PESTICIDES: ACTIONS, APPLICATIONS, THE ENVIRONMENT AND HUMAN HEALTH

OS AGROTÓXICOS: AÇÕES, APLICAÇÕES, MEIO AMBIENTE E A SAÚDE HUMANA

PLAGUICIDAS: ACCIONES, APLICACIONES, MEDIO AMBIENTE Y SALUD HUMANA

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ABSTRACT

Pesticides, in agriculture called 5.0, have several forms of dispersion that present environmental changes as well as in human health. However, the literature already published shows the efficacy, but the side effects on the environment and humans are not the object of studies. This gap allowed this investigation. The objective was to search for data to 1) disseminate the types most commonly used for pesticide application in Brazil; 2) What are the consequences of this use for the environment and human health. The method used was *ex post-facto*. Secondary data were obtained from electronic databases of journals, higher education institutions, federal, state and municipal agencies linked to the theme of this research, and of open access. The data obtained and analyzed indicated that: a) the application actions were evident to combat fungi (50%), insects, rodents (50%), among others; as for the method for applying pesticides in the national territory, the most frequent was aerial spraying (42.9%); Environmental contamination indicated that the impairment of the quality of water, air, soil, fauna and flora showed the greatest expansion (47.4%), and the impairment of human health is the highest (68.4%)**.** Therefore, the type of application and use of aerial spraying does not consider, during spraying, the speed, direction and direction of the wind, as well as the relative humidity of the air or the temperature at the time of spraying. It also shows that the legislation on use and application alone is not enough to prevent the expansion of the areas adjacent to the place of application.

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RESUMO

Os agrotóxicos, na agricultura denominada 5.0, apresenta várias formas de dispersão que apresentam alterações ambientais bem como na saúde humana. Todavia, as literaturas já publicadas mostram a eficácia, porem os efeitos colaterais no ambiente e no humana, não são objetos de estudos. Esta lacuna permitiu esta investigação. O objetivo foi a busca de dados para: 1) divulgar os tipos mais comumente usados para aplicação dos agrotóxicos, no Brasil; 2) Quais as consequências desse uso para o ambiente e à saude humana. O método utilizado foi *ex- post-facto*. A obtenção de dados secundários foram obtidos em bases eletrônicas de periódicos, ,instituições de ensino superior, órgãos federais, estaduais e municipais atrelados ao tema desta pesquisa., e de acesso livre. Os dados obtidos e analisados indicaram que: a) as ações aplicativas foram evidentes para combate aos fungos (50%), insetos, roedores (50%), dentre outros; quanto o método para aplicação dos agrotóxicos no território nacional o mais frequente, foi a pulverização aérea (42,9%); a contaminação ambiental indicou que o comprometimento da qualidade da água, ar, solo fauna e flora apresentou maior expansão (47,4%)**,** e o comprometimento da saúde humana é o mais elevado (68.4%)**.** Então, o tipo de aplicação e uso da pulverização aérea não considera, durante a pulverização, a velocidade, sentido e direção do vento, bem como a umidade relativa ou a temperatura do ar no momento da pulverização. Mostra também, que somente a legislação acerca do uso e aplicação não está sendo suficiente para evitar a expansão as áreas adjacentes ao local da aplicação.

Palavras-chave: Agricultura 5.0. Combate a Pragas na Agricultura Moderna. Tecnologías Agrícolas. Saúde Ambiental e Humana.

