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ESSAY

Integrated, participatory, and territorialized health surveillance in contexts of exposure to agrotoxics in Brazil

Vigilância da saúde integrada, participativa e territorializada em contextos de exposição aos agrotóxicos no Brasil

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DOI: 10.1590/2358-28982025E2105291

ABSTRACT The damage caused by agrotoxics to health is underestimated by the National Health Surveillance System, both in terms of registration and investigation, and health care. In particular, there is underreporting of acute cases, rare reports of chronic effects, and virtually no diagnosis of the impact of agrotoxics on reproductive health in urban, rural, Indigenous, Quilombola, and riverine communities, and also population groups living in urban peripheries – areas marked by poor environmental sanitation and severe epidemiological problems linked to arboviruses, that are poorly addressed by an ineffective, chemical-dependent vector combat model. In response to ABRASCO's Reproductive Health and Agrotoxics project, a workshop was held during the 9th SIMBRAVISA. The methodology brought together 70 participants from diverse disciplinary and institutional backgrounds to discuss how health surveillance should be conducted to tackle the severe public health crisis caused by the high consumption of agrotoxics in Brazil. Building on the evaluation of this process, this essay aims to deepen and update these discussions amid the current health crisis resulting from the ongoing deregulation of Brazil's agrotoxic legal framework and to propose a new model of health surveillance grounded in participatory, democratic, integrated, and territorialized actions and deliberative processes.

KEYWORDS Public health surveillance. Precautionary principle. Social participation, Integrality in health. Territoriality.

RESUMO *Os danos dos agrotóxicos na saúde estão subdimensionados no Sistema Nacional de Vigilância em Saúde, tanto nas ações de registro como investigação e cuidado. Observa-se, especialmente, subnotificação de agravos agudos, raras notificações de efeitos crônicos e praticamente nenhum diagnóstico da situação dos impactos dos agrotóxicos na saúde reprodutiva em áreas urbanas, rurais, nos territórios indígenas, quilombolas, ribeirinhos e de grupos populacionais que vivem em periferias urbanas, com baixa cobertura de saneamento ambiental e grave problema epidemiológico decorrente de arboviroses, que é mal enfrentado por um ineficaz modelo de combate vetorial químico-dependente. Em atenção ao projeto Saúde Reprodutiva e Agrotóxicos da Abrasco, foi realizada Oficina no 9º Simbravisa. A metodologia adotada permitiu reunir 70 convidados com diversidade disciplinar e institucional, que debateram como deveria se processar uma vigilância da saúde para atender ao grave quadro sanitário provocado pelo alto consumo de agrotóxicos no Brasil. A partir da avaliação desse processo, o objetivo deste ensaio foi aprofundar e atualizar esses elementos no atual cenário de crise sanitária decorrente do processo de desregulação do marco legal dos agrotóxicos em curso e apresentar propostas para um novo modo de fazer vigilância da saúde, constituídos por ações e processos deliberativos participativos, democráticos, integrados e territorializados.*

PALAVRAS-CHAVE *Vigilância em saúde pública. Princípio da precaução. Participação social. Integralidade em saúde. Territorialidade.*

Introduction

In November 2023, a workshop was held during the 9th SIMBRAVISA Conference in João Pessoa, state of Paraíba, to reflect on health surveillance in the context of agrotoxics exposure in Brazil. The event brought together 70 invited participants, including representatives from eight thematic groups of the Brazilian Association of Collective Health (ABRASCO): Health and Environment; Workers' Health; Health Surveillance; Popular Education; Gender and Health; Nutrition and Collective Health; Indigenous Health; and Racism and Health. Also in attendance were technical experts and researchers from the Department of Environmental Health Surveillance and Workers' Health (DSAST), under the Secretary of Health Surveillance and Environment (SVSA) of the Ministry of Health, and from the Oswaldo Cruz Foundation (FIOCRUZ), along with members of the Peasant Women's Movement, the National Forum to Combat the Impacts of Agrotoxics, the Campaign Against Agrotoxics and for Life, and the Primary Health Care Network.

The workshop used a methodology based on active participation, critical dialogue, acknowledgment of different types of knowledge, and the collective building of understanding. This approach aimed to encourage reflection on health surveillance in contexts of agrotoxic exposure and to explore the challenges of advancing such efforts within the country's current political and economic context. Particular emphasis was placed on a critical analysis of the traditional model of conducting epidemiological and sanitary surveillance in Brazil—an approach that remains largely unchanged, despite the significant transformations introduced by Law No. 8,080 of 1990, which established the Unified Health System (SUS). It was documented that both forms of surveillance were established during the 1970s, under the corporate-military dictatorship, following a model inspired by the United States Centers for Disease Control and Prevention (CDC/USA). This model failed to consider the socio-environmental health determination and disease processes.

Although the SUS has made progress in thematic surveillance, such as for water- and foodborne diseases, workers' health, and environmental health, the way surveillance is carried out in communities affected by harmful production and consumption practices has changed little. A dedicated system for Health Surveillance of Populations Exposed to Agrotoxics (VSPEA) was only recently established. Still, it does not actively engage with the living and working environments of these vulnerable groups. Instead, it mainly relies on passive reporting of confirmed or suspected toxic exposure cases.

Another key focus of the workshop was the discussion of the limited effectiveness of prevention and care regarding exposure to agrotoxics and the resulting harms. The SUS's low capacity to respond to the public health crisis caused by environmental, occupational, and consumer exposure in Brazil further hinders professionals' ability to fulfill their roles in prevention, protection, and care for exposed populations, as well as in diagnosing and mandatorily reporting cases of exogenous poisoning, whether acute, chronic, or related to reproductive health.

