The article aims to present an overview of pesticide usage and population exposure, focusing on the impact on health and the correlation with food and nutrition security (FNS). This review is relevant due to the extensive use of pesticides in food production, which exposes individuals in various ways, including the ingestion of contaminated food, with adverse health effects. Brazil is one of the largest consumers of pesticides in the world, with product sale growth above 200% from 2000 to 2013, increasing the predisposition of the population and environment to the impacts caused by these compounds. The country has weaknesses regarding the monitoring of pesticide usage, besides its vulnerable population affected by social and economic problems. Studies on the correlation between pesticides and diseases have shown potential health risks, including birth defects, hearing loss, cancer, and infertility, in addition to symptoms related to acute intoxication, such as weakness, vomiting, seizures, difficulty breathing, loss of appetite, and nosebleed, among others. Reduction policies in pesticide usage and the encouragement for the sustainable agricultural practices should be prioritized by public managers. It is also essential to improve the monitoring and surveillance programs and research on the topic, as well as training of health professionals to identify and report the cases of pesticide poisoning.

Pesticide poisoning can be acute, with great exposure for short period of time and/or chronic, when the exposure is generally small for long periods. Thus, pesticide exposure contradicts food practices that promote health and the concept of FNS, which calls, among other things, the right to quality food based on healthy and environmentally sustainable food practices [2, 3].

Thus, the present study aimed to elucidate the panorama of pesticide use, the forms of exposure, the impact of these substances on health, forms of control, the effects of processing on waste load, and the correlation with food and nutrition security in the Brazilian context.

Food and nutrition security and food challenges
Food and nutrition security includes several factors and involves interests of governments, international organizations, civil society, and productive sectors, among others [4].

The food safety concept originated in Europe in the early twentieth century and suggested that each country should have the capacity to produce its own food, due
to vulnerabilities caused by the world wars, which gained international visibility from the United Nations (UN) and the United Nations Food and Agriculture Organization (FAO) [5].

Initially, although the term strictly referred to food supply and self-sufficiency, over time, this view was not enough to eliminate hunger; thus, that look should be directed also to social aspects and better living standards, that is, the individual’s ability to access food has been emphasized [4–6].

From the mid-1990s, the concept of food sovereignty has focused on the right of people to build their own policies related to FNS, which has gained strength in the debate on food security during the World Food Summit in 1996, in Roma [4]. The discussions converge on the understanding of the concept of food sovereignty as a way of enabling food autonomy to countries and less dependence on imports and international market price fluctuations [7].

The World Food Summit in 1996 also emphasized the association of the Human Right to Adequate Food (HRAF) with the guarantee of FNS. Since then, the concept of FNS has been recognized from the perspective that all individuals should have regular, permanent, and unrestricted access to nutritionally adequate and safe food, respecting the cultural characteristics of each population [8, 9]. In this context, the right to food should be ensured by FNS policies, and the state should be responsible for this situation [4].

Brazil has been actively discussed the FNS, especially focused on the fight against hunger and poverty, and the social scientist Josué de Castro was a pioneer in linking the political and social problems with feeding [8]. In 1988, the right to health was included in the Brazilian Constitution, with food as conditioning and determining factor, whose rights must be ensured by the food and nutrition security policy (FNS) [4, 5, 10, 11].

Only from the Amendment 64, adopted in October 2012 through the introduction of Art. 6 in the Constitution [12], food is recognized as a right. The Law 11.346 of 2006 (Organic Law for Food and Nutrition Security LOSAN) [3, 11] aims to guarantee the human right to adequate food in all its dimensions and the importance of intersectoral cooperation.

According to that Law,

Food and Nutrition Security consists in the realization of the right of all individuals to regular and permanent access to quality food in sufficient quantity, without compromising the fulfillment of other essential needs, based on food practices that promote health respecting the cultural diversity, and are environmental, culturally, economically, and socially sustainable. (Art. 3) [3].

Food safety and food security comprise the concept of food and nutrition security. The food safety permeates the objectives of ensuring the harmlessness of food so that its consumption does not compromise the individual’s health, while the access to food is considered one of the requirements for achieving food security [4, 13].

Therefore, the use of pesticides in agriculture emerged from the benefit claims for increasing agricultural productivity with a consequent increase in profitability, given the potential ability of these substances to combat pests in agriculture and to enable accelerated growth of food crops. Thus, a sufficient amount of food would be guaranteed for the world population, despite the hundreds of millions of undernourished people in the world, and the access to food is conditioned to the financial resources of individuals [13, 14].

