The use of pesticides in Brazil and the risks linked to human health

O uso de pesticidas no Brasil e os riscos associados à saúde humana

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ABSTRACT
The increased demand for food has intensified large-scale production systems, mainly represented by monocultures that encourage the indiscriminate use of pesticides. These products have been considered a public health concern around the world, being responsible for environmental and food contamination, which lead to risks to human health. Globally, one can note a discrepancy in the regulation of these chemicals among countries, with a wide range of maximum accepted levels of contaminants depending on the country. In Brazil, agriculture has been the main economic activity over centuries, which have led commonly to the use of huge amounts of pesticides, i.e., ~ 620,000 tons pesticides in 2019. This study aims at to discuss the regulatory differences in Brazil vis-à-vis in respecting to other countries and correlating them with the worsening of the

public health status due to the risk of developing acute and chronic diseases. The scenario that come out from the analysis of the ongoing Brazilian legislation on pesticide registration and commercialization suggests that it is quite lesser restrictive than noted, for instance, in the European Union. Thus, a series of urgent and harmonized efforts are required to mitigate the ongoing risk to human health resulting from the increasing amounts of pesticides used in Brazil, as result of an erroneous policy carried out by the Federal government. Among other actions, firstly it is urgent to restructure the laws and regulations on the release and use of pesticides in the country. In addition, policies directed towards sustainable production systems must be foster and strengthened, providing adequate food to consumers and improving the lives of rural workers, as well as reducing the risk of environmental contamination of soil and water. Finally, it has been assumed that only when a more rational and environmental-friendly legislation replaces the current set of rules on pesticide release and usage, along with the adoption of agroecological production systems of biomasses coupled to public campaigns for information of the society as a whole, it will be possible to reduce the risks to the human health caused by the overuse of pesticides.

Keywords: toxicology, food security, contamination, exposure.

RESUMO
O aumento da demanda por alimentos intensificou os sistemas de produção em larga escala, representados principalmente por monoculturas que incentivam o uso indiscriminado de agrotóxicos. Tais produtos têm sido considerados um problema de saúde pública em todo o mundo, sendo responsáveis pela contaminação ambiental e de alimentos que acarretam riscos crescentes à saúde humana. Globalmente, pode-se notar uma discrepância na regulamentação desses produtos químicos entre os países, com uma ampla gama aceita de níveis máximos de contaminantes em alimentos, dependendo do país. No Brasil, a agricultura tem sido a principal atividade econômica ao longo dos séculos, o que tem levado comumente ao uso de grandes quantidades de agrotóxicos, como observado em 2019, i.e., 620.000 t. Este estudo objetiva discutir as diferenças regulatórias entre o Brasil e países desenvolvidos, correlacionando-as com o agravamento do estado de saúde pública no país, considerando os riscos de desenvolvimento de doenças agudas e crônicas. O cenário resultante da análise da legislação brasileira em vigor sobre registro e comercialização de agrotóxicos sugere ser esta bastante menos restritiva, por exemplo, em relação à União Europeia. Assim, esforços urgentes e harmonizados são necessários para mitigar o risco permanente à saúde humana decorrente do aumento da quantidade de agrotóxicos utilizada no Brasil, resultante de uma política equivocada do Governo Federal. Entre outras ações, em primeiro lugar é urgente reestruturar as leis e regulamentos sobre a liberação e uso de agrotóxicos no país. Além disso, políticas voltadas a sistemas produtivos sustentáveis devem ser fomentadas e fortalecidas, proporcionando alimentação saudável aos consumidores e melhorando a vida dos trabalhadores rurais, bem como reduzindo o risco de contaminação ambiental do solo e da água. Por fim, parte-se do pressuposto de que somente quando uma legislação mais racional e ecologicamente correta substituir o atual conjunto de normas sobre liberação e uso de agrotóxicos, juntamente com a adoção de sistemas agroecológicos de produção de biomassas, atrelados a campanhas públicas de informação da sociedade como um todo, será possível reduzir os riscos à saúde humana causados pelo uso excessivo de agrotóxicos.

Palavras-chave: toxicologia, segurança alimentar, contaminação, exposição.