RESUMEN

Los pesticidas, en la agricultura llamados 5.0, tienen varias formas de dispersión que presentan cambios ambientales y en la salud humana. Sin embargo, la literatura ya publicada muestra la eficacia, pero los efectos secundarios sobre el medio ambiente y los seres humanos no son objeto de estudios. Esta brecha permitió esta investigación. El objetivo fue buscar datos para: 1) difundir los tipos más utilizados para la aplicación de plaguicidas en Brasil; 2) ¿Cuáles son las consecuencias de este uso para el medio ambiente y la salud humana? El método utilizado fue *ex post facto*. Los datos secundarios se obtuvieron de bases de datos electrónicas de revistas, instituciones de educación superior, agencias federales, estatales y municipales vinculadas al tema de esta investigación, y de acceso abierto. Los datos obtenidos y analizados indicaron que: a) las acciones de aplicación fueron evidentes para combatir hongos (50%), insectos, roedores (50%), entre otros; En cuanto al método de aplicación de plaguicidas en el territorio nacional, el más frecuente fue la fumigación aérea (42,9%); La contaminación ambiental indicó que el deterioro de la calidad del agua, el aire, el suelo, la fauna y la flora mostró la mayor expansión (47,4%), y el deterioro de la salud humana es el más alto (68,4%). Por lo tanto, el tipo de aplicación y uso de la pulverización aérea no considera, durante la pulverización, la velocidad, dirección y dirección del viento, así como la humedad relativa del aire o la temperatura en el momento de la pulverización. También muestra que la legislación sobre el uso y la aplicación por sí sola no es suficiente para evitar la expansión de las áreas adyacentes al lugar de aplicación.

Palabras clave: Agricultura 5.0. Control de Plagas en la Agricultura Moderna. Tecnologías Agrarias. Medio Ambiente y Salud Humana.

INTRODUCTION

Since the green revolution in the 1950's, when pesticides were used indiscriminately, Motoyama *et al.* (2003) report that pesticides[7] are used to control pests and diseases in agricultural crops, and that they have caused problems for human health and the environment in both rural and urban communities. Soares, Freitas and Coutinho (2005), state that these effects are caused by the frequent use of agrochemicals in the agricultural economy, thanks to incentives from public policies such as the National Agricultural Defensive Program, which was launched in 1975. Pereira *et al.* (2023) proved that this is already true in one of Brazil's commodities, cotton (genus Gossypium, family Malvaceae), where Brazil ranks fifth in terms of world production.

In the context of pesticides, Castro, Carvalho and Vieira (2021), explain that since the so-called "green revolution"[8], these chemical compounds have had their values increased, to mitigate the cost of agricultural production and increase final production. Taking a more derogatory view of pesticides, Lopes, K., Monteiro, and Lopes, P., (2022); Lopes and Albuquerque (2018) and Lima and de Jesus (2025) point out that current agroecology neglects traditional peoples and communities (e.g. Yanomami people - Roraima and Amazonas; Xukuru de Ororubá – Pernambuco), in the face of the release of new pesticides as one of the main factors in the environmental collapse.

The problem with pesticide use is not just about spraying, as the way in which the pesticide is applied is also a problem. Costa *et al.* (2020) exemplify the problems that occur in traditional coffee-growing, where application is conducted by motorized traction (tractor), coupled to a sprayer called a cannon. In this case, the terrain must be considered because, depending on the physical structure, it may require greater acceleration. In addition to the problem for occupational

[7] The Regional Council of Chemistry approves and indicates this term for disclosure and the purpose for which the chemical products in intended (CRQ, 1997)

[8] In Brazil, this Revolution les to territorial expansion, growth in domestic food consumption, na increase in commodities, as well as land concentration, rural, gentrifications, monoculture, and dependence on pesticides (Campagnolla; Macedo, 2022).

health, Moraes *et al.* (2023) indicate that this causes a reduction in the performance of the task to be conducted, which can be extended to the community living around the sites where this happens.

Another concern is the problems generated in the surrounding communities. Lopes K., Monteiro and Lopes, P. (2022), warn about the process of spraying pesticides and the form of spraying used. Betoni *et al.* (2024), warn that drones, or unmanned aerial vehicles (UAV's[9]), are used in monocultures over large areas. In this regard, Olivete, Thomaz Júnior and Barreto (2025) cite the cultivation of soybeans, whose nomenclature is Glycine max (L) Merrill, Family Fabaceae, as an example. Tudi *et al.* (2021) report that this leads to attacks on uncultivated targets such as air, water, soil, and other crops.