The massive use of pesticides contradicts with the concept of food safety due to the potential risks to health and the environment, in addition to monocultures affecting the diversity of food cultures, culminating in a food monotony frame. Furthermore, there is an increased risk of aggravation of the rural poverty, among other issues closely related to the FNS [14, 15].

Although the country has considerable gains for reducing the extreme poverty, income distribution, and child malnutrition, the results obtained through the aid of income transfer programs and enhancement of minimum wage have faced some challenges to achieve the FNS in food production, which is more focused on the adoption of a production philosophy in the farmed environment and massive use of pesticides and agricultural crops systems based on monocultures, which can have a negative impact on the basis that integrates the FNS concept.

Pesticide usage

Agribusiness, i.e., the set of activities involving the production, storage, and distribution of agricultural supplies, is considered as one of the main activities of the Brazilian economy, responsible for 21.46% of the gross domestic product (GDP) in 2015, according to statistics data of the Ministry of Agriculture Livestock and Supply (MAPA). It also impacts on the trade balance, accounting for 49.55% of national exports from January to July 2016 [16].

The citrus industry is one of the outstanding examples of the success of Brazilian exports in the agribusiness sector, requiring little import inputs among other important crops including sugarcane, coffee, soy, and beef [17].

Much of the success of the Brazilian agribusiness is related to technological advances in agriculture, resulting in increased productivity and enabling competitiveness in the international market. Among these inputs are the pesticides, which are considered necessary to achieve the
objectives of the productive sector without compromising the production and no negative impact on the prices of agricultural products [18].

The pesticides were developed primarily for use as chemical weapons in the world wars but won a promising new market in agriculture in the post-war period. Their implementation was encouraged by various policies and agricultural research, which evidenced the necessity in agriculture, along with the appeal that this green revolution and agricultural modernization could be essential to eradicating hunger in the world [19].

It is worth emphasizing that the FAO and the World Bank were the institutions that most stimulated the adoption of the Green Revolution package. In Brazil, policies have been implemented to modernize agriculture, including the creation of the National Rural Credit System in 1965, which recommended the compulsory purchase of chemical inputs for farmers obtaining agricultural credit [19–21].

In addition, the use of pesticides in Brazil was encouraged by other facilities, such as the National Pesticide Program, which provided financial resources for the implementation of agricultural input companies, besides the fiscal and tax exemptions granted to such trade, all associated with an outdated and inaccurate regulatory framework, in addition to the oligopoly of companies that sell the product [19–21].

Data on the sale and marketing of pesticides in Brazil are obtained from the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) [22], one of the federal agencies responsible for the registration and controlling of these inputs in the country, together with the MAPA and the National Health Surveillance Agency (ANVISA). According to Art. 41 of the Decree 4.074/02 [23], the companies are required to provide half-yearly values of production, import, export, and sales to federal and state bodies responsible for supervision of these products.

The pesticide sales in the country increased by 205.1% from 2000 to 2013. From 2009 to 2012, there was an increase of 59.08%, reaching the amount of 495,764.55 tonnes of active ingredients (AI) sold in 2013, giving the lead marketing for the state of Mato Grosso, which reached 87,520.38 tones [24].

From 2009 to 2013, the AI glyphosate (herbicide) was the most sold in the country, representing over 30% of domestic sales per year, and the herbicides were classified as the most used, followed by fungicides and insecticides [24].

The National Union of the Crop Protection Products Industry (SINDIVEG) previously named as National Union of the Industry of Agricultural Defense Products, formed by 50 manufacturers of crop protection products, announced 2014 year data a reduction in crop protection sector (6.9% decline), reaching US$ 12.249 billion [24].

It is worth mentioning an increase in the total sale from 51 to 55.5% due to the growth of the planted soybean area when compared with the 2013 data, reaching US$ 11.454 billion. The SINDIVEG has also reported that 39% sales were derived from the insecticides class because the increase of some pests and the state of Mato Grosso led sales in 2014 (US$ 2,567 billion), followed by Rio Grande do Sul, Parana, and Sao Paulo (US$ 1.582 billion, US$ 1.574 billion, and US$ 1.479 billion, respectively) [24].

Indices of pesticide waste control

Pesticide is one of the connotations used for inputs, according to the Federal Law 7802 of 11 July 1989 [25] by Decree 4074 of 04 January 2002 [23], which specifies as agrochemicals the products and/or physical, chemical, or biological agents used in the production, storage, and processing of agricultural products and may also be applied in urban, water, and industrial environments, aiming to prevent damage caused by living organisms considered harmful.

