalities showed small variation (Chart 4).

[4] The category 'others' corresponds to adjuvants, spreaders, growth regulators, acaricide/insecticide, acaricide/adjuvant/insecticide, acaricide/ fungicide, fungicide/insecticide.

Graph 4: Percentage of the commercialized volume of pesticides according to their classification, in 2016, in the 27 municipalities of the 8th Health Regional



Source: ADAPAR (2017).

The herbicides reached the mark of 68.2%, followed by insecticides (11.8%), fungicides (10.8%), acaricides (3.2%) and others (6%).

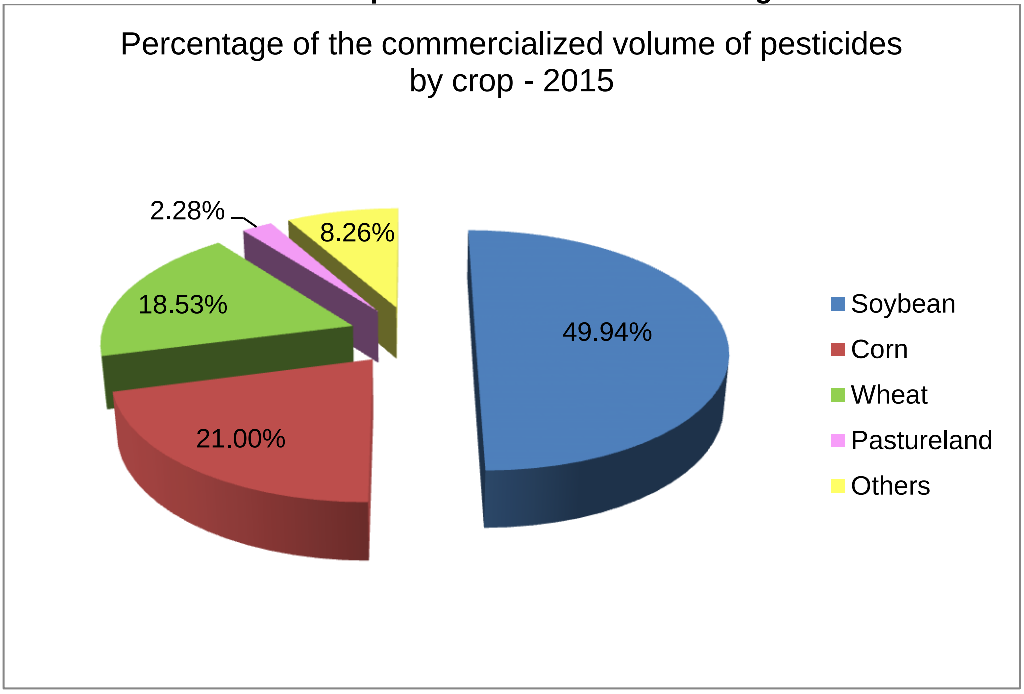
According to data available from ADAPAR, these pesticides were mainly applied to soybean, corn, wheat and pasture crops (charts 5 and 6).

Chart 5 shows that 49.9% of the commercialized volume of pesticides were destined for soybean crops in 2015, followed by 21% for corn, 18.3% for wheat, 2.3% for pasture and 8.3% for others[5].

Chart 6 indicates that, in 2016, commercialized pesticides continued to be applied mainly to soybean (47.7%), corn (26.1%) and wheat (11.2%).