1 INTRODUCTION

The publication of the book entitled Silent Spring in 1962 by Rachel Carson has been considered one of the main historical milestones that led to the advance of studies on the impacts of pesticides on human health and environment. After this fact, the debates began about the harmful effects of the use of the dichlorodiphenyltrichloroethane (DDT) pesticide. Shortly after, the products based on this compound were banned in several countries, such as Hungary, Norway, Sweden, Germany, United States, Brazil, Austria, Spain and others (CLARK, 2017; MORRIS, 2019). However, even with restrictions applied to their usage, there are several chemical substances approved for use in crop plants to control pests and diseases in different cultures, e.g., herbicides, insecticides, bactericides, fungicides, acaricides, algicides, avicides and others, which, similarly to DDT are also toxic to human health (ZHANG, 2018). Currently, more than 500,000 new compounds have been discovered from natural products and chemical synthesis every year as lead compounds for use as new pesticides (CASIDA; DURKIN, 2016).

As a trait of large-scale food production systems worldwide, mostly composed of monocultures, one can note an intensive and continuous use of agrochemicals over the production seasons, eventually leading to the emergence of pest and pathogen resistant phenotypes to certain chemicals. Such a scenario usually results in crop fields treated with increased doses of pesticides aiming at to control the biotic stress factor, even tentatively. In the last decades, researchers have recursively claimed that the agribusiness model currently adopted by several countries directly contributes to a public health concern due to the high levels of acute and chronic contaminations recorded in human beings directly (farmers) or indirectly (consumers) exposed to pesticides. Besides, it has also been frequently disclosed a series of episodes regarding the contamination of water reservoirs, soils and non-target species (HEDLUND; LONGO; YORK, 2019). In fact, most of the active compounds of pesticides are chemically stable molecules and persistent in the soil, gradually dispersing in the environment and contaminating water resources, e.g., rivers, lagoons, and seas (STORCK; KARPOUZAS; MARTIN-LAURENT, 2017).

In order to regulate and propose control measures for the distribution and application of pesticides, the Food and Agriculture Organization of the United Nations (FAO) developed an International Code of Conduct on Pesticide Management (ICCPM) in 1985. Through worldwide communication, the Code serves as a scope for governments, regulatory bodies, the private sector, and civil society; so that they can adopt guidelines based on several technical aspects, taking into account the risks to human health and the environment (FAO, 2014). However, counties are sovereign to adopt the FAO's ICCPM, as well as to interpret the toxicological properties of the pesticides' active compounds and, therefore, great discrepancies have been found in the classification thereof and, accordingly, in the restrictions of usage applied to such products (ZHANG, 2018). As an example, a recent study by van den BERG et al. (2020), analyzing the pesticide life cycle management (i.e., legislation, regulation, manufacturing, application, and disposal of waste) in 194 countries, revealed the existence of serious gaps along the chain release→usage→disposal, especially in low-income countries. Inadequate records of accidents in crops stand out, inefficiency to promote protection against occupational exposure of farmers, and also the lack of protection for consumers regarding the consumption of contaminated products and recurrent environmental pollution have been detected over and over again, mostly in non-developed countries. Besides, it has been reported that proposals made by the International Code of Conduct for the Management of Pesticides, such as the adoption of integrated pest and disease management practices, have not been adopted in several countries, which would be a measure to reduce the intensive use of pesticides (FAO, 2014; van den BERG et al., 2020).

Nowadays, it is estimated that around 4.1 million tons of pesticides worldwide are annually released into the environment. The pesticides market is important in several countries, such as France, Brazil, China, the United States, and Japan; relevant producer and user of these products (ROSER, 2019). The pesticide market share is dominated by a small number of multinational companies, which have strong influence over legislation and regulation in certain countries, directly resulting in the overuse of pesticides and making impossible the adoption of alternative food cultivation systems to mitigate environmental pollution and the risks offered to human health (ZALLER, 2020).