For pesticide registration in Brazil, the company should provide a lot of information about the product for the ANVISA to determine the potential danger, aimed to reduce the risk to final consumers [26].

The toxicity data are obtained through animal experiments and laboratory analysis. Then, the toxicological classification of pesticides is established according to dermal exposure, oral or inhalation studies, thus determining the parameters lethal concentration (LC 50) and lethal dose (LD 50), and the acute effects [27]. The classification is reported on the labels and instructions for use of pesticides, as shown in Table 1.

Pesticides can also be classified by target organism. The system of Phytosanitary Agrochemicals of the MAPA has registered the following classes of compounds: acaricide, plant activator, bactericide, termicide, defoliant, spreader, pheromone, ant killer, fungicide, herbicide, insecticide, growth maturing, molluscicide, nematicide, seed saver, rodenticide, and plant growth regulator, including different active ingredients belonging to different chemical groups [28].

ANVISA has used toxicity data of each compound to set the maximum residue limit (MRL), defined as the

| Class | Toxicity      | Color |
|-------|---------------|-------|
| I     | Extremely toxic | Red   |
| II    | Highly toxic   | Yellow|
| III   | Moderately toxic| Blue  |
| IV    | Slightly toxic | Green |

Source: ANVISA [27]
maximum level of pesticide residue officially accepted that remain in food and according to the dosages recommended by the product label, demonstrating theoretically the quality of food sold. The MRL is used as a basis for the calculation of exposure and assessment of dietary risk [23, 27]. Another important parameter is the acceptable daily intake (ADI), which allows estimating the waste load that can be ingested in relation to body weight over a lifetime without health risks, obtained from toxicological studies, which comprises the intake safety parameter before establishing the MRLs [27, 29].

It is important to note that each country has the autonomy to setting MRLs values. There is no harmonization even with the parameters set by the Codex Alimentarius, which can vary greatly from one country to another. The limits set by the Codex Alimentarius are used when there is no limit set for a product in the country and can also be applied to similar products. This variation in the MRL values can affect the international market of products due to differences between exporters and importers [30].

**Pesticide waste in foods and control programs**

When used, the pesticides are spread to all plant parts and the remaining waste load depends on the crop characteristics, its tissues, as well as the physicochemical properties of the substances. If the application is carried out in the foliage, for example, the dissipation of waste occurs more quickly as compared with the application in fruits [31, 32].

Waste includes conversion and degradation products, metabolites, reaction products, and impurities that have toxicological or environmental significance, as defined in Decree 4074 of January 4, 2002 [23].

Establishing continuum monitoring programs of pesticide waste in food for several consecutive years makes it possible to know the profile of the existing waste and manage quality assurance, focusing on the education of farmers, control of selling pesticides, integrated pest management, and increase in organic farming. Waste management programs have been continuously applied in foods of plant origin, animal origin, grain cereals, and infant food in many countries [33–38].

Considering the national context for pesticide usage, federal agriculture, health, and environment protection agencies should monitor residues of pesticides to preserve public health. Monitoring programs implemented in Brazil with results in food have been carried out by the MAPA and the Ministry of Health through the ANVISA.

MAPA coordinates the National Plan to Control Residues and Contaminants in Products of Plant Origin, established by Normative Instruction 42 of 2008 [39], aimed to generate frequency data and distribution levels of residues and contaminants to guide actions of research and control. Through this plan, there is an inspection and supervision of the quality of plant products throughout the country, both for the domestic market and exports. Samples are randomly collected by federal inspectors in rural properties and supply centers [39]. The samples collected in the packing house showed a higher percentage of non-compliance to meet the MRL when compared to the samples collected in the supply centers. However, the samples from the supply centers exhibited higher non-compliance to the use of unauthorized products in Brazil. A lower waste load in the products from the supply centers may be due to degradation after harvest and storage, while the pesticides not permitted by law are not used in the packing house because the products are intended for export [40, 41].

Since 2003, the monitoring program of pesticide residue in food coordinated by ANVISA has aimed to verify whether food available at retail meets the MRL and the use of pesticides registered in the country and authorized to that crop. The results subsidize government actions with regard to regulation, supervision, and education, selecting the food most consumed by the population and adopting the results of the household budget survey (POF) as a parameter. It is worth noting that different foods are selected every year, and meat, milk, grains, and cereals are not part of the systematic monitoring programs [29].