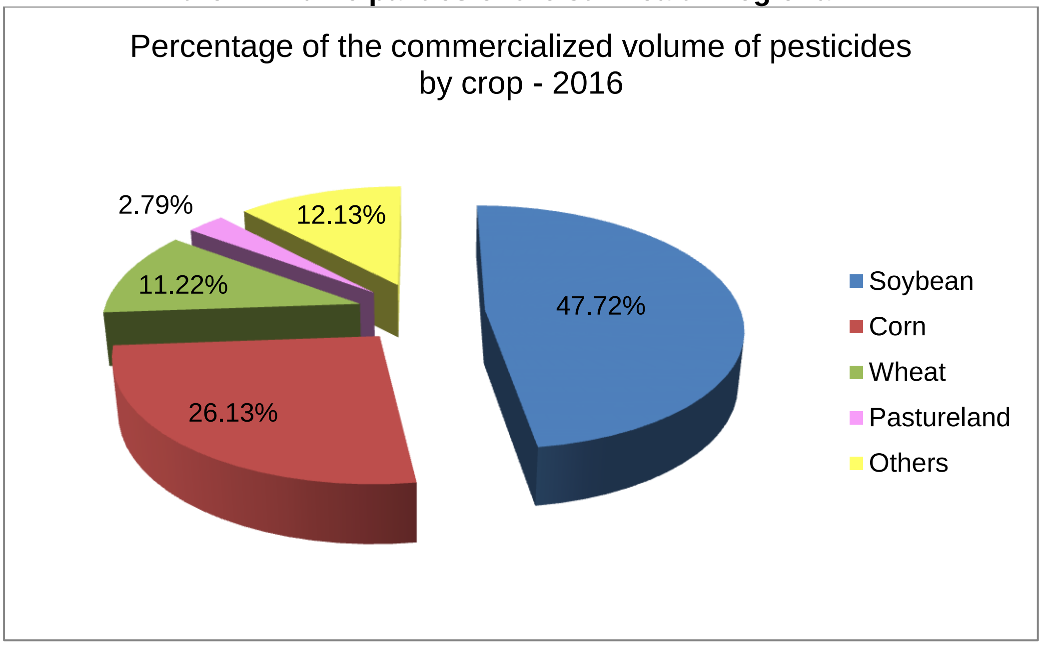
[5] The 'others' category corresponds to several crops such as: beans, rice, tobacco, sugar cane, fruits and vegetables.

Graph 5: Percentage of the commercialized volume of pesticides by crop, in 2015, in the 27 municipalities of the 8th Health Regional



Source: ADAPAR (2017).

Graph 6: Percentage of the commercialized volume of pesticides by crop, in 2015, in the 27 municipalities of the 8th Health Regional