The flexibility in regulations on the release and use of pesticides has increasingly become it a public health problem in many countries. In fact, several studies have been done around the world to determine how pesticides can affect human health in the short and long term (ASGHAR; MALIK; JAVED, 2016) and it seems consensus that the set of laws regulating this matter is essential for reducing the exposure of human populations to these pollutant agents. However, the picture that emerges by analyzing the countries' legal rules on the release for usage of pesticides is quite discrepant. More restrictive and environmentally-oriented laws have been adopted by some countries, while other like Brazil, for example, have been more liberal, especially in the recent past, where a series of changes in the current legislation have been proposed by the Federal government and supported by the national congress and regulatory agencies, being broadly favorable to large agrochemical corporations (SERRA et al., 2016). Thus, this study aims to discuss the regulatory divergences between Brazil and developed countries in regards to pesticides, correlating with the worsening of the state of public health.

2 PESTICIDE RESIDUES AND DIVERGENT REGULATIONS

Pesticides are used during different stages of cultivation to protect plants against pests and pathogens in field and also to increase the half-life time of the harvested biomasses over their storage, transport, distribution, and processing times. Although this have allowed the expansion of crops worldwide to provide food for the growing population, by their physical-chemical characteristics most of the active compounds of pesticide formulations persist for years or even decades in the environment, leading to food, soil, and water contamination, environmental hazards, and adverse effects on the human health (ZIBANKUBA et al., 2019).

The toxic limits of pesticide residues in food are measured using the Maximum Residue Limits (MRLs), which refer to the highest level of tolerated pesticide residues detected in food or feed. The MRLs are regulated by the International Union of Pure and Applied Chemistry (IUPAC), however, the tolerated limits may differ between countries (BOTITSI; TSIPI; ECONOMOU, 2017). Bombardi (2017) reported differences in MRLs for pesticides between Brazil and the European Union, indicating for example that in Brazil amounts (mg/kg) of pesticide residues up to 400 times higher have been allowed in, e.g., beans (*Phaseolus vulgaris*), in comparison to European Union (EU).

Another important parameter for measuring the contents of pesticides in the environment is the Maximum Contaminant Level (MCL) of a molecule in water and the accepted limits vary among the countries according to their regulatory jurisdictions. Fr example, Li and Jennings (2018) describe that at least 145 jurisdictions in 103 nations determine 5,474 MCLs in drinking water. However, regulatory agencies disagree about the magnitude of MCLs, varying five, six, or even seven orders of magnitude according to the type of pesticide. In the same line in Brazil, residues of chemicals such as 2,4-D, mancozeb and glyphosate, are allowed 300; 1,800 and 5,000 times more in potable water, respectively than in the EU.

Unlike Brazil, the EU Regulation (EC) n. 396/2005 has determinate MRLs for more than 1000 pesticides, which are used inside or outside the EU. In the case of an unlisted active ingredient, it has a standard limit of 0.01 mg/kg. The MRLs values adopted by several countries typically range from 0.01 to 10 mg/kg, however, for vegetables, fruits and cereals, generally the amounts cannot exceed 0.01-0.02 mg/kg. Interestingly, such contents differ from those noted in Brazil, which allows, for instance, 0.2 mg/kg in citrus (*Citrus* spp.) and 5 mg/kg in broccoli (*Brassica oleracea*) (BOMBARDI, 2017; BOTITSI; TSIPI; ECONOMOU, 2017).

The discrepancies in MRL values observed over countries might be explained, in any extension, by their policies oriented to the agribusiness sector. Although there is a set of rules for regulation, inspection, and investigation of pesticides' toxicity in Brazil, determined by the National Health Surveillance Agency (ANVISA, in Portuguese) and by the Ministry of Agriculture, Livestock and Supply (MAPA, in Portuguese), the strong influence of lobbyists and the "ruralist" bench in the congress has foster directly the continuous releasing of new assets to the market in recent years, as well as the intensification of their use (CARNEIRO et al., 2015). As a major exporter of commodities, Brazil is continuously under great political and economic pressure, which favors the action of transnational companies in the parliament forcing the releasing of new pesticides, many of them never launched in other countries or banned after a few years of use, as for instance fipronil, thiamethoxam, and clothianidin, already banned in the EU (ARAÚJO, OLIVEIRA, 2017; EUROPEAN COMMISSION, 2020).