Given its central role in the National Policy on Workers' Health, the limitations of current surveillance practices in the country must be critically examined to envision new approaches that more effectively address workers' health needs. The workshop produced several documents, among them the Technical Note: Agrotoxics, Human Exposure, Reproductive Health Damage, and Health Surveillance[1], which forms Part III of the dossier Harms of Agrotoxics to Reproductive Health[2], published by ABRASCO and the Sergio Arouca National School of Public Health (ENSP/FIOCRUZ). These materials underpin the present essay, whose objective is to situate agrotoxics legislation within the current Brazilian context and to provide elements for rethinking health surveillance in situations of vulnerability arising from the country's high levels of agrotoxics use. Among the proposals, the idea of participatory

and community-based health surveillance was discussed, although this term has yet to be uniformly defined within the field of public health. According to Carneiro, Silva e Silva[3], the expression 'popular health surveillance':

> [...] has been used to describe surveillance practices that prioritize the leadership of communities and social movements. Such practices may include different levels of involvement from the state, academic institutions, and technical experts, as long as these actors recognize the legitimacy of community stakeholders and local knowledge, and commit to participatory processes grounded in dialogue and mutual exchange.

The contributions of this essay aim to open a dialogue and expand the possibility for greater community involvement in discussions on agrotoxics and their harmful effects on the environment and human health. In this regard, popular surveillance offers a pathway to strengthening public policies. According to Oliveira et al.[4], and drawing on a theoretical–methodological framework grounded in the concepts of the social determination of the health–disease process, the voices of the territory, popular education, intersectoriality, intersectionality, interdisciplinarity, and care from a decolonial perspective are guiding principles for a new model to be implemented within the SUS.

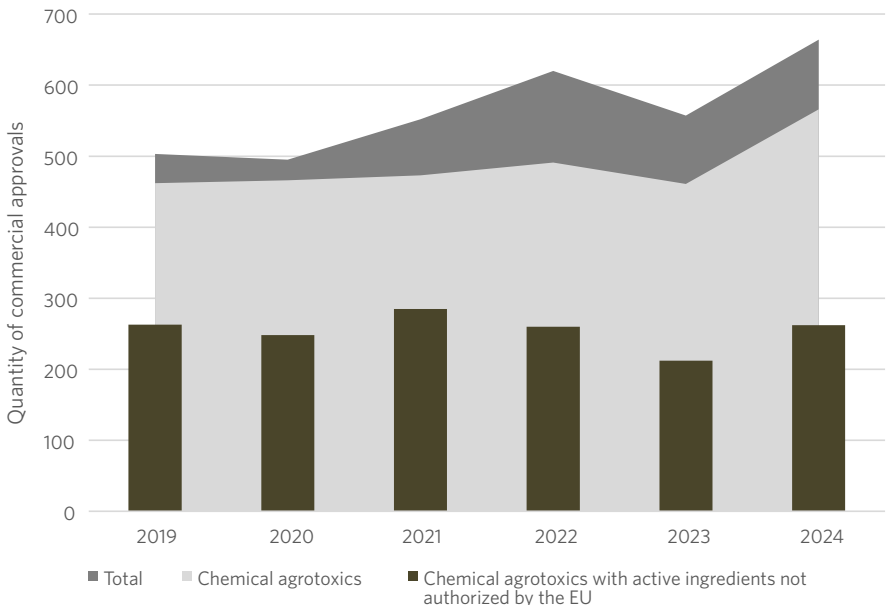
The public health crisis and the context of exposure to agrotoxics

The hegemonic economic development model in Brazil is based on the production of raw agricultural, mineral, and fossil fuel commodities. Historically, these sectors have been responsible for the systematic contamination of water bodies and the territories of Indigenous peoples and traditional communities, land conflicts, major environmental disasters, and significant harm to workers' health. Brazilian agribusiness is characterized by large estates and monocultures that are typically dependent on chemical inputs; livestock farming uses veterinary drugs, some of which contain the same active ingredients as agrotoxics. The commercialization of agrotoxics in Brazil exceeds 1 million tons annually, with approximately 80% used for cultivating major crops, including soybeans, corn, sugarcane, and cotton. These crops cover 75 million hectares—accounting for 83% of arable land[5]—spread across Brazil's diverse biomes, mainly concentrated in the Cerrado, because of its topography and its importance as a vital water source reservoir. In these extensive areas, large volumes of herbicides and other types of agrotoxics are used, along with chemical fertilizers, which drive the loss of vegetation cover and biodiversity, thereby exacerbating the climate crisis at both local and global scales[6,7].

Another component of this model, which exacerbates the harmful effects observed, is the cultivation of genetically modified crops that are tolerant to herbicidal agrotoxics. Since 2003, the use of agrotoxics in Brazil—particularly glyphosate[8]—has increased exponentially. In the following years, commercial releases included crops resistant to one or more herbicides, such as glufosinate ammonium, 2,4-D, and dicamba. This situation has further increased population exposure—including rural workers—to mixtures of agrotoxics linked to various severe chronic diseases, such as cancer and reproductive and endocrine disorders, while also creating a high environmental hazard to aquatic organisms, especially amphibians and mammals[2,9].

Reports on agrotoxics sales published by the Brazilian Institute of Environment and Renewable Natural Resources[10] (IBAMA) indicate that in Brazil, 620,538 tons of active agrotoxics ingredients were sold in 2019, increasing to 755,489 tons in 2023—an increase of 21.7% over four years. The data on total annual commercial approvals of agrotoxics in Brazil between 2019 and 2024 are presented in *graph 1*.

Graph 1. Total number of commercial approvals of agrotoxics registered annually in Brazil between 2019 and 2024 (area in dark gray) and the quantity of products containing active chemical ingredients



Source: Own elaboration.

Note: The bars show the quantity of commercial approvals containing active ingredients not authorized for use in the European Union.

Among the 36 active agrotoxics ingredients with over 3,000 tons sold in Brazil in 2023, 13 were herbicides, 12 were insecticides or acaricides, 10 were fungicides, and one was an algicide. The herbicide glyphosate and its salts ranked first; mancozeb (fungicide and acaricide) second; and the herbicide 2,4-D and its salts third. Of these 36 active ingredients, 17 (47.2%) are not authorized for use in the European Union (EU)[11]. They are listed below in order of highest to lowest sales in Brazil in 2023 (the last on the list is the 36th most sold): mancozeb (fungicide and acaricide), acephate (insecticide and acaricide), chlorothalonil (fungicide), atrazine (herbicide), glufosinate ammonium (herbicide), diquat dibromide (herbicide), methomyl (insecticide and acaricide), thiophanate-methyl (fungicide), chlorpyrifos (insecticide, formicide, and acaricide), diuron (herbicide), imidacloprid (insecticide), ametryn (herbicide), bifenthrin (insecticide, formicide, and acaricide), thiamethoxam (insecticide), carbosulfan (insecticide, acaricide, and nematicide), profenofos (insecticide and acaricide), and chlorfenapyr (insecticide and acaricide)[10].