Not only unmanned aerial vehicles (UAV's) are used in agriculture. Vilela, Malagoli and Morrone (2005) identify the existence of the "motorized knapsack" sprayer, which imposes weight loss, sun exposure, and other problems on applicators. Furtado (2004) also identified that the noise caused by the application can reach 97 *dB*. As for manual backpack sprayers, Coelho and Machado (2022) warn that this type of sprayer has caused muscle problems due to the repetitive efforts made to spray the pesticide. Walker *et al.* (2014) state that, in addition, the applicator's spine can be injured with the onset of low back pain.

Regardless of the type of sprayer, a key concern should be the surrounding area, especially family farming settlements. Souza and Sevá (2021) show that these agricultural production sites can be home to children's schools. Weyermüller and Dewes (2025) justify this concern due to the direction, speed and direction of the winds which contribute to the dispersion of pesticides to these locations and which, in addition to children's schools, can contaminate pollinators such as bees. they state that non-compliance with legislation on the application and care of pesticides.

Agricultural pesticides are toxic, and that is a definite statement. The São Paulo State Environmental Company (Cetesb) [10] defines toxicity as when a chemical compound acts on a living organism and causes a harmful effect on a particular organ, altering its biochemistry or enzyme system. This characteristic, toxicity, is identified by the Oswaldo Cruz[11] Foundation from three aspects: (1) exposure and (2) the life cycle of the pesticide, as well as (3) the method of

[9] For the Brazilian Model Aircraft Association, it is a vehicle capable of flying in the atmosphere, whose original design does not allow for a crew because it is controlled remotely (Paiva; Péra, 2023).
[10] Available at: Basic concepts of Toxicology – Chemical Emergencies.
[11] Available in: Toxicology

administration of the chemical solution. They also point out that there is a direct relationship between these three variables.

The problem also affects human health and, directly, rural workers. Lopes and Albuquerque (2018) identified cases of lethal and non-lethal poisoning, with a prevalence in males in the northeast and, in the south, respiratory diseases. These situations occur through direct or indirect exposure. Germano (2024) explains that, in Brazil, the use of pesticides is high, and, for this reason, the frontiers of diseases caused by these chemical substances are increasingly expanding and reaching the capitals, as they are already causing skin irritations, respiratory problems, cancer and endocrine disorders in the urban population.

All for this cause an imbalance in environmental homeostasis, either in the environment and/or in human health where they are applied, and the discussion needs to be updated and expanded, which justifies and expands the relevance of this research, whose objectives are: 1) to publicize the types most commonly used in Brazil; 2) what consequences this has for human health.

METHODOLOGY

For this study, *ex-post-facto* research was used because the report contained here comes after the application of pesticides and their action on human health and the environment, in a cause-effect relationship. The choice of this method was based on the explanations made by Fernandes *et al* (2025), as well as the arguments written by Almeida (2016). She states that, in this type of study, the researcher reports what they see. This corresponds to publications that deal with the relationship between the application of pesticides (the cause) and what happens to human health and the rural and/or urban environment (the effect) after this action.

To create the corpus for this study, literature was selected from open access electronic links such as Google Scholar, the Portal of the Coordination for the Improvement of Higher Education Personnel - CAPES, Semantic Scholar, Web of Science, repositories of higher education institutions, ResearchGate, among others. Among those selected were experimental and review articles, monographs (Course Conclusion Work, Specialization Monographs, Dissertations and Theses) and hemerographic literature.

To better obtain specific data, the literature was selected along four lines of investigation: 1) Pesticides x Actions; 2) Pesticides x Types of Applicators; 3) Pesticides x Environment; 4)

Pesticides x Human Health. The statistical analysis of the data, after this distribution, was conducted by calculating frequencies (absolute - fi; relative fr -%), mean and deviation for better quantification and analysis of the data obtained.

RESULTS

Literature Selection

Analysis of the data obtained indicated that the most frequent publications focused on two relationships out of the four investigated: 1) pesticides x environment; 2) pesticides x human health, with, when applied with aerial sprayers, cause negative changes in these two environments (Table 1).

Table 1. Statistical data obtained from the literature selected for the four associations analyzed.