Brazil, EU, China, and the United States (US) are among the largest consumers of pesticides in the world. In the US, the Environmental Protection Agency (EPA) is in charge of the pesticide regulation and uses the term "tolerance" to determine the maximum permitted amount of residues in foods. To regulate the release and usage of pesticides, EPA takes into account a series of parameters, such as: *i)* toxicity of the compound(s), *ii)* degradation products thereof, *iii)* physicochemical traits, *iv)* stability, and *v)* the amount recommended for treatment of agricultural crops - which is related to the MRL value - and *vi)* the commercialization time (BOTITSI; TSIPI; ECONOMOU, 2017). In US, 72 pesticides already banned in the EU are still in use, with 12 banned in at least one of the two other major agricultural nations (Brazil, China or EU). Interestingly, the US agency seems not to be enough restrictive in protecting the environment and human health from hazardous pesticides, as far as the prohibition of marketing of products already proven toxic shall happen through the voluntary cancellation expressed by the industries and not by the regulator of norms (DONLEY, 2019).

In China, pesticide regulation is established by the Ministry of Health and also through the National Committee for Standardization Management. For determining the acceptable MRL values of pesticides, data from industry are taken into account, in addition to national standards. However, there are no limit values initially set for the use of pesticides so far, because the country still lacks basic data from toxicological tests and, therefore, little scientific proofs regarding the risks on human health and environment. Thus, the release and use of those products has been facilitated and for this reason, in recent years, pesticide excesses have been reported in foods exported by China, mainly in fruits, vegetables, and teas (LIU; GUO, 2019).

In the EU, the European Food Safety Authority (EFSA) has carried out the risk assessment for pesticide use since 2006. EFSA takes into consideration a series of parameters before the release of the pesticide, such as the dietary risks thereof previously to its marketing, as well as the post-marketing risk, and the toxicity upon long-term exposure (chronic) and short-term exposure (acute) (EUROPEAN FOOD SAFETY AUTHORITY, 2019). Since the adoption of this methodology, several pesticides have been reassessed by EFSA over the last years and many have been banned from the market when environmental contamination and risks to human health are identified (STORCK; KARPOUZAS; MATIN-LAURENT, 2016).

In Brazil, the Program of Analysis of Pesticide Residues in Food Products (PARA, in Portuguese) started in 2001, aiming the continuous evaluation and monitoring of the pesticide residues levels in foods (PARA, 2019). Lopes and Albuquerque (2021), analyzing the PARA reports since its implementation until 2016, describe a non-uniformity of the protocol for the food assaying, as only lettuce and tomatoes have been analyzed all years. The 2017-2018 report points out that 4,616 samples from 14 different foods were evaluated as to containing pesticide residues. The results show that 77% of the samples were considered satisfactory, where in 49% of these no pesticide residue was detected, as amounts equal to or lesser than MRLs were found in 28% of food investigated. On the other hand, 1,072 samples (~ 23%) were considered unsatisfactory, with MRL'S larger than allowed by the ongoing rules (PARA, 2019). However, all indicators show an annual increase in the consumption of pesticides in Brazil. Besides, as already described, the values of MRLs allowed by the Brazilian legislation are higher in comparison with other countries (BOMBARDI, 2017), eventually leading to a sub-optimal risk analysis of the exposure of consumers to pesticides.