Regarding agrotoxics registered for use in Brazil, there were 503 new products in 2019; 495 in 2020; 552 in 2021; 620 in 2022; 557 in 2023; and 664 in 2024[12]. In those same years, products containing at least one active ingredient not authorized for use in the EU accounted for 57%, 53%, 60%, 53%, 46%, and 46%, respectively, of the chemical agrotoxics registered[11,12]. As of March 27, 2025, there were 561 active agrotoxics ingredients authorized for use in Brazil. Among these, 369 (65.8%) were chemical products, and the rest were biological products; 234 (63.4%) of the active ingredients were not authorized for use in the EU[11,13].

Of the total volume of agrotoxics sold in Brazil, 67% are classified as toxic to reproduction, endocrine disruptors, or carcinogenic, according to the European Union, the United States Environmental Protection Agency (USEPA), and the International Agency for Research on Cancer (IARC)[9]. At the same time,

the legally permitted limits for agrotoxic residues in water and food in Brazil are generally much higher than those established in other countries[6,7]. Approximately 30% of the active ingredients in agrotoxics authorized for use in Brazil lack approval in the European Union or other member countries of the Organization for Economic Co-operation and Development (OECD)[14]. Among those not authorized in the European Community but with over sixty registered derivative products for use in Brazil, the following active ingredients stand out: mancozeb, atrazine, fipronil, chlorothalonil, diuron, and hexazinone[9,15].

In 2019, the Brazilian Health Regulatory Agency (ANVISA) mandated the adoption of the Globally Harmonized System (GHS) to determine acute toxicological classification and the corresponding labeling and package inserts information[9]. Consequently, products previously recognized by farmers as extremely toxic (red category) were reclassified into lower toxicity classes (blue or green categories), as illustrated in *table 1*.

Table 1. Toxicological classification and classification of environmental hazard potential before (active ingredients) and after (products) the implementation of ANVISA Resolution RDC 294/2019, and the year of ban in the European Union of agrotoxics active ingredients still authorized for use in Brazil

	Toxicological classification		Classification of environmental hazard potential		Year of ban in the EU
	Before[a]	After[b]	Before[a]	After[b]	
2,4-D	1	1, 3, 4	3	2, 3	
Acephate	3	2, 4, 5	2	2, 3	2003
Acetamiprid	3	3, 4, 5	2	1, 2	
Ametryn	3	4, 5	2	2, 3	2002
Amicarbazone	3	2, 4, 5, Not classified	3	2, 3	2009
Atrazine	1	3, 4, 5, Not classified	3	1, 2, 3	2004
Azoxystrobin	2	4, 5	2	2, 3	
Bifenthrin	2	2, 3, 4	2	2, 3	2009
Cyproconazole	3	4, 5	2	2	2011
Clethodim	1	4, 5	3	3, 4	
Clomazone	4	5	2	2, 3	
Chlorantraniliprole	4	5, Not classified	2	2	
Chlorfenapyr	2	4, 5, Not classified	2	2	2001
Chlorothalonil	1	2, 3, 4, 5	2	2, 3	2009
Chlorpyrifos	1	2, 3, 4	2	1, 2	2009
Clothianidin	4	4	3	2, 3	2009
Diafenthiuron	3	2, 4, 5	2	2	2002
Diquat dibromide	1	1, 2, 3, 4	2	2, 3	2018
Difenoconazole	1	3, 4, 5	2	2	
Diuron	3	4, 5	2	2, 3	2009
Epoxiconazole	3	5	3	2, 3	2009
Etiprole	3	5	2	2, 3	2009
Fipronil	3	2, 3, 4, 5	2	2	2009
Fluazinam	3	4, 5	2	1, 2	

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	Toxicological classification		Classification of environmental hazard potential		Year of ban in the EU
	Before[a]	After[b]	Before[a]	After[b]	
Flumioxazin	4	5	3	3, 4	
Fluroxypyr-meptyl	3	5	3	3	
Glyphosate	3	4, 5, Not classified	3	3, 4	
Ammonium glufosinate	3	4, 5, Not classified	3	2, 3	2009
Haloxyfop methyl	1	4, 5	3	2, 3	2020
Hexazinone	1	4, 5	3	2, 3	2002
Imazethapyr	2	4, 5, Not classified	3	2, 3	2004
Imidacloprid	2	1, 2, 3, 4, 5,	3	2, 3	2009
Lambda-cyhalothrin	1	1, 2, 3, 4, 5	1	1, 2	
Malathion	3	3, 4, 5	2	1, 2, 3	
Mancozeb	1	5	3	2, 3	2021
Methomyl	1	2, 3	2	2	2009
Picloram	1	3, 4, 5, Not classified	2	2, 3	
Picoxystrobin	2	5	2	2	2017
Propiconazole	1	4, 5	2	2	2009
S-metolachlor	3	4, 5	2	2	2024
Sulfentrazone	3	4, 5, Not classified	2	2	2009
Tebuconazole	1	3, 4, 5	2	1, 2, 3	
Tebuthiuron	2	3, 4, 5	2	2, 3	2002
Thiamethoxam	3	4, 5, Not classified	3	3	2009
Thiodicarb	2	1, 2, 3, 4	1	2, 3	2007
Thiophanate-methyl	4	4, 5, Not classified	3	3	2020
Triclopyr-butotyl	3	4	2	2, 3	

Sources: Brazilian Ministry of Agriculture, Livestock, and Food Supply (MAPA)[12,16], European Union[11].