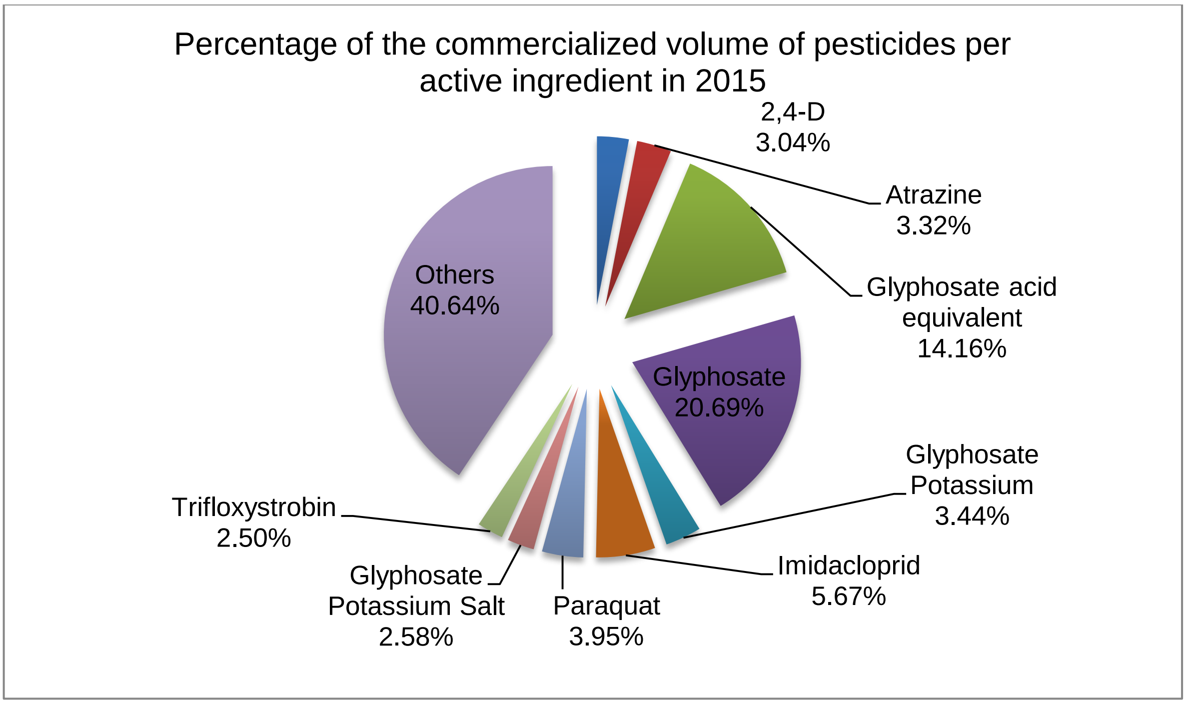


Source: ADAPAR (2017).

The analysis of the sales volume of pesticides per active ingredient in 2015 shows that each municipality commercialized between 96 and 157 active ingredients during the year. Charts 7 and 8 present the active ingredients most commercialized in the 27 studied municipalities.

In 2015, nine active ingredients predominated, namely: Glyphosate (20.7%), Glyphosate Acid Equivalent (14.2%), Imidacloprid (5.7%), Paraquat (4%), Potassium Glyphosate (3.4%), Atrazine (3.3%), 2,4-D (3%), Glyphosate Potassium Salt (2.6%) and Trifloxystrobin (2.5%). The category “others” (40.6%) corresponds to the sum of the active ingredients whose pesticides represented less than 2% of the total volume sold.

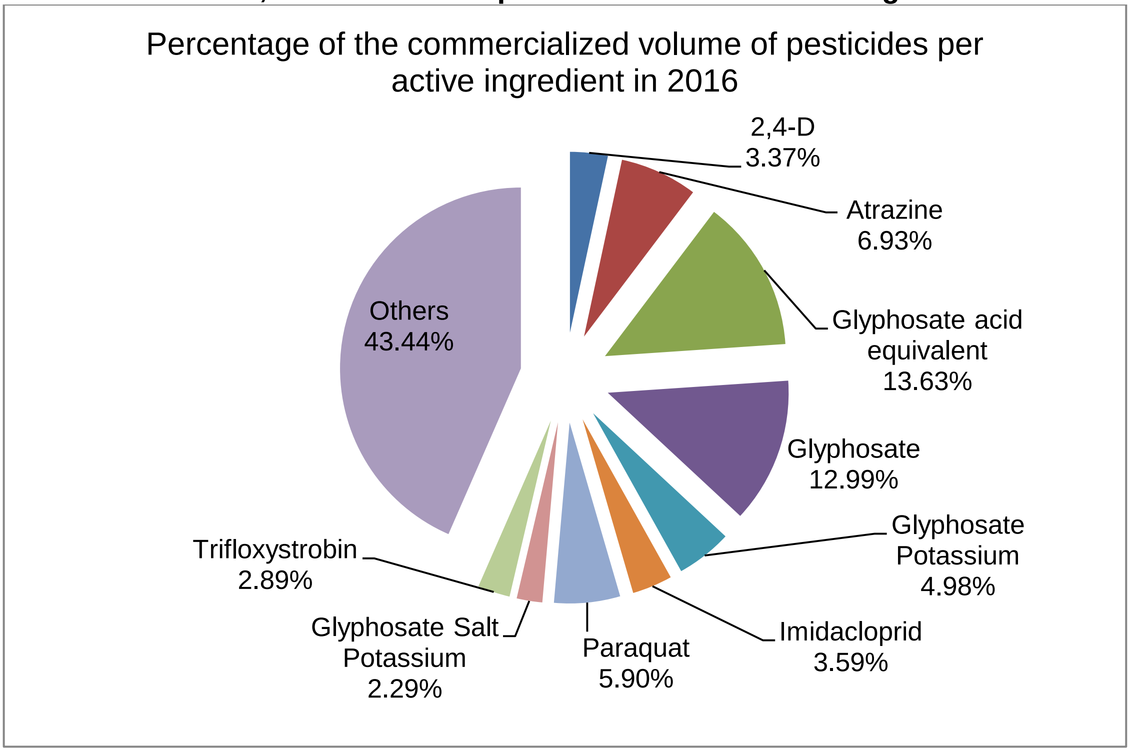
Graph 7: Percentage of the commercialized volume of pesticides per active ingredient in 2015, in the 27 municipalities of the 8th Health Regional