Pesticides and..		
the action		
	Absolut frequency	***Relative frequency (%)***
Antifungal	2	50
Inseticides; herbicides; defoliants; fumigants; rodenticides; molluscicides; nematicide; acaricide.	2	50
Subtotal	4	100
$\underline{x} \pm \sigma$	**2.0 ± 0.0**	
he applicators		
Coastal manual	2,0	14.3
Motorized sack	2.0	14.3
Tratorized sets	3.0	21.4
Aerial spraying	6.0	42.9
Turbo sprayers	1.0	7.1
Subtotal	14	100
$\underline{x} \pm \sigma$	**2.4 ± 1.1**	
the environment		
Erratic Targets and Public Policy	3.0	15.8
Pollinating insects	7.0	36.8
Quality of water, air, soil, fauna, and flora	9.0	47.4
Subtotal	19	100
$\underline{x} \pm \sigma$	**6.3 ± 3.1**	
...Human health		
Traditional Peoples	3	15.8
Noise from tractors with sprayers	1	5.3
Noise and weight loss	2	10.5
Human health [1]	13	68.4
Subtotal	19	100
$\underline{x} \pm \sigma$	**4.8 ± 4.8**	
Total Geral	**56**	**100**

[1] Human health, in the data obtained correspond to: Public health management, cancer and neurological disorders, mental health and impacts on pregnancy and postpartum, food contamination, Each of these represents rf = 2. Non-Hodgkin's lymphoma, rf = 1.
Source: authors (2025).

Table 1 shows that the environment receives the greatest degree of negative impacts from the application of pesticides in four areas: water quality, air, soil, fauna and flora (47.4%), and health (68.4%), and this area was the most affected as it involves vital diseases such as cancer.

DISCUSSION

Pesticides

Spraying - Advantages and Disadvantages

Among the advantages, Betoni *et al.* (2024) state that the cost related to cultivated areas offers more effective savings for farmers with more sustainable environmental practices. However, Freitas, Bonfatti and Vasconcelos (2022) state that aerial spraying with drones' results in many complaints from the surrounding communities where it is used. On this panoramic view, Olivete, Thomaz Junior and Barreto (2025) state that the growth of agricultural areas in Brazil will increase the number of complaints about the negative impacts caused by the exacerbation of the use of pesticides in national crops.

Costa *et al.* (2020) cite another advantage of using agrochemicals as being the care taken with pests and invasive vegetation in traditional coffee growing. On the other hand, other problems regarding the application of pesticides are related to the types of applicators used and the relief (sloping, slightly undulating or undulating) of the area where the pesticide will be sprayed. In this case, the use of a cannon attached to a tractor in such terrain causes a lot of noise, especially on slopes. Soares, Freitas, and Coutinho (2005) add that we must not forget the cases of poisoning among farmers who deal directly with this application.

Toxicity

According to Spadotto and Gomes (2021), depending on the organism, they can be waterborne, chronic, systemic, and topical. They also warn of the cumulative factor and that they

can decompose very quickly or not[12] at all when they reach the soil. The National Health Surveillance Agency (Anvisa, 2019) reclassified the toxicological effect of pesticides from 1924 (99.0%) to 1942 (Table 1).

Table 1. Toxicological reclassification of pesticides conducted by ANVISA.

		Quantity			
Categoria	**Toxicity**	**Aircraft range (*Ar*) (mg/kg)**	***Absolute frequency***	***Relative frequency***	**Colors**
1	Extremely toxic	≤ 5	43	2.2	
2	Highly toxic	$5 \geq Ar \leq 50$	79	4.1	
3	Moderately toxic	$50 \geq Ar \leq 500$	136	7.0	
4	Low toxicity	$500 \geq Ar \leq 5.000$	599	31.1	
5	Unlikely to cause acute damage	--	899	46.7	
Not classified	Not classified	--	168	8.7	

Source: Prepared from ANVISA data, 2019.

The degree of toxicity is already being monitored by specialized sectors. The National Cancer Institute (Inca, 2023) explains that the World Health Organization (WHO) has already identified a high number of deaths/years: 20.000. The World Labor Organization (ILO), on the other hand, reports 70,000 poisonings per year. da Matta and Oliveira (2020) indicate that these substances for agricultural use have six functions in this economic area: agrochemicals, pesticides, pesticides, plant protection products, or phytosanitary products. Peres, Moreira, and Dubois (2003) warn that this toxicity also affects non-target organs such as microorganisms and causes gene mutations, as well as carcinogenic effects.