[a] Acts: No. 01 of 09/01/2019; No. 04 of 17/01/2019; No. 07 of 04/02/2019; No. 10 of 18/02/2019; No. 17 of 19/03/2019; No. 24 of 09/04/2019; No. 29 of 29/04/2019; No. 34 of 16/05/2019; No. 42 of 19/06/2019; No. 48 of 19/06/2019; No. 62 of 13/09/2019; No. 70 of 02/10/2019; No. 82 of 25/11/2019; No. 91 of 26/12/2019; No. 12 of 19/02/2020; No. 13 of 19/02/2020; No. 22 of 25/03/2020; No. 26 of 04/04/2020; No. 28 of 22/04/2020; No. 31 of 04/05/2020; No. 36 of 05/06/2020; No. 39 of 06/07/2020; No. 43 of 27/07/2020; No. 46 of 05/08/2020; No. 48 of 17/08/2020; No. 51 of 03/09/2020; No. 55 of 21/09/2020; No. 59 of 19/10/2020; No. 60 of 26/10/2020; No. 64 of 18/11/2020; No. 65 of 23/11/2020; No. 70 of 23/12/2020; No. 71 of 28/12/2020; No. 09 of 22/02/2021; No. 13 of 26/02/2021; No. 19 of 07/04/2021; No. 20 of 08/04/2021; No. 26 of 28/05/2021; No. 29 of 11/06/2021; No. 32 of 16/07/2021; No. 35 of 02/08/2021; No. 42 of 21/09/2021; No. 47 of 09/11/2021; No. 49 of 16/11/2021; No. 55 of 23/12/2021; No. 02 of 06/01/2022; No. 06 of 02/02/2022; No. 09 of 14/02/2022; No. 11 of 25/02/2022; No. 14 of 07/03/2022; No. 18 of 14/04/2022; No. 20 of 26/04/2022; No. 23 of 16/05/2022; No. 26 of 03/06/2022; No. 31 of 28/06/2022; No. 38 of 12/08/2022; No. 46 of 13/09/2022; No. 50 of 21/10/2022; No. 53 of 23/11/2022; No. 57 of 02/12/2022; No. 64 of 28/12/2022; No. 05 of 08/02/2023; No. 06 of 10/02/2023; No. 15 of 31/03/2023; No. 16 of 06/04/2023; No. 22 of 19/05/2023; No. 26 of 15/06/2023; No. 30 of 06/07/2023; No. 32 of 14/07/2023; No. 34 of 01/08/2023; No. 37 of 22/08/2023; No. 39 of 04/09/2023; No. 42 of 22/09/2023; No. 45 of 05/10/2023; No. 48 of 27/10/2023; No. 52 of 30/11/2023; No. 56 of 07/12/2023; No. 60 of 28/12/2023; No. 61 of 28/12/2023; No. 06 of 05/02/2024; No. 09 of 21/02/2024; No. 12 of 28/03/2024; No. 16 of 15/04/2024; No. 21 of 06/05/2024; No. 25 of 28/05/2024; No. 26 of 04/06/2024; No. 32 of 18/07/2024; No. 33 of 26/07/2024; No. 41 of 06/09/2024; No. 43 of 09/09/2024; No. 45 of 23/09/2024; No. 49 of 21/10/2024; No. 52 of 05/11/2024; No. 54 of 16/11/2024; No. 58 of 10/12/2024; No. 61 of 27/12/2024; No. 63 of 30/12/2024.

[b] Acts: 22 of 05/05/2016; 06 of 11/01/2017; 33 of 16/05/2017; 51 of 26/06/2017; 83 of 29/09/2017; 74 of 14/09/2018; 76 of 18/09/2018; 101 of 17/12/2018; 01 of 09/01/2019; 04 of 17/01/2019; 07 of 04/02/2019; 10 of 18/02/2019; 17 of 19/03/2019; 24 of 09/04/2019; 29 of 29/04/2019; 34 of 16/05/2019; 42 of 19/06/2019; 48 of 19/06/2019; 62 of 13/09/2019; 70 of 02/10/2019; 82 of 25/11/2019; 91 of 26/12/2019.

The high toxicity levels, large volumes of agrotoxics, and intensive use of aerial spraying in Brazil have resulted in a significant number of poisoning cases reported in the Notifiable Diseases Information System (SINAN)[6], as well as widespread contamination across various Brazilian biomes. Epidemiological studies conducted in the country reveal the occurrence of chronic illnesses—such as cancer, endocrine, reproductive, and neurological disorders—linked to exposure to agrotoxics[2,9,17].

Public policies focused on monitoring populations exposed to highly hazardous contaminants and preventing diseases related to the contamination of water for human consumption, food, and environments, including workplaces, have progressed disproportionately less compared to the economic sector's influence over public policy, despite the important regulatory framework established since 1988[9] that underpins these actions.

Reports from ANVISA's Agrotoxic Residue Evaluation Program (PARA) published over the past decade reveal contamination by agrotoxics in two-thirds of the food samples analyzed. A significant portion of these samples (approximately 30%) contained multiple agrotoxics, thereby increasing the risk of disease emergence. In certain foods, residues of up to 21 different agrotoxics were detected, many of which can induce similar health effects—such as neurological disorders, central nervous system depression, and reproductive problems—through analogous or complementary mechanisms of action[9]. The monitoring and control of water quality for human consumption are still not conducted following the Ministry of Health regulations, both in terms of the number of samples to be collected and analyzed, and most importantly, in the lack of adequate laboratory resources capable of detecting contaminants related to the presence of agrotoxics in water supply sources. In this context, it is essential to note the permissiveness of Brazilian standards, which establish Maximum Allowed Values (MAVs) for residues of certain agrotoxics in drinking water at levels significantly higher than those mandated by regulations in EU countries, for example[7,18,19].

Environmental contamination by agrotoxics is not limited to rural areas. The majority of the Brazilian population consumes both fresh and processed foods containing concerning levels of agrotoxics, which have also been detected in samples of drinking water. In densely populated urban areas, the application of insecticides as a public health measure to combat arbovirus vectors is common. These insecticides contain the same chemical formulations as some agrotoxics used in agriculture. It is noteworthy that, until the enactment of Law No. 14,785/2023[20], these products were also classified as agrotoxics[21]. In 2023, these insecticides intended for use in public health campaigns, residential, industrial, and other environments began to be classified as domestic sanitary products (domissanitary), becoming subject to Law No. 6,360/1976[22], which has the effect of masking their impacts

Among the products used for vector combat in urban areas are malathion, an organophosphate classified by the IARC as probably carcinogenic (Group 2A), and neonicotinoids, such as imidacloprid, which is banned in the EU due to its lethal effects on bees. Imidacloprid is one of the active compounds in the product Cielo, which is applied via Ultra-Low Volume (ULV) spraying in peridomiciles to combat arboviral disease vectors[23]. It is important to note that backpack spraying and ULV (fogging) methods used by public health authorities for vector combat are ineffective and dangerous to the health of workers, the population, and the environment[17,24–28].