3 USE OF PESTICIDES IN BRAZIL

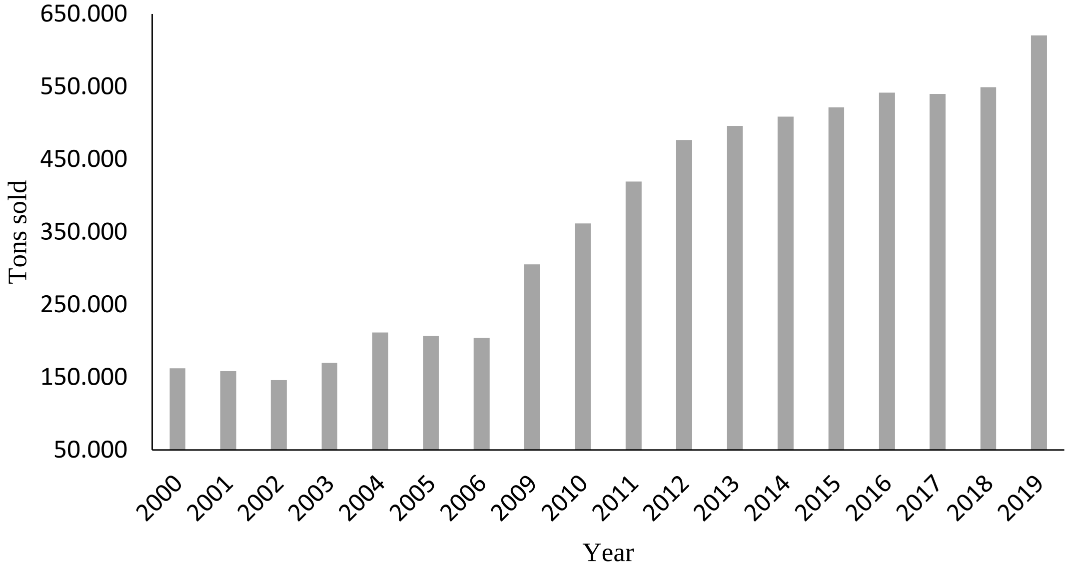
In Brazil, agriculture is the main economic activity with predominance of agribusiness. This model is characterized by large latifundium, high concentration of land ownership, production based on monocultures, large-scale mechanization, precarious working relationships, large infrastructure for the storage, commercialization, and transportation of crops and inputs, and an increase in socio-environmental risks (NASRALA NETO; LACAZ; PIGNATI, 2014).

Since 2008, Brazil has been considered the largest consumer of pesticides worldwide, with consequences on the health of human populations, mostly in rural areas, where the occurrence of diseases rarely found in the past has been intensified (SERRA et al., 2016). In the same way, the persistence of these compounds in the environment, have been extensively reported, affecting springs, mangroves, fauna, and flora. Still, the drift caused by the winds and its evaporation are important ways those chemicals are spread out to other places, mainly reaching the soils and surface waters (BOUDH; SINGH, 2019). According to Pignati et al. (2017), the use of pesticides in Brazil can be considered a public health concern, given the levels of environmental and food contamination, in addition to the poisoning cases of farmers and consumers reported daily.

Despite the increasing evidences of the negative impacts of pesticide on the human health and environment all over the world, Brazil has continuously allowed the registration of new products in recent years, e.g., 474 in 2019 and 493 in 2020. Many of the pesticides released are generic products that have been launched in the country previously, as ones have not been registered before, such as dinotefuran, fluopyram, pyroxasulfone, and tolfenpyrad, and other have been released despite several restrictions in other countries (BRAZIL, 2021). Thus, in our recent political history, one can note an increase in the release of pesticides never seen before in the country and, in consequence, the exposure of human populations, the contamination of waters and soils, and the risks to human health are expeceted to be augmented.

In a time line analysis, the Brazilian´s pesticide market increased by 540% between 1978 to 1998, followed by a stabilization period between 2000-2006. After 2009, a dramatic increase in the sells was detected and, in 2019, it was reported the largest amount of commercialization of pesticides ever observed in Brazil, reaching 620.537.98 tons (IBAMA, 2020), i.e., about four times the amount marketed in 2000 (Figure 1).

Figure 1. Active ingredients (tons) of pesticides commercialized in Brazil between 2000-2019.



Data for 2007 and 2008 were not collected.
Source: Adapted from IBAMA, 2020.

The pesticide's toxicity classification system used in Brazil takes into account the risks to human health, based on the lethal dose (LD_{50}) in experiments with laboratory animals. Until the middle 2019, the toxicity classification provided by the Ordinance n° 3 (January 16, 1992) discloses: Category I – Extremely Toxic; II – Highly Toxic; III – Moderately Toxic; and IV – Low Toxic (BRAZIL, 1992). However, one should keep in mind that such a system considers only the acute effects on human health, lacking the chronic ones, as for instance the eventual impacts in chronic diseases, e.g., cancer, neuropathies, liver diseases, as well as a series of pathophysiologies that affect the respiratory system, among other.

Summarizing, the Brazilian classification system serves to distinguish the pesticides according to their potential in causing damages acutely to human health. Nonetheless, it has only served to communicate the risks on the product's labels to the consumers. Considering that the usage of pesticides should take place under controlled conditions, especially those of higher toxicity, the purpose of the toxicological classification should restrict their usage, being released only after recommendations adopted by agricultural producers (GARCIA GARCIA; BUSSACOS; FISCHER, 2005).