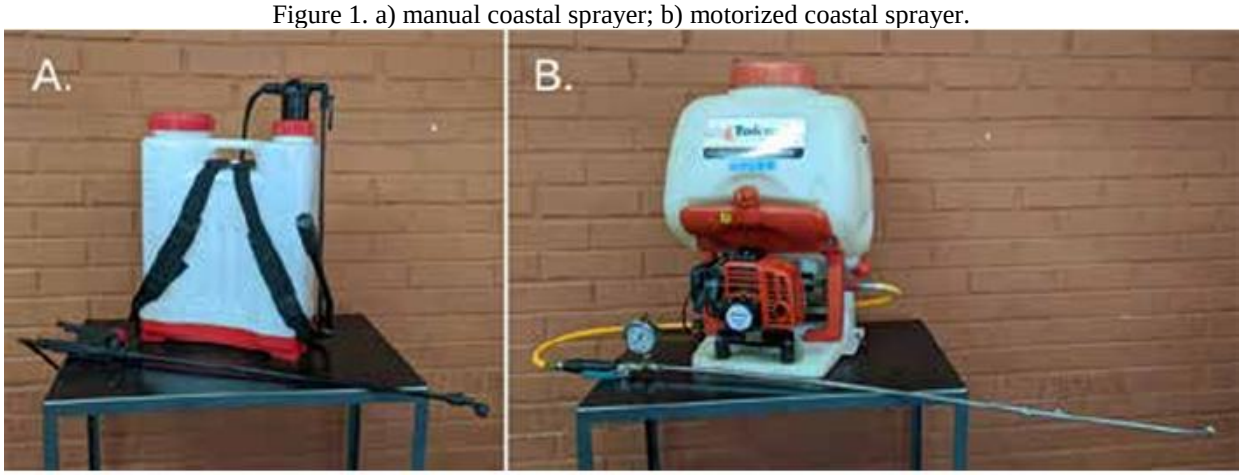
Sprayers - Types

Manual and Mechanization

As far as spraying is concerned, the Technical Assistance and Rural Extension Company - EMATER (Emater, 2022) points out that knapsack sprayers offer the possibility of operating with two misting drive options: manual (Figure 1a) or motorized (Figure 1b).

[12] It depends on the chemical compound and the active ingredient.

Figure 1. a) manual coastal sprayer; b) motorized coastal sprayer.



Source: Coelho and Machado (2022)

Regarding the manual knapsack sprayer, Coelho and Machado (2022) point out that it is a traditional method of agricultural spraying with two advantages: 1) low cost; 2) its ease of use in places that are difficult to access, and that this method is suitable for applications in small areas. These authors identified the physical effort involved in manual pumping as a disadvantage. For this reason, Sasaki (2014) stresses that there is a need to update the methodology of use to minimize the excess physical effort of the activity, since it is classified as moderately heavy and causes changes to the health of the applicator.

As for the motorized costal sprayer, Furtado (2004) warns that, despite its functionality, mechanical drive equipment can cause damage to the driver of the device, due to the presence of motorization combined with physical and environmental agents that pose health risks and ergonomic accidents. In addition, Alencar (2010) presents the advantages of this atomizer's functional air flow and the yield of day/man/hour = 0.9 ha. This author warns of the negative points: 1) the weight of the atomizer; 2) the noise generated; 3) the lack of training to operate it more effectively.

Turbo Atomizers Sprayers

Faced with the challenges related to direct and excessive exposure to pesticides, Ramos (2012) proposes an alternative that could mitigate these complaints: the use of turbo atomizing sprayers, since other tools are used to disperse the pesticide, such as: the turbine, the tank, the pump, the spray nozzles, the reflector ducts that direct the air flow with droplets towards the target. This is because these tools are not dependent on-air currents, but on the pressure inside the

turbo. This fact, together with sustainable technological developments that reduce the uncontrolled dispersion of pesticides, have become fundamental strategies for minimizing health risks, as argued by Oliveira *et al.* (2024). However, using the tractor with the cannon (Figure 2a) attached (Figure 2b) causes a lot of noise.