Brazil differs significantly from the European Union by frequently employing aerial spraying of agrotoxics via agricultural aircraft, a practice prohibited in those countries. Robust scientific studies have shown that spray drift occurs at a high rate and is influenced by numerous factors, including humidity, ambient temperature, wind conditions, and the chemical composition of the spray mixture.

Furthermore, research indicates that this practice causes substantial environmental damage, such as severe declines in bee populations and contamination of Indigenous reserves. These impacts extend beyond the immediate vicinity of sprayed fields, affecting national parks located far from major agricultural areas[29,30].

The risks of exposure, contamination, and poisoning from these products significantly affect workers in multiple productive sectors, both through their occupational activities and environmental contact. While the agricultural sector remains the most critical from an occupational health standpoint, other vulnerable groups include workers in forestry, the timber industry, pest control companies, and public health, commonly referred to as Endemic Disease Control Agents, Endemic Disease Guards, or Public Health Agents[24-28]. Alongside these, workers involved in the production, transportation, storage, and sale of agrotoxics, as well as those engaged in the recycling of agrotoxic packaging and rural extension agents, are also at risk.

Legal and historical frameworks of health surveillance

The two decades preceding the enactment of the 1988 Federal Constitution (CF/88)[31], known as the Citizen Constitution, were marked by a corporate-military dictatorship that ruled Brazil from 1964 to 1985. This regime silenced political opposition and suppressed attempts at labor organization. During this period, industrialization was strongly promoted, facilitating the establishment of agrotoxic manufacturing factories in Brazil's Southeast region, most of which were owned by European and U.S. companies[32]. Besides tax incentives, both Brazil and Latin America offered more permissive regulatory environments, cheap labor, and 'natural resources' to be exploited[33].

On September 23, 1976, Law No. 6,360 was enacted, establishing regulations for sanitary surveillance applicable to medicines, drugs, pharmaceutical inputs and related products, cosmetics, sanitizing agents, and other products[22]. This law addresses issues that directly impact public health, including the regulation, manufacturing, inspection, and monitoring of these products.

The 1988 Constitution (CF/88), in its articles 196 to 200, establishes that health is a right of all and a duty of the state, and that public health actions and services constitute a unified system, today recognized as SUS, which provides universal and equitable access in a decentralized, comprehensive manner with community participation[31]. The CF/88 provided the legal foundation for advancing health rights, enabling the implementation of various public policies focused on the prevention of infectious and contagious diseases, vaccine-preventable illnesses, and surveillance actions, especially epidemiological surveillance.

Law No. 7,802, enacted on July 11, 1989, known as the Agrotoxics Law, began to regulate various aspects related to agrotoxics, their components, and related products, with significant participation from society, labor unions, and popular movements in its drafting[21]. This law assigns distinct responsibilities to health, environmental, and agricultural agencies, including functions related to the registration, manufacturing, inspection, and monitoring of these hazardous substances, as well as the surveillance of products and individuals exposed to them. The Agrotoxics Law was repealed with the enactment of Law No. 14,785/2023[20], popularly known as the 'Poison Package' due to its severe negative impacts on disease prevention and control, as well as environmental damage[34]. It is worth mentioning some critical points of divergence between Law No. 7,802/1989[21] and the Poison Package/2023[20], which repealed it:

- Under Law No. 7,802/1989[21], the registration of agrotoxics with mutagenic, carcinogenic, teratogenic, endocrine-disrupting, or reproductive toxicity potential was

prohibited (subsections c and d, § 6, art. 3). In contrast, Law No. 14,785/2023[20] prohibits such registration only in cases where the risk is deemed 'unacceptable', regardless of the severity or irreversibility of the diseases identified (§ 3, art. 4);

• Under the previous law, it was prohibited to register products that were more toxic than those already approved in Brazil for the same uses (§ 5, art. 3)[21], whereas the new law removes this restriction;

• Law No. 7,802/1989 required that all agrotoxics circulating in the country be previously authorized by the competent authorities (art. 3)[21]. Law No. 14,785/2023, however, exempts products intended for export from registration, requiring only that the Ministry of Agriculture, Livestock, and Food Supply (MAPA) be notified of their production for export (art. 17, caput and § 1). The exporting company must inform the product, the quantities to be exported, and its destination, with no requirement to disclose information on health or environmental risks (§ 1, art. 17)[20];

• The Poison Package assigns to the federal health authority the responsibility for establishing requirements for dietary and occupational risk assessment, while omitting, from its legal provisions, the data necessary to investigate harm resulting from environmental exposure to agrotoxics (item III, art. 6)[20].

Since the creation of ANVISA, through Law No. 9,782/1999[35], the agency has been assigned a set of responsibilities to be carried out by institutions within the direct and indirect public administration of the Union, states, and municipalities engaged in regulatory, standard-setting, control, and inspection activities in the field of sanitary surveillance.

On January 16, 1992, the National System of Sanitary Surveillance (SNVS) issued Ordinance No. 3, setting forth the 'Guidelines and requirements for the authorization of registration, renewal of registration, and extension of use for agrotoxic products and related substances'[36]. These provisions covered a range of aspects, from the toxicological studies required from companies for the registration of new products to the information to be included in package inserts and labels, as well as the labeling and toxicological classification of products (slightly toxic, moderately toxic, highly toxic, and extremely toxic). This Ordinance remained in use by ANVISA until 2019, when it was repealed by the following Resolutions of the Collegiate Board (RDC): RDC No. 294/2019, RDC No. 295/2019, and RDC No. 296/2019[37-39]. ANVISA assumed the responsibilities related to human health as established in agrotoxics legislation[35].