Source: ADAPAR (2017).

In 2016, between 93 and 158 active ingredients were commercialized. Chart 8 shows the same nine active ingredients presented in Chart 7, with variation only in quantities sold: Glyphosate Acid Equivalent (13.6%), Glyphosate (13%), Atrazine (6.9%), Paraquat (5.9%), Potassium Glyphosate (5%), Imidacloprid (3.6%), 2,4-D (3,4%), Trifloxystrobin (2.9%) and Glyphosate Potassium Salt (2,3%). The category “others” (43.4%) is also the sum of the active ingredients whose pesticides accounted for less than 2% of the total volume sold.

Graph 8: Percentage of the commercialized volume of pesticides per active ingredient in 2016, in the 27 municipalities of the 8th Health Regional



Source: ADAPAR (2017).

It is worth noting that, in the two charts above, the listed active ingredients include Potassium Glyphosate and Potassium Glyphosate Salt as distinct active ingredients. However, a closer look reveals that both ingredients have the same CAS[6] number, i.e. they are the same active ingredient. They are listed as two different ones because their register in the database is made as it appears in the information leaflet. Another significant data is the active ingredient Glyphosate Acid Equivalent, which does not appear in the registers of the Brazilian Health Regulatory Agency (ANVISA). The reason is that "Acid Equivalent" is a generic term to designate the portion of an active ingredient that ultimately acts on the plant and so it is not a chemical compound with a CAS number. In the case in question, the Glyphosate Acid Equivalent is the portion of the glyphosate which kills the weed or undesired plant and it is found in five different active ingredients: glyphosate (CAS 1071-83-6), glyphosate isopropylamine salt (CAS 38641 -94-0), the potassium salt of glyphosate (CAS 70901-12-1, or the old number 39600-42-5), the ammonium salt of glyphosate (CAS 114370-14-8) and the dimethylamine salt of glyphosate (34494-04-7). The possible explanation for this vague registration is the same as previously mentioned, i.e. the way it is described in the information leaflet, as well as the purpose of determining the actual active ingredient that was

[6] The *Chemical Abstract Services* (CAS) is a division of the American Chemical Society (ACS) that, among other activities, identifies and lists the different chemicals, so that each chemical compound has a unique registration number even when marketed in different concentrations, thus avoiding ambiguities when the same compound may have different usual names.