In 2019, ANVISA published a new classification that takes into account the toxicological effects on humans, the result of a new approved regulatory framework.

From the new model, pesticides were distributed into six classifications and were given colors to determine toxicity (ANVISA, 2019) (Table 1).

Table 1. New classification of pesticides in Brazil issued in 2019, according to the National Health Surveillance Agency (ANVISA, in Portuguese).

Category	Toxicity	Risks
I (Red stripe)	Extremely toxic	Fatal if swallowed, in contact with skin or inhaled
II (Red stripe)	Highly toxic	Fatal too, depending on exposure
III (Yellow stripe)	Moderately toxic	Causes poisoning if swallowed, in contact with skin or inhaled
IV (Blue stripe)	Low toxic	Harmful if swallowed, in contact with skin or inhaled
V (Blue stripe)	Product unlikely to cause acute damage	May be dangerous if swallowed, in contact with skin or inhaled
VI (Green stripe)	Not classified	No risks or recommendations

Source: Adapted from ANVISA, 2019.

Among the ten best-selling pesticides' active ingredients in Brazil in 2019 (IBAMA, 2020), two are considered to be of low toxicity (AGROLINK, 2020), while four are moderately toxic, and two are extremely toxic (Table 2).

Table 2. The 10 best-selling active ingredients of pesticides in Brazil in 2019.

Active ingredient	Type	Toxicity (category)	Sales (x10^3 tons)
Glyphosate	Herbicide	V	217.592,24
2, 4 Dichlorophenoxyacetic acid (2, 4-D)	Herbicide	IV	52.426,92
Mancozebe	Fungicide	V	49.162,59
Acephate	Insecticide/Acaricide	IV	28.432,50
Atrazine	Herbicide	V	23.429,38
Chlorothalonil	Fungicide	III	16.653,05
Paraquat dichloride	Herbicide	I	16.398,14
Malathion	Insecticide	V	13.576,47
Sulfur	Acaricide/Fungicide	V	11.882,33
Chlorpyrifos	Insecticide	II	10.827,78

Source: Adapted from IBAMA, 2020; AGROLINK, 2020.

ANVISA indicated that the active ingredient paraquat dichloride, the seventh most commercialized in 2019, was banned from Brazil as of September 22, 2020, therefore, the most used desiccant in soy has been replaced by other similar products.

4 THE RISKS TO HUMAN HEALTH FROM EXPOSURE AND CONTAMINATION BY PESTICIDES

The risks that compounds used as pesticides present to human health and the environment depend on countless factors, which are associated with the physicochemical characteristics of them (PEREIRA et al., 2016), as they react to leaching, sorption, volatilization, photodegradation, as well as to microbial and chemical degradation. Form of application, air temperature and relative humidity, wind direction and speed, the microbial activity in soil as well its values of pH, organic matter and water contents are factors that help to determine human exposure or how the environment will be affected by those xenobiotics (LEWIS et al., 2016).