In 2003, Law No. 10,688 of June 13 authorized the cultivation of genetically modified (transgenic) soybeans engineered for tolerance to the herbicide glyphosate[40]. Less than two years later, the Biosafety Law (Law No. 11,105 of March 24, 2005) was enacted[41], establishing safety standards and oversight mechanisms for activities involving Genetically Modified Organisms (GMOs) and their derivatives. This law also created the National Biosafety Council (CNBS) and restructured the National Technical Biosafety Commission (CTNBIO), an agency whose actions have been increasingly questioned due to corporate interference in decision-making processes and the issuance of technical-scientific opinions often considered questionable[8,42]. In the following years, an exponential increase in herbicide use was observed, consistent with a study showing that a 1% increase in productivity requires a 13% higher use of agrotoxics[8].

On February 22, 2008, ANVISA issued Resolution No. 10[43], initiating the toxicological reevaluation of 14 active agrotoxic ingredients (abamectin, acephate, cyhexatin, carbofuran, endosulfan, phorate, phosmet, glyphosate, lactofen, methamidophos, paraquat, methyl parathion, thiram, trichlorfon). Initially, ANVISA established a collaboration with FIOCRUZ[42], which prepared Technical Notes

for each of the 14 active ingredients under review, based on open scientific literature, recommending the prohibition of all due to their toxic effects, in line with the prohibitive registration criteria of Law No. 7,802/1989[21]. The re-evaluations were completed in 2020, resulting in the prohibition of the following agrotoxics: carbofuran, cyhexatin, endosulfan, phorate, methamidophos, paraquat, methyl parathion, and trichlorfon, while the registration of abamectin, acephate, phosmet, glyphosate, lactofen, and thiram was maintained with restrictions[13].

Despite the progress represented by the bans on certain agrotoxics between 2009 and 2011 (cyhexatin, methamidophos, trichlorfon, endosulfan), some regions of the country with intensive use of these products reported severe health issues, such as cancer, abnormalities, and endocrine problems in both adults and children[1,2]. A notable example is the Chapada do Apodí case, in the Northeast region, which sparked protests involving multiple sectors and led to the approval of Law No. 16,820, dated January 8, 2019, prohibiting aerial spraying[44]. In 2009, the region was characterized by fruit farming with intensive aerial spraying of agrotoxics using agricultural aircraft, resulting in cases of illness. Due to community mobilization, led by the farmer Zé Maria do Tomé, Municipal Law No. 1,278/2009 was enacted, prohibiting aerial spraying in the municipality of Limoeiro do Norte, in the state of Ceará. Just a few months after the law's approval, on April 21, 2010, Zé Maria do Tomé was assassinated with 25 gunshots, and one month after his death, the aforementioned law was repealed[17].

With the escalating issues surrounding agrotoxics, the first State Forum to Combat the Effects of Agrotoxics was established in the state of Pernambuco in 2001. This initiative later expanded, leading to the creation of a National Forum, actively coordinated by the Ministry of Public Labor Prosecution. On April 7, 2011 (World Health Day), the Campaign Against Agrotoxics and for Life was launched, bringing together popular movements advocating for family farming, agrarian reform, and agroecology, alongside academic institutions and research associations such as the National Cancer Institute, FIOCRUZ, the Brazilian Association of Agroecology, and ABRASCO.

Following the impeachment of President Dilma Rousseff and the inauguration of Vice President Michel Temer, Law No. 13,301 of June 27, 2016[45] was enacted. Article 3, subsection IV, authorizes the use of aerial dispersal mechanisms to combat *Aedes aegypti*, despite scientific evidence demonstrating the ineffectiveness and toxicity of these practices[30] for both human health and the environment. Within this favorable political context, Bill No. 6,299/2002, which proposes amendments to Law No. 7,802 of July 11, 1989, began to be processed in a Special Committee in the Chamber of Deputies. However, also in 2016, ABRASCO and other organizations, including the Campaign Against Agrotoxics, submitted Bill No. 6,670/2016—a Popular Initiative Bill proposing the National Policy for the Reduction of Agrotoxics (PNARA)[46]. It is worth noting that the National Program for the Reduction of Agrotoxics (PRONARA) was only officially established by Decree No. 12,538[47] on June 30, 2025. During the legislative proceedings of Bill No. 6,299/2002 — widely known as the Poison Package and which, in 2023, became Law No. 14,785/2020[20] — the organizations comprising the Campaign Against Agrotoxics, along with institutions such as Public Defender's Offices and various branches of the Public Prosecutor's Office, played a pivotal role in securing certain amendments to the bill and in delaying its approval by seven years.

After the 2018 elections, economic sectors expanded their political influence within both the Legislative and Executive branches, resulting in the dismantling of environmental, health, family agriculture, and agrarian reform policies. Furthermore, the elected government dissolved or dismantled commissions and other bodies of social participation and oversight, such as the National Council for

Food and Nutritional Security (CONSEA), the National Commission on Agroecology and Organic Production (CNAPO), the National Commission on Chemical Safety (CONASQ), and the National Environmental Council (CONAMA), among others.