Figure 2. a) atomized cannon; b) cannon attached to the tractor.

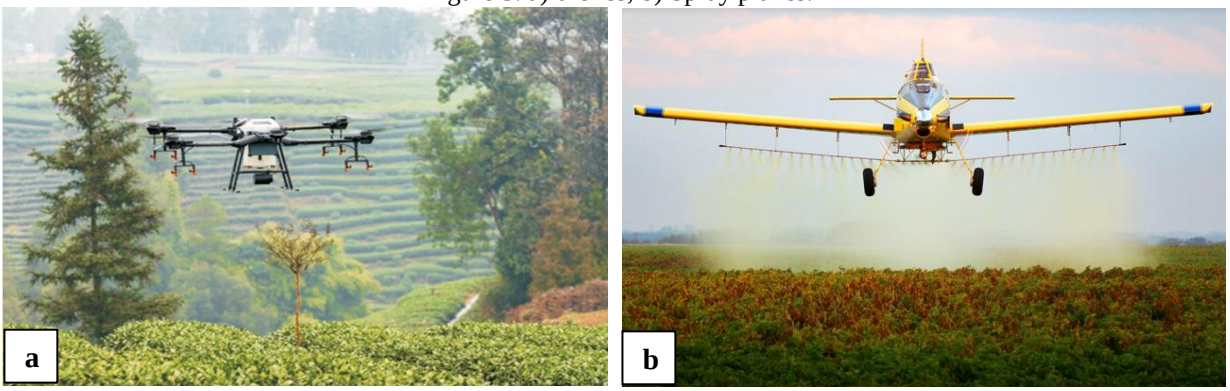
Available at: a) Jatão/Canhão Agricultural Atomizer Sprayers in Artur Nogueira 773306; b) Pelegrini, Rodrigues and Ferreira (2024).

In addition to this organic anomaly, Soares, Freitas, and Coutinho (2005) identified that there is also poisoning for the farmers who deal directly with this application. One of the problems related to the types of pesticide applicators involves the relief of the area where the pesticide will be sprayed, as well as, of course, the type of sprayer used. As an example of this, Costa et al. (2020) cite traditional coffee growing, where pests and invasive vegetation must be controlled with the use of pesticides.

Aereas

Aerial spraying of pesticides in Brazil currently has two application routes: drones (Figure 3a) and spray planes (Figure 3b).

Figure 3. a) drones; b) Spray planes.



Source: a) Daniel and Dabianco (2023); b) Procampo Magazine (2019)

The use of aerial technology is growing, as it is not only used for spraying. Moraes *et al.* (2024) report that the sophistication of aerial drones makes it possible to recognize the color of plantations and thus detect whether there are pest problems attacking the crops. Santana Júnior *et al.* (2025) present negative points regarding these aircraft, such as their high cost, lack of technical information and registration with the National Civil Aviation Agency (ANAC).

In terms of the environment, Paiva (2023) reports that pest control, whether conducted by drones or not, has the same effect in this area: it is highly harmful, both in the short and long term, causing water and soil pollution, as well as in the soil. Ferreira (2014) warns about the negligence that is still in force in Brazil, not only for this aspect, as it also includes human health, in addition to the ecological imbalance that this can cause. Olivete, Thomas Júnior and Barreto (2025), described that imprecision generates "drift"[13], and this increases the vulnerability of communities located around the area where this spraying occurred.

Effects on...

Pollinators

Environmentally, Feltrin *et al.* (2021) report that the rampant use of pesticides is one of the main causes of bee colony collapse syndrome, as there is a progressive reduction in the bee population. These creatures are extremely important in most ecosystems, considering their role in maintaining countless species of natural and managed flora through pollination. Silva and

[13] When this occurs, the particle or droplet released by the aircraft, due to wind speed, direction, and flow, reaches a non-target location, harming the health of individuals in other communities.