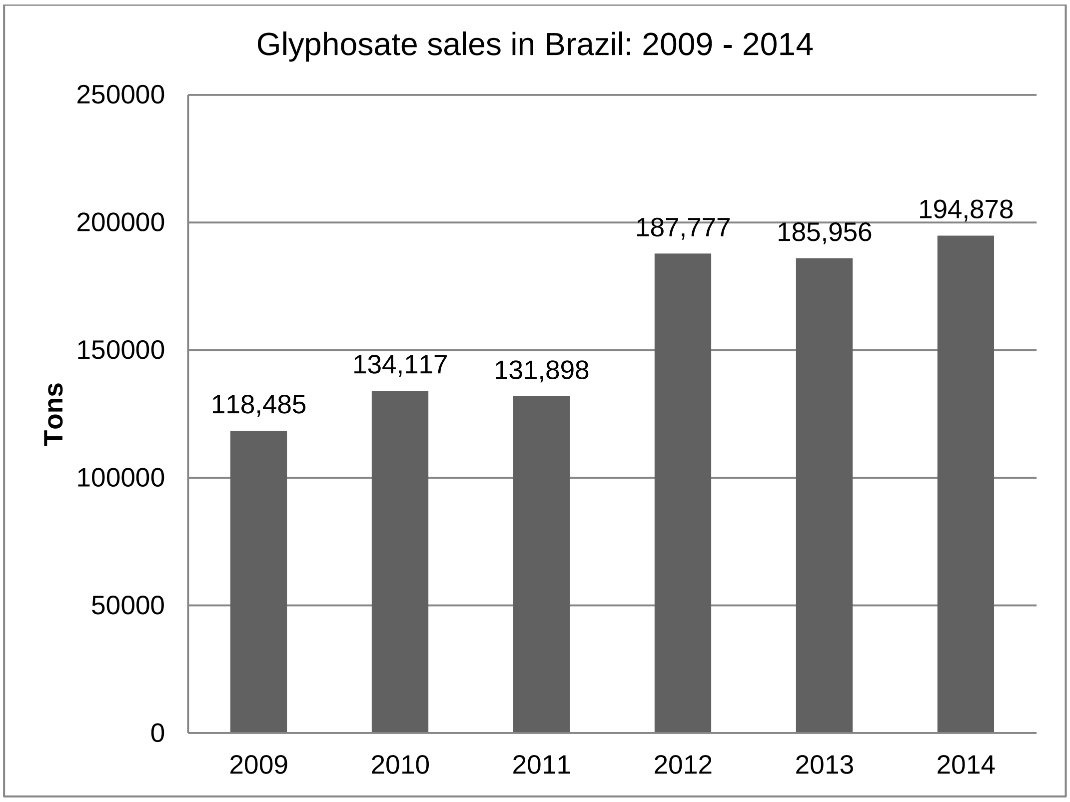
sold. Based on this discussion, specifying the amount of glyphosate and derivatives sold in 2015 and 2016 is very difficult, which does not preclude the magnitude of the use of the active ingredient glyphosate in its various possible chemical variants.

Seven out of the nine active ingredients sold in the 27 municipalities of the 8th Regional Health Authority are herbicides: Glyphosate, Glyphosate Acid Equivalent, Potassium Glyphosate, Glyphosate Potassium Salt, Atrazine, Paraquat and 2,4-D. The two remaining, imidacloprid and trifloxystrobin are respectively an insecticide and a fungicide.

Considering the total percentage of active ingredients with Glyphosate and its derivatives (Glyphosate Acid Equivalent, Glyphosate Potassium and Glyphosate Potassium Salt), it can be seen that 40.9% of the active ingredients used in 2015 in the 27 municipalities of the 8th Regional Health Authority of Paraná contained Glyphosate. In 2016, this value fell to 33.9%, though remaining very relevant.