Studies have shown extrapolations of MRL and ADI values and exposure to pesticides in Brazil. A survey conducted in 1999 showed that 6.4% of pesticides exceeded the ADI values [42]. Estimation of mean and median chronic pesticide intake for the population showed that 68 compounds extrapolated the ADI values, and the two pesticides classified with greater potential exposure did not exhibit ADI parameters set by ANVISA and belong to the classification I, extremely toxic [43].

It is worth emphasizing the increase in the average consumption of fruits and vegetables with growth in household incomes. From the perspective of food and nutritional security, higher income and the improvement of social conditions are positively correlated with a healthy diet, encouraging the consumption of food in natura rather than the ultra-processed foods. However, when consuming fruits and vegetables (FLVs) with a potential risk of contamination by pesticide residues, the aspects recommended by the FNS come in disagreement, especially regarding the consumption of quality food, free of poisoning [44, 45].

Weaving discussions on pesticide residue intake focused on the most vulnerable population groups give a degree of importance of the most alarming dimensions when considering the potential health risks. Population groups in developing countries living with serious social, economic, and nutrition problems, pregnant women, and children are considered vulnerable [46].
The report of the National Research Council in 1993 [47] stated food consumption as the main source of pesticide exposure for infants and children. Furthermore, the great diversity of substances used in agriculture is chemically stable and has the potential to bioaccumulation, and as an aggravating factor, many of these substances are soluble, probably allowing the milk to be a potential pesticide vehicle for the infant, for containing significant fat content [48–51].

A study in the USA [52] on the intake of pesticide residue by children aged 3–12 years through the analysis of food intake demonstrated residue levels higher than those specified by the Pesticide Data Program [53].

A survey found intake values of nine pesticides in school children living in São Paulo exceeding the ADI levels established by ANVISA, and most pesticides were classified as very toxic, with compounds in the group of organophosphates, chemical class with a recognized association with neurotoxic effects [54]. Given the existence of compounds related to endocrine disruption, which may adversely affect growth, especially in school children, further attention regarding the monitoring of these compounds is required [55–58].

**Effect of manufacturing processes**

Regarding the use of pesticides in the manufacturing processes, the application of good agricultural practices is necessary to meet the safety conditions for the worker and crop. Good agricultural practices (GAP) are practices and procedures to control physical, chemical, or biological hazards, aimed to increase productivity and quality of the final product, focusing on the preservation of human health and the environment [59]. For proper use of GAP, fundamental aspects in the work routine should be supplied, such as the provision of appropriate tools to prevent improvisation, having an organized and clean environment as much as possible. An identified and separate place for agrochemical storage, with inventory control is also important, besides the provision of personal protective equipment and investment in staff training [60].

However, even adopting the practices regarding the safe use of pesticides, raw materials used by industries can present pesticide residues arising from crop or post-harvest, which remain in food after processing. Thus, the quality control in the food industry is an essential step to preserve the consumers’ health and to maintain the market competitiveness [61].

Knowledge about the physicochemical properties of pesticides is important, since they affect stay or degradation of pesticides in the environment, influencing waste load in food of plant origin and elimination during processing [61].

The different types of food processing are effective in reducing pesticide residues in vegetables. The steps that further reduce the waste load are washing, peeling, and heat treatment. Specific studies on pesticides and crop receiving application are key factors to understanding the waste load of a food [61–65].

In the case of grains, larger amounts of pesticides accumulate in the bark rather than in the bran and flour, and drying reduces the volatile compounds. As for dairy products, organochlorine pesticides from the animal feed and contaminated soil accumulate in the fatty fraction due to the thermal degradation process, although the waste load can be increased, for example, in the butter manufacture [61].

The strawberry pulp analysis conducted by the Health Surveillance State of Minas Gerais showed that 94.5% of the samples had pesticide residues, with waste load above the MRL, and presence of unauthorized pesticides for the strawberry crop. Therefore, waste control in processed foods is a fundamental step, since the levels may not fit those recommended by the MRL even after processing, as it depends on the initial waste load in the product [66].

**Pesticides-related diseases**

Pesticide exposure can cause acute poisoning, with symptoms appearing a few hours after exposure to large amounts of pesticides, or chronic, when the exposure is moderate, and the effects take longer to manifest, both with great impacts on public health [19].

Although the massive use of pesticides occurs in developed countries, there is a higher occurrence of poisonings and deaths in developing countries, as well as environmental damage by the use of these inputs [67]. The reasons include the use of products in excessive amounts, inadequacies in occupational and safety standards, inefficient use of personal protective equipment, the high level of illiteracy among handlers, regulations and inefficient labeling, inadequacies in leftovers handling procedures, ineffective washing of the application apparatus and packaging disposal, poor supervision, low technical assistance in the field, and pressure of producing companies and distributors [67–69].