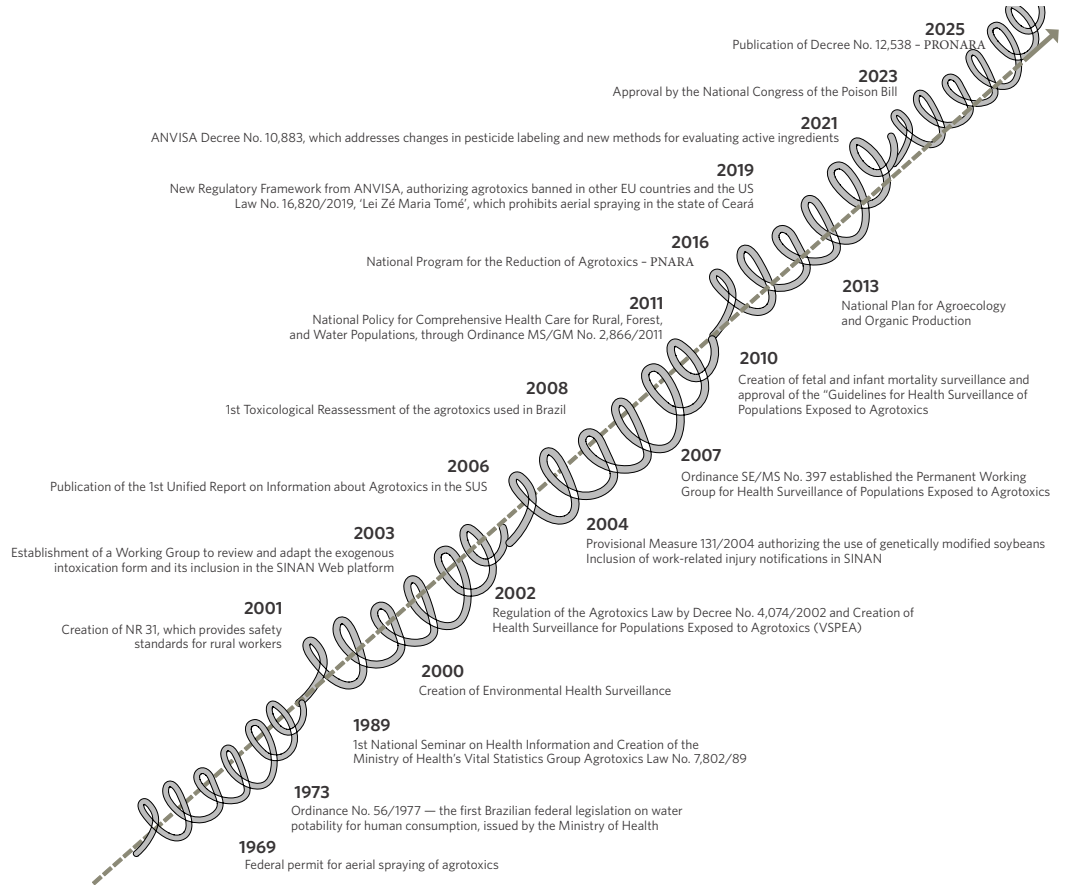
During this period, a process of deregulating the commercialization of agrotoxics began, with the significant increase in numbers explained by legal and sub-legal changes adopted by regulatory bodies such as MAPA and ANVISA. Examples of this were ANVISA's Resolutions RDCs No. 294, 295, and 296/2019[37-39], which repealed SNVS/MS Ordinance No. 3 of 1992 and modified the criteria for toxicological classification, labeling, package inserts, and dietary risk assessment. Measures that have directly or indirectly allowed the use of larger volumes of agrotoxics, either by expanding the crops where they are permitted or by increasing authorized quantities[42], combined with regulatory gaps in occupational and environmental risk assessments introduced by Law No. 14,785/2023 (Poison Package), have worsened the regulatory dismantling[20,34]. The public health emergency brought on by the COVID-19 pandemic justified the issuance of numerous exceptional regulatory measures, such as Presidential Decree No. 10,833/2021[48], of January 8, 2021, which amended Decree No. 4,074/2002[49]—regulating Law No. 7,802/1989[21]—relaxing the restrictions on the registration of the most hazardous agrotoxics in the country[9,34].

Challenges for health surveillance in contexts of exposure to agrotoxics

The institutional legal framework underpinning health surveillance efforts for populations exposed to agrotoxics within the SUS has evolved over time and now incorporates the recent Guidelines of the VSPEA Program. *Figure 1* illustrates a historical overview of the key legal milestones that empower the SUS to engage in both prevention and health care for individuals and communities affected by agrotoxics exposure. This timeline highlights progress as well as setbacks, reflecting fluctuating political and social conditions that impact the consolidation of SUS principles.

Box 1 systematizes the ongoing political and institutional foundations within the SUS framework, identifying its legal and institutional structure as well as the intra- and intersectoral elements that must be considered to support integrated, participatory, and territorial actions in the health surveillance of populations exposed to agrotoxics.

Figure 1. Historical timeline of regulatory acts related to health surveillance of populations exposed to agrotoxics



Source: Own elaboration based on research documents[1,2].

Box 1. Political and institutional foundations of health surveillance in contexts of exposure to agrotoxics

Political-institutional foundations	Description
Principles and Guidelines of the Unified Health System (SUS) – Law No. 8,080/1990[50]	Universal access to health services, comprehensive healthcare, political and administrative decentralization, community participation, etc.
National Policy on Workers' Health (PNSTT) – MS/GM Ordinance No. 1,823/2012[51]	It presents the principles, guidelines, and strategies to be observed by the three levels of SUS management for the development of comprehensive worker health care, with an emphasis on surveillance, aiming to promote and protect workers' health and to reduce morbidity and mortality resulting from development models and production processes
National Subsystem of Environmental Health Surveillance (SINVSA) – 2005[52]	It comprises the set of actions and services provided by public and private agencies and entities related to environmental health surveillance, aiming to understand, detect, or prevent any changes in the determining and conditioning factors of the environment that affect human health, to recommend and adopt measures to promote environmental health, and to prevent and control risk factors related to diseases and other health hazards.
Health Surveillance of Populations Exposed to Agrotoxics (VSPEA) – 2017[53]	Its objective is to enhance quality of life by reducing, controlling, or eliminating health vulnerabilities and risks faced by populations exposed or potentially exposed to agrotoxics through comprehensive measures of prevention, promotion, surveillance, and health care
MS Ordinance No. 2,938/2012[54]	It authorizes the transfer of funds from the National Health Fund to the States and the Federal District Health Funds to strengthen Health Surveillance of Populations Exposed to Agrotoxics

Box 1. Political and institutional foundations of health surveillance in contexts of exposure to agrotoxics