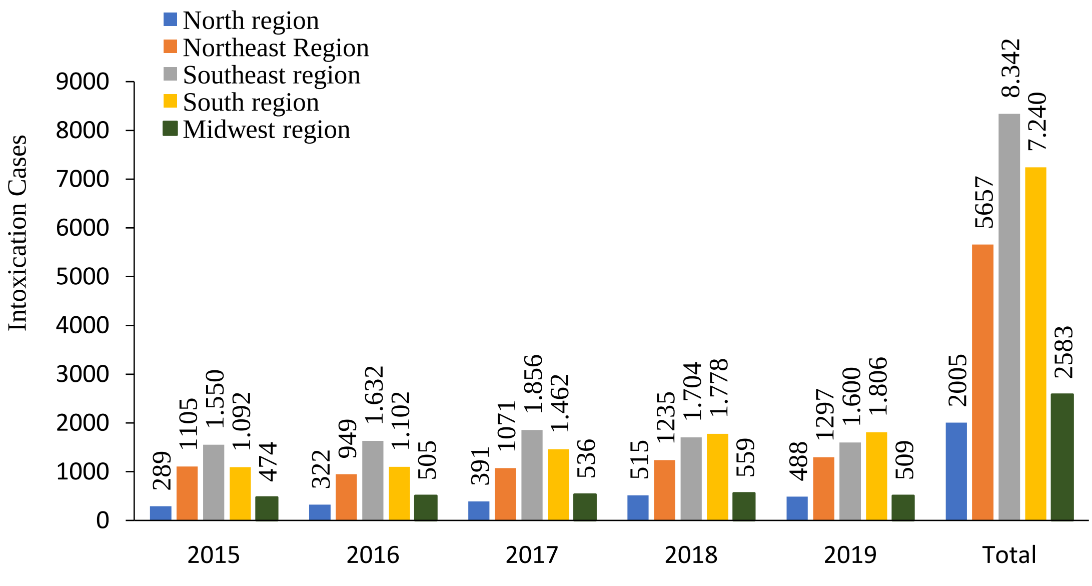
In recent years, researchers have highlighted the health risks (HR) caused by pesticides. The HR refers to pesticide residues present in foods (vegetables and fruits) and contamination of farmers in agricultural areas. The occupational exposure of farmers to agricultural practices has been widely considered, not only because of the risks of contamination and intoxication. Among the risks, nausea and blurred vision (SANKOH et al., 2016), genetic damage (JACOBSEN-PEREIRA et al., 2018), hypertension, seizure, bleeding, and cramps (RAZA et al., 2019) have been frequently reported. Ye et al. (2017) address in a systematic review that pesticides, especially organophosphate and pyrethroid insecticides and DDT, cause complications in respiratory health, compromising lung function through environmental exposure. Manyilizy et al. (2017) describe that among the symptoms reported by farmers when using pesticides in Arusha (Tanzania) are: burning sensation in the eyes and face, headache, tiredness, dizziness, chest pain, forgetfulness, diarrhea, and vomiting.

In countries as USA (ROSENBAUM et al., 2017), Mexico (OSTEN; DZUL-CAAMAL, 2017), Colombia (LANS-CEBALLOS et al., 2018), Russia (TSYGANKOV et al., 2019), Spain (GÓMEZ-BARROSO et al., 2016), and Brazil (SALAROLI et al., 2019), among other, the use of pesticides has been associated with an augmented susceptibility to different human pathogens and the risks brought by long-term exposure. Research indicates that pesticides can affect the nervous system leading to neurological dysfunction (HIRANO et al., 2019; RICHARDSON et al., 2019), induce renal injury (PRUDENTE et al., 2017), alter functions in hematopoietic tissue (HOCHANE et al., 2017) and increase the risk of congenital malformations (ASMUS et al., 2017). Long-term use of pesticides can induce the appearance of different types of cancer, e.g., liver (VOPHAM et al., 2017), breast (VENTURA et al., 2019), prostate, leukemia, myeloma multiple, colonic (PLUTH; ZANINI; BATTISTI, 2019), and others.

In Brazil, pesticides are considered a public health concern because of the countless reports of environmental contamination, residues present in foods, and occupational intoxications. Lara et al. (2015) reports the chemical exposure and the incidence of acute intoxication in Brazil between the years 2006 to 2010, where the states of Paraná, Santa Catarina, and Tocantins have the highest incidences of intoxications, varying from 5 to 11 cases per 100 thousand inhabitants. However, the largest expenditure on pesticides has been found in Mato Grosso and São Paulo states. Besides, it is possible that the number of underreporting cases in these locations and in the rest of the country may be meaningful, making it more difficult to accurately determine the framework of pesticide intoxication in the country. Queiroz et al. (2019) point out that between 2001 and 2014, 80,069 cases of intoxication were registered in Brazil, with the South and Midwest regions showing the highest rates. In addition, the authors point out that following pesticide intoxication, suicide attempt was the most aggravating circumstance reported among cases investigated.

The Notifiable Diseases Information System (SINAN, in Portuguese, available at http://portalsinan.saude.gov.br/o-sinan) has been implemented to investigate cases of diseases in human populations and the conditions of occurrence thereof. From 2015 to 2019, 25,827 cases of poisoning by pesticides were registered in the 5 Brazilian regions by SINAN, mostly in Southeast (8.342) and South (7.240) regions as shown in Figure 2.