Ferrarezi Junior (2022) report that without pesticide aggression on the bee population, there will be quality pollination, with a significant increase in the number of grains, optimization of quality and mitigation of grain malformations as a result of the presence of pesticides in the colonies.

In addition, Centamori (2025) warns that the frequent and growing use of pesticides could exterminate up to 50% of pollinators. From this perspective, Pinheiro and Freitas (2010) and Rego (2022) explain that the lethality of pesticides depends essentially on the quantity and frequency of their use, with mortality ranging from 64.4% to 100%. Issac and Maggi (2024) report that pesticides such as neonicotinoids are absorbed by flowers, settle in the nectar and pollen and therefore affect the foraging, navigation and immunity of pollinators.

The Environment

Changes in pesticides are causing various alterations in environmental compartments, damaging not only the environment, but also health, as explained by Deitos *et al.* (2024). Alves and Silva (2003), they can cause a tendency for variations in temperature, chemical interactions with other atmospheric pollutants, alter organic matter in the soil, the hydrogen potential - pH, and its salinity. Massi *et al*. (2022), states that pesticides such as permethrin, picoxystrobin, and atrazine, among others, are present in atmospheric air particles, with an average of between 1.1 and 0.7 ng/m³.

The soil absorbs a great deal, which over time causes irreversible damage. Santos, J., and Santos, M. (2023), warn that this damage proves a decrease in the resilience of this soil. Mello *et al.* (2019) make another warning. For them, half of what is absorbed and stored in the soil undergoes chemical reactions and, through the pores, reaches surface water. Weyermüller and Dewes (2025) explain that these changes end up interfering in a harmful and irreversible way in the environment.

In water[14], Peres, Moreira and Dubois (2003) point out that these substances can infiltrate and percolate through pores in the soil and thus reach groundwater, but first they pass through surface water from atmospheric air, via rainfall and surface runoff. Grandi *et al.* (2021) warn that 18 of the pesticides used in Brazil pose a risk of contamination to surface and groundwater.

[14] Pesticides undergo hydrolysis and photolysis, biological degradation, bioaccumulation, and biomagnification (Spadotto; Gomes, 2021).

Furthermore, make a caveat regarding the excessive use of glyphosate and 2.4- D[15] the risk offered is classified as medium.

Consequently, the effects on the environment are so severe that the federal government has established specific sectors for constant surveillance, in addition to Federal Law 7.802 (Brazil, 1989), which regulates each stage of the marketing of this product, starting from its development. Souza et al (2017) identify four bodies: I) Water Quality Surveillance for Human Consumption - VIGIAGUA; II) Health Surveillance of Populations Exposed to Chemical Contaminants - VIGIPEQ. This includes soil surveillance - VIGISOLO[16]; III) Surveillance of populations exposed to atmospheric pollution - VIGIAR; IV) Environmental Health Surveillance of Risks Associated with Disasters (VIGIDESASTRES), which includes: surveillance of physical factors - VIGIFIS; surveillance of accidents involving dangerous products - VIGIAPP.

Still on the subject of the environment and pesticides, the federal government's concern is not limited to their application and dispersal, which is why it enacted and published Decree No. 4.074 (Brazil, 2002), which regulates Law No. 7.802 (Brazil, 1989), which provides for 14 items related to these substances, and the destination of their waste and packaging when empty. Article 1, item XLIV of this law considers "waste" to be a substance or mixture of substances, both in food and in the environment, resulting from the application of pesticides. In order to mitigate the concentrations of these substances in these two environments, Carvalho (2024) states that it is necessary to use strict chemical controls.

Human Health

Although there are agreed ideas regarding the use of pesticides due to their important role in controlling pests and diseases that are harmful to crops, Basso, Siqueira and Richards (2021) and Gomes *et al.* (2021) argue that there are opposing points of view, considering that the improper use of phytosanitary substances triggers numerous risks for the farmers who apply them, the residents of nearby communities, the final recipients of agricultural production, and the ecosystem, among them, the main one being the health, which was identified by Modesto, Gomes

[15] [15] Dichlorophenoxyacetic acid. Available at: Agrotóxico 2,4-D passa a ter restrições na aplicação — Agência Nacional de Vigilância Sanitária - Anvisa

[16] It is Health Surveillance with the mission of identifying populations exposed or at risk of exposure to chemical contaminants in soil (MS, 2008)

and Câmara (2025), as mental health and good living, needs that Silvério, Cunha and Almeida (2023) claim are neglected by their responsible management.