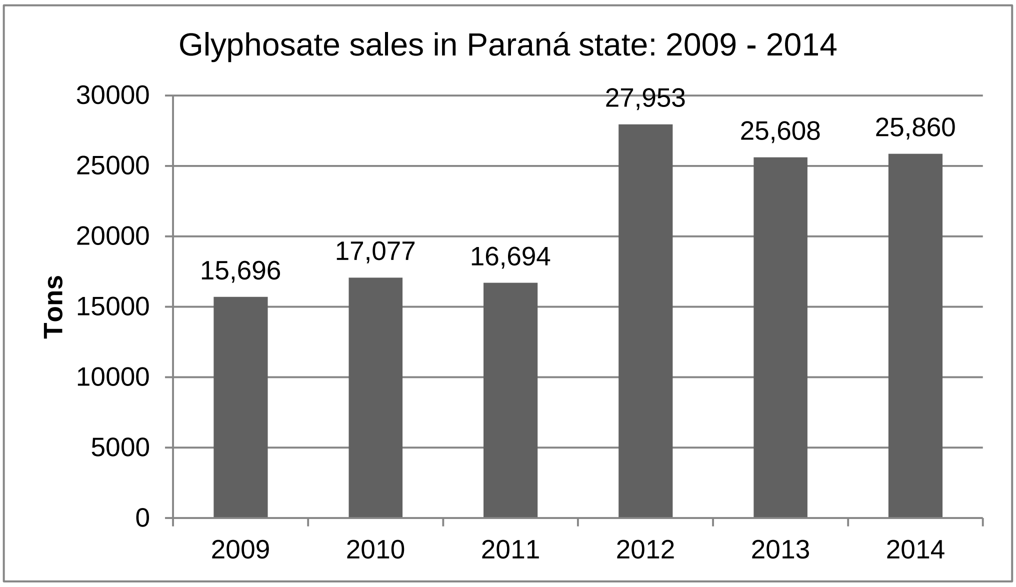
According to data from the Brazilian Institute for the Environment and Natural Renewable Resources - IBAMA (2018), between 2009 and 2014, three of the active ingredients most commercialized in the 27 municipalities of the 8th Regional Health Authority of Paraná were among the ten most sold in Brazil: Glyphosate and its salts, 2,4-D and Atrazine. Still according to these data, the leading active ingredient in the Brazilian ranking is Glyphosate and, in the state of Paraná, the same occurs, as can be seen in Charts 9 and 10.

Graph 9: Glyphosate sales in Brazil: tons / year (2009 to 2014)



Source: IBAMA (2018).

Graph 10: Glyphosate sales in Paraná state: tons / year (2009 to 2014)



Source: IBAMA (2018).

Charts 9 and 10 show that in a period of only six years, the percentage of Glyphosate sales in Brazil increased by 64.4%. Paraná accompanied this growth in the use of the active ingredient, since from 2009 to 2014, sales of the product increased by 64.7%.

The magnitude of the use of Glyphosate in the country and in Paraná brings out questions about a public health problem, given the contamination of the environment, food and humans, especially rural workers who use this product.

A paper published in 2017 by the World Health Organization, entitled "IARC Monographs on the evaluation of carcinogenic risks to humans - Some organophosphate insecticides and herbicides; Volume 112 ", recognized the carcinogenic potential of this active ingredient in humans and animals. According to the document, there is limited evidence of the carcinogenicity of glyphosate in humans, though a positive association has been observed for non-Hodgkin's lymphoma. Thus, the active ingredient was framed as probably carcinogenic to humans. Animal experiments, however, have provided enough evidence for the carcinogenicity of glyphosate (IARC, 2017).

Glyphosate is also considered to be an *environmentally hazardous pesticide* - *Class III*, according to the classification made by IBAMA, which is the institution responsible for the analysis, registration and control of agrochemicals in Brazil:

> The Evaluation of the Environmental Hazard Potential, conducted by IBAMA, is based on the characteristics of the product, such as the physical-chemical properties and their toxicity to the varied organisms found in nature; the degree of accumulation of the product in living tissue; if it persists for a long time in the environment; and if it can spread (to soil, air or water). Also, the

hazards of causing mutations, cancer, malformations in fetuses or embryos, and the risk to reproduction of birds and mammals are analyzed (IBAMA, 2010).

The classification of pesticides by environmental hazard corresponds to the following graduation: Class I – Extremely hazardous to environment; Class II - Highly hazardous to environment; Class III – Moderately Hazardous to environment; and Class IV – Slightly hazardous to environment. Among the pesticides most commercialized in the 27 municipalities of the 8th Regional Health Authority of Paraná in 2016, as shown in Chart 8, four are classified as moderately hazardous to environment and two as highly hazardous to environment, as can be seen in Table 1.