Figure 2. Cases of pesticide poisoning in the North, Northeast, Southeast, South, and Mideast regions in Brazil, from 2015 to 2019, according to SINAN's records.



Source: Adapted from SINAN, 2020.

Again, despite the high number of poisoning cases reported by SINAN, it is believed that the data recovered are underestimated, especially in regions without an information center for that purpose, as noted in the countryside Brazil. In addition to this factor, underreporting can occur when individuals do not seek medical attention, either due to the precarious health system in some areas of the country, or because farmers do not relate their symptoms to the use of pesticides, mainly after occupational exposure (CALDAS, 2016).

According to Pignati et al. (2017), analyzing 21 predominant crops in Brazil in 2015, it was observed that soybeans, corn, and sugarcane sum up to 76% of the cultivated lands, where 899 million liters of pesticides were sprayed only in these crops. Mato Grosso, Paraná, and Rio Grande do Sul states have been pointed out as the regions with the largest amounts used, showing a direct correlation between the human health problems detected and the overuse of pesticides.

The environment contamination (springs, mangroves, fauna, and flora) by pesticides is also a serious problem in the country and occurs mainly due to the product losses resulting from the applications. The drift caused by the winds and by the evaporation of the product reaches the atmosphere and the residues are distributed to other places, mainly reaching the soils and surface waters (NASCIMENTO; MELNYK, 2016). Mato Grosso state, for example, is considered a region with high risk of environmental contamination due to the overuse of pesticides and where 45.6% of pesticides currently used belong to the extremely toxic or highly toxic groups (SOARES; FARIA; ROSA, 2017).

The excessive use of pesticides has caused a serious biological imbalance, negatively impacting the entire food production chain, from the farmer to the consumer's table. The right to food is provided by the Federal Constitution issued in 1988. However, it brings up the reflection on what type of food is being routinely consumed. Agribusiness in Brazil was introduced with the concept of “food security”, and as seen, it has triggered a series of risks to human health, eliminating any possibility of providing what was promised. Thus, it is emphasized that the State must promote public policies that guarantee adequate and safe food to population, without causing impacts to health and environmental risks. Policies that already exist in the country, such as the National Policy for Reduction of Pesticide Use (PNARA, in Portuguese) and the National Policy on Agroecology and Organic Production (PNAPO, in Portuguese) must be strengthened to encourage and raise awareness among farmers to cultivate without the use of pesticides, as well as to stimulate population to consume foods from organic and agroecological production systems (GODOI; DOMINGOS, 2020).

5 CONCLUSIONS

In recent past, Brazil has reported an increased number of registered pesticides, ones classified as highly toxic and already banned in several countries. Such scenario results of political choses with economic consequences whether not in domestic market of foods, eventually in the external one. As many developed countries search for new alternatives to pesticides to treat pest and diseases of crop plants, Brazil seems to insist in the opposite way, elevating the risk of environmental contaminations and of exposure of its population to hazardous and toxic chemicals. In a rational basis, that is not acceptable at all.

The ease allowed by the Brazilian legislation for pesticide release and use in recent years results from the advance of agribusiness sector in the National Congress, where the presence of the "ruralist" group is prominent. In consequence, one might envisage the country will face serious public health problems in the coming years, as well as environmental disturbances in both agricultural and natural ecosystems. If so, this picture could not be attributed to the fate, rather to a series of misguided political and economic choses. Besides, it seems to be relevant to argue the social and economic costs associated to the political decisions adopted by the Brazilian government and the National Congress regarding the amounts of public money that should be driven in the coming years to support the treatment of the increasing number of pesticide-related pathophysiologies, besides the loss of work power in the crop fields.

Finally, it seems to be urgent to re-write the pesticide laws and regulations in Brazil, taking into account the various studies that have recursively demonstrating the risks to human health associated with the use of those products, as well as by using global criteria from countries where the use of pesticides has successfully been reduced. Additionally, economic incentives should be offered to farmers interested in agroecological food production systems and not on the contrary. If, and only if, new ways were implemented in the country as above describe, it will be possible in a near future to reduce the public health problems associated to the overuse of pesticides, as well as to provide adequate foods for consumers and improve the lives of small producers and family farmers.

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