According to Benatti (2025), modern agriculture and exposure to pesticides are the main risk factors for depression, neurobehavioral changes, suicides, and intoxication, and affect the mental health of those who are directly exposed to occupational conditions related to pesticides. Frota and Siqueira (2021) wrote that Brazilians use an average of 7 kg/year of pesticides, which means that Brazil has become the world's largest consumer of this substance and, as a result, there have been an increase in the use of public health services in relation to acute and severe poisoning, which has raised the lethality rate related to these events.

The changes to the female body caused by pesticides are real and can cause irreversible damage. Mescka, Costa and Ceonelin (2022) found that pesticides can cause insomnia, anemia, hormonal changes, immune problems, cancer, infertility, congenital malformations, miscarriages, early menopause, fetal death and premature labor, the latter of which have an increased risk due to maternal exposure during pregnancy.

Fernandino (2019) also stresses that not only those exposed to the intensive use of pesticides are subject to the potential risk of contamination, as in the case of women they are prone when they live close to the application sites. Law 14.785 (Brazil, 2023) defines these agricultural products as agents of physical-chemical or biological processes. It also states that their purpose is to alter both flora and fauna. One of them, 2,4-D, was the subject of a study by Assunção, Pinto and Pereira (2025), with a water content of around 68% in the human body.

CONCLUSION

With regard to the types of chemical application of agrochemicals found in Brazil, whether in common use, through the manual or motorized costal method, or in areas of greater reach by turbo sprayers or unmanned aerial vehicles (UAV’s) in large-scale crops, there is a prevalent deficit in measures to mitigate the damage caused to the applicator, the environment and the community around the target perimeter, when used in an unsustainable manner.

The excessive use of aerial or cannon spraying, even though protection methods have been introduced to reduce the consequences of possible physical injuries and pathological compliance, there is still contamination and ergonomic consequences, related to the exposure time and

physical effort exerted by the farmer, affecting productivity levels in the long term, as they have an impact on quality of life and occupational health.

Although the aim of their use is to protect crops, agrochemicals are extremely harmful to the environment, being the main cause of the loss of nutrients and microorganisms in the soil and its compaction through the continuous use of products in conjunction with heavy machinery; water contamination; bioaccumulation of toxins; interference in the performance of pollinators in the ecosystem, preventing them from maintaining vegetative genetic diversity and drastically reducing their population niche.

Therefore, it is necessary to readjust both the use of agrochemicals and the way they are applied, so that the agricultural economy, associated with excellent technologies, does not suffer a solution of continuity, nor does it harm the environment around the applications or interfere with the consequence but, but, if it does, it should be in the least aggressive way possible compared to what currently occurs, in such a way that environmental homeostasis is maintained, with the maintenance of natural resources such as water and soil, as well as the conservation of biodiversity and the physical and mental health of everyone, so that technology is not a nefarious and deadly consequence, but maintains the decrease in food vulnerability.

The data reported here are a warning to the consumer community about agricultural products and health reactions, always remembering that the bioaccumulation of these agricultural substances causes lethal diseases such as cancer. The role of academia is to deepen biochemical studies of pesticides, which contribute to the mitigation of negative reactions to the environment and human health. Among these studies, it is necessary to add, in addition to biological efficacy and lower environmental and human impact, the climatic conditions of the application site.

The limitations of the research were inherent to the data regarding professional information arising from the scarcity of data and research that better clarifies between pesticides and the indiscriminate use of this agricultural product in modern agriculture, as well as studies where biological control maintains greater frequency with positive results, since the resistance of insects has evolved as pesticides change their chemical composition, and the non-adequacy and supervision of safety standards regarding use and application.

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