The National System of Toxic-Pharmacological Information [70] reported 7676 cases of poisoning by agricultural and household pesticides in 2010, of which 203 have evolved to death (195 pesticide/agricultural use). In 2011 [71], 7560 cases of pesticide poisoning (agricultural and household) were registered, with 133 deaths (229 pesticide/agricultural use), and 6802 cases with 137 deaths (130 pesticide/agricultural use) in 2012 [72]. Although alarming, these figures do not reflect reality due to the bias of underreporting, since it is estimated...
Table 2 Studies on the correlations between pesticides and human health

| Study characteristics | Associated diseases (results) |
|-----------------------|-----------------------------|
| Perry et al. (2007) [77] Reproductive cohort study | • The results showed high prevalence of exposure to organophosphates and pyrethroids; • The analysis of the urine samples of the group with high exposure to these compounds indicated a lower concentration of sperm, suggesting greater attention and further studies on the toxicity of the mixture of compounds (organophosphates and pyrethroids). |
| Objective: To determine whether men joining the study were exposed to pesticides due to contact with the agricultural environment, and to analyze the concentration of spermatozoa using urine samples | • Neatens with congenital malformations were more exposed to pesticides during pregnancy when compared to healthy neonates; • There was an association between increased risk of birth defects and the fact that parents work in farming, live near farming, and exposure of at least one parent to pesticides. |
| n = 126 (42 cases and 84 controls), living neonates, Vale do São Francisco-São Paulo | | |
| Gonçalves and Silva et al. (2010) [78] Case-control study | | |
| Objective: To evaluate the association between exposure of parents to pesticides and births defects | • Twenty-four percent of the MI population are occupied with agricultural activities, with 14–11% in the state of RS and Brazil, respectively; • The results suggest a proportionally higher prevalence of mortality due to neoplasm in the micro region of Ijuí than in the state of RS and Brazil; • Higher cancer mortality was observed for man rather than women in Brazil, RS, and MI; • These findings do not rule out the effect of pesticide exposure on the higher cancer mortality rate in the micro region of Ijuí when compared to the Rio Grande do Sul and Brazil. |
| n = 2710 neonates admitted to the hospital, whose parents had direct contact with pesticides, city of Campina Grande, State of Paraíba | | |
| Jobim et al. (2010) [79] Ecological study | • Of the pilots, 95.1% use personal protective equipment during flights, and 58.5% have contact with pesticides; • The correlation between contact with pesticide and audiometric classification was not significant. However, p = 0.088 is close to the significance level (p = 0.050); • The study has shown that agricultural pilots have a high hearing loss, once they experimented high level of noise in addition to the contact with pesticides. |
| Objective: To compare the neoplastic mortality rates in Brazil, Rio Grande do Sul (RS) and the micro-region of Ijuí (MI), which is located in the Colonial Northwest Region (RS) | • In this study, 80.36% mothers and 58.93% parents reported contact with pesticides in their occupations; • 56 cases of genital malformations (2.07%) with normal production of testosterone in all cases; • Of 56 cases, 18 cases of micropenis (0.66%) were observed; • There is a likelihood that the exposure of parents and fetal infection are risk factors for micropenis (high prevalence) and other genital malformations. |
| Analysis period: 1979–2003 | | |
| Foltz et al. (2010) [80] Cross-sectional study | • The neoplasm admission rate was 1.76 times higher in the case group when compared to the control group (p < 0.001); • Cancer mortality rate was also higher in the municipalities of study/case (OR = 1.38; p = 0.007); • No significant differences were observed in fetal death rate (p > 0.05) when compared to live births with lethal malformation (p > 0.05). |
| Objective: To evaluate the degree of exposure of agricultural pilots and the correlation with hearing loss n = 41 | | |
| Gaspari et al. (2012) [81] Cross-sectional study | | |
| Objective: To analyze the incidence of genital malformations in male newborns n = 2710 neonates admitted to the hospital, whose parents had direct contact with pesticides, city of Campina Grande, State of Paraíba | • Fetal malformations were statistically associated with male sex (OR = 1.50, 95% CI = 1.11 to 2.04) and children of mothers living with a partner (OR = 1.34 95% CI = 1.02–1.85); • In the multiple analysis, considering all exposure trimesters, positive associations between exposure to pesticides and malformation were observed; • The effects with significant associations were observed mainly in the fourth quartile (OR = 2.04, 95% CI 1.17 to 3.56) in the periconceptional period; • The study presents the hypothesis that the statistical association between mothers living with a partner and the occurrence of birth defects is related to the handling of contaminated clothing and tools of the husband, who is usually most exposed to pesticides. |
| Rigotto et al. (2013) [82] Ecological study | | |
| Objective: To compare morbidity and mortality indicators of chronic diseases related to pesticides among municipalities in two groups (case group with intensive pesticide usage and control group with low pesticide usage, predominantly family farming) Period: 2000 to 2010 study conducted in the municipalities of the state of Ceará | | |
| Oliveira et al. (2014) [83] Population-based case-control study | | |
| Objective: To investigate the association between maternal past exposure to pesticides and the occurrence of congenital malformations in some municipalities in the state of Mato Grosso Group case: all live births with malformation in the years 2000–2009. Control group: live births over 37 weeks of pregnancy and no congenital malformation | | |