Political-institutional foundations	Description
National Health Surveillance Policy (PNVS) – CNS Resolution No. 588/2018[55]	This is a state public policy and an essential function of the SUS, characterized by universality, cross-sectoral scope, and guidance of the care model within territories, with its management being the sole responsibility of the Public Authority. It defines Health Surveillance as 'the continuous and systematic process of data collection, consolidation, analysis, and dissemination of information on health-related events, intending to plan and implement public health measures, including regulation, intervention, and addressing health determinants and conditions to protect and promote the population's health, and to prevent and control risks, diseases, and other health issues'
National Food and Nutrition Policy (PNAN) – 2013[56]	It aims to improve the food, nutrition, and health conditions of the Brazilian population by promoting adequate and healthy eating habits, food and nutrition surveillance, prevention, and comprehensive care for food and nutrition-related diseases
National Policy on Agroecology and Organic Agriculture (PNAPO) – Decree No. 7,794/2012[57]	It seeks to integrate, coordinate, and align policies, programs, and initiatives that support the agroecological transition and the development of organic and agroecologically based production, contributing to sustainable development and the population's quality of life through the sustainable use of natural resources and the supply and consumption of healthy foods
Health Care Networks in the SUS (RAS) – Ordinance MS/2017[58]	These are organizational arrangements of health actions and services with varying technological complexities, integrated through systems of technical, logistical, and managerial support, aimed at ensuring comprehensive care
National Agrotoxics Reduction Program (Pronara) – Decree No. 12,538/2025[47]	PRONARA seeks to promote the transition to more sustainable agricultural practices—such as agroecology and organic production—through public policies, thereby reducing dependence on the use of agrotoxics. The PRONARA Decree was published in 2025 after nearly a decade of debate

Source: Own elaboration based on ABRASCO and Augusto et al.[1,2].

Based on the analyses and recommendations from the Workshop, structured around the three discussed axes (comprehensiveness, participation, and territoriality), four essential dimensions were systematized: System, Organization, Method, and Evaluation (SOMA). *Box 2* presents proposals that can guide directives toward a more appropriate approach to prevention and care in the living and working territories affected by environmental and consumer hazards related to exposure to agrotoxics.

Box 2. Proposals across the Systemic, Organizational, Methodological, and Evaluative (SOMA) dimensions for the axes of participation, comprehensiveness, and territoriality for health surveillance and care for populations affected by agrotoxics

Dimensions	Participation	Integrality	Territoriality
Sistemic	• Define instruments for reporting, participatory investigations, and risk and/or damage communication • Create effective mechanisms for social participation and oversight in health surveillance actions (registration, water and food monitoring, health surveillance and care, etc.) • Ensure equal conditions for participation as those granted to the private sector	• Approach territories holistically, considering cultural interactions, local production chains, and access to essential resources such as water, food, healthcare services, and basic sanitation • Systematically collect, share, and analyze actions and data from diverse health surveillance domains—including sanitary, epidemiological, environmental, and occupational health—as well as from related sectors such as social security, agriculture, and environmental management	• Seek coordination and structuring of the various health surveillance sectors following the factors influencing the social determinants of health and the organizational dynamics within the affected territories • Integrate actions and information from the different health surveillance areas into healthcare programs across all levels of care, with particular emphasis on Primary Health Care (PHC)

Box 2. Proposals across the Systemic, Organizational, Methodological, and Evaluative (SOMA) dimensions for the axes of participation, comprehensiveness, and territoriality for health surveillance and care for populations affected by agrotoxics

Dimensions	Participation	Integrality	Territoriality
Organizational	• Strengthen, promote, and establish mechanisms for public participation and social oversight, including the representation of territories experiencing conflict • Identify LACENS (Central Public Health Laboratories) and laboratories for analysis. Specialized clinics and complementary examination facilities must be equipped and trained to support necessary investigations when required for clinical support purposes • Develop and implement health policies that include community participation and all of its demands	• Integrate diverse information systems to investigate cases of poisoning, hospitalization, mortality, congenital abnormalities, spontaneous abortions, cancer, and exposure to agrotoxics • Establish a network of agrotoxics laboratories capable of conducting analyses both routinely and in emergencies • Provide accessible information to enable accurate diagnosis and ensure comprehensive reparations for affected territories	• Develop educational and informational content regarding the harms caused by agrotoxics to support interventions at the territorial level • Map relevant institutions—such as health agencies, environmental and agricultural bodies, CERESTs (Reference Center for Workers' Health), and the Public Prosecutor's Office—and their respective responsibilities to provide support to territories and address risk, hazards, and damages
Methodological	• Establish and integrate data consultation and dissemination systems related to agrotoxics, including information on commercialization by crop and municipality, poisoning cases, inspections, contamination, labeling, and food traceability, among others • Strengthen actions across different areas of health surveillance, such as data on agrotoxics sales by crop and municipality, water quality monitoring, and the results of toxicological and environmental studies submitted to regulatory authorities	• Engage in intersectoral collaboration, including popular movements, to develop methodologies that integrate Primary Care with health surveillance actions and information	• Identify affected or at-risk territories to guide health surveillance actions targeting populations exposed to agrotoxics. • Establish data for territorial mapping, including economic activities, location, and characteristics of dwellings, working conditions, and the presence of hazardous agents—physical, chemical, and biological
Evaluative	• Establish mechanisms to verify intrasectoral and intersectoral coordination, as well as social oversight, through open and participatory processes • Develop an inclusive social communication system that takes into account the factors influencing the social health determination in affected territories	• Knowledge of production, labor, consumption, and environmental contamination processes should not be limited to quantitative monitoring. Qualitative data describing exposure patterns and the perception of harm to individual, collective, and environmental health must also be taken into account	• Evaluate the surveillance system for exposed populations and health conditions, emphasizing the identification of the most vulnerable groups, chronic effects, impacts on reproductive health, and psychological disorders through a critical review of how surveillance is conducted in the territories where these populations live and work

Source: Own elaboration based on ABRASCO and Augusto et al.[1,2].

Among the guidelines outlined in the VSPEA, there is a clear intention to carry out intersectoral actions, aiming for an integrated approach to support critical aspects such as food and environmental security, for example, through a network of chemical and toxicological analysis laboratories. However, as discussed in the Workshop, highlighted

in a Technical Note[1], and presented in the ABRASCO/ENSP Dossier[2], the regions with the highest agrotoxic usage in the country correspond to those with the fewest municipalities prioritized for VSPEA actions, the lowest number of agrotoxic poisoning cases reported to SINAN, and the least scientific studies published in academic journals.

The discussion at the Workshop also highlighted that, given the current context of conflicts of interest shaped by the ongoing chemical dependence in agriculture and vector combat, there is a need to expand social participation and oversight in surveillance activities. Since these depend largely on improvements within the SUS and in popular organizations, the importance of the Popular Health Education Policy was emphasized for implementing these surveillance processes.

Contributions and proposals for health surveillance

For effective health surveillance of populations exposed to agrotoxics, different conceptual foundations