Table 2: Classification of Environmental Hazard Potential of the most commercialized active ingredients in 2016 in Paraná's 8th Health Regional

CLASSIFICATION OF ENVIRONMENTAL HAZARD POTENTIAL	
Glyphosate	Class III (dangerous)
Atrazine	Class II (very dangerous)
Paraquat	Class III (dangerous)
Imidacloprid	Class III (dangerous)
2,4-D	Class III (dangerous)
Trifloxystrobin	Class II (very dangerous)

Source: ADAPAR (2018).

According to Silva and Fay (2004), agrochemicals, by their nature and purpose, are poisonous and, even if their amounts are minimal as compared to soil minerals, they can have a huge impact on the environment.

These products account for several detrimental effects on the environment, since, besides contaminating the soil and water, they affect the producers of the food chain (plants) and can cause ecological imbalances in plants, animals and ecosystems.

Final remarks

The social and environmental problems entailed by the indiscriminate use of pesticides have concerned scientists, rural workers and institutions devoted to environment and human health. However, a gap of information on agrochemicals prevails in Brazil, regarding the volume of these products commercialized in several municipalities; their types and active ingredients, the cultures to which they are applied, among other information. In the state of Paraná, SIAGRO data allow to discuss the use of pesticides, although these data began to be collected only in 2011.

With regard to the southwestern region of Paraná, this issue comprises a problem that has been poorly researched or disseminated to the society, which is exposed to very high amounts of hazardous pesticides to food and environment, as shown in this article. Although since 2011 ADAPAR has been collecting data, by means of SIAGRO, the own technicians of the institution consider that only from 2012 on these data have become truly reliable, despite the problem of the use of illegal pesticides (allowed or not) from the neighbor countries Paraguay and Argentina.

Data from SIAGRO makes clear that there has been a considerable increase in the use of agrochemicals in the 27 municipalities that are part of the 8th Regional Health Authority of Paraná. However, since there are no records prior to 2011, it is difficult to establish a broader time-frame and comparison.

The data presented and discussed in this article indicate the seriousness of the situation, since despite the argument that transgenics would reduce the use of agrochemicals, the opposite has been observe. The example of Glyphosate and its derivatives is emblematic, insofar as these products have been widely used in crops of transgenic soy and corn.

By comparing the average use in the 27 studied municipalities with the national average, an intense use of pesticides is observed. This is due to the importance of agriculture in both the state and the particular region, and in addition, the political-economic structure that underpins agribusiness, from the hegemonic media, transnational groups, producers' syndicates, grain producers, "cooperatives" and other actors.

The graphical expression of data obtained from official agencies made easier to visualize the spatial distribution of the use of pesticides in the 27 municipalities that constitute the 8th Regional Health Authority of Paraná. Based on this spatial distribution, it was possible to observe consumption patterns of the municipalities, thus identifying those with the most significant use of pesticides and whose rural population is more exposed to hazard.

The municipalities of Santa Izabel do Oeste, São Jorge d'Oeste, Realeza, Renascença, Francisco Beltrão, Dois Vizinhos and Verê present the highest consumption rates between 2011 and 2016. However, the situation can be considered serious in almost all the 27 analyzed municipalities.

In addition, soybean, corn and wheat crops account for more than 90% of the area harvested from temporary crops in the studied municipalities, which has demanded exorbitant volumes of agrochemicals. It was also found that these products contain active ingredients that are harmful to the environment and to human health, according to IBAMA's classification, particularly the Glyphosate, which is the pesticide most widely used both in Brazil and in Paraná state, particularly in the 27 analyzed municipalities.

The analysis and debate of these data is thought to be fundamental to show that, unlike some countries, Brazil has been extremely permissive in relation to the use of pesticides. In addition, it can be stated that, in Brazil, there is a growing liberalization and, consequently, an increase in the use of these products, despite awareness raising and resistance movements, such as the National Campaign against the use of pesticides. This is a political, ideological and economic clashes that must be scientifically evidenced and that must be part of the agenda of debates about the future of the Brazilian society and environment.

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