that the reported cases account for 20% of occurrences [73–75].

The health problems caused by pesticide exposure should be discussed in the light of the scientific evidence, including the manifestations in the individual's health, that is, the lifestyle of patients and occupational conditions, among others should be also taken into account [76].
According to several studies, acute pesticide poisoning causes symptoms such as weakness, abdominal cramps, vomiting, muscle spasms, convulsions, irritation of the conjunctiva, headache, difficult breathing, loss of appetite, and nosebleed, among others, and each substance can be responsible for distinct symptoms or effects [51, 76].

Chronic poisoning also exhibits characteristic symptoms for each substance, including delayed neurotoxic effects, chromosomal changes, contact dermatitis, liver damage, cardiac arrhythmias, kidney damage, peripheral neuropathies, allergies, asthma, Parkinson’s disease, cancers, teratogenic effects, and hearing loss, among others [51, 76].

Table 2 shows some studies about the correlations between pesticides and human health.

Conclusions
In Brazil, agricultural practices are based on the intensive pesticide use; thus, all aspects involved in this practice should be assessed. The country ranked in the top of pesticide consumption mainly for the production of commodities. Waste management programs in fruits and vegetables for domestic consumption confirm this result since food-containing residues of pesticides in quantities greater than those recommended by law are found in the retail market, besides the unauthorized substances in food consumed daily by the Brazilian population. Still, in comparison to international control programs, the monitoring program of pesticide residue in food does not estimate the reality of chronic exposure arising from consumption, not generating consistent data for comparison over a period.

Studies have also shown the relationship between pesticide exposure and different types of diseases and/or symptoms, with a negative effect on public health, particularly with regard to groups considered vulnerable.

Despite the food processing allows the reduction of residual pesticides in the raw material, the fulfillment of safe limits depends on the initial load. It is also worth emphasizing the higher levels of residues in some processes, such as drying and manufacturing of margarine or mashed potatoes, thus further results that can support safe processing management are needed.

The indiscriminate pesticide usage in Brazil has affected the fundamental pillars of food and nutrition security, particularly with regard to health risks, environmental contamination, diversity of food crops, and rural poverty that involves food production. It is necessary to reduce the use of pesticides or adopt less toxic substances. It is also important to increase the incentives for sustainable agricultural practices, by encouraging research on farming practices that are less harmful to the environment and health. The improvement of the existing monitoring programs, supervision, and constant training of health professionals are also required, aimed to identify and communicate the health information systems about the cases of pesticide poisoning.

Abbreviations
ADI: Acceptable daily intake; AI: Active ingredients; ANVISA: National Health Surveillance Agency; FAO: Food and Agriculture Organization; FLV: Fruits, legumes, and vegetables; FNS: Food and nutrition security; GAP: Good agricultural practices; GDP: Gross domestic product; HRAF: Human right to adequate food; HRFN: Human right to food and nutrition; IBAMA: Brazilian Institute of the Environment and Renewable Natural Resources; LOSAN: Organic Law for Food and Nutrition Security; MAPA: Ministry of Agriculture Livestock and Supply; MCI: Micro-region of Ijuí; MRL: Maximum residue limit; POE: Household budget survey; RS: Rio Grande do Sul (Brazilian State); SINDIVEG: National Union of the Crop Protection Products Industry; UN: United Nations

Authors’ contributions
JMG and APGM contributed to the manuscript drafting and final revision of the study. MVVS carried out the manuscript conception and final revision of the study. All authors read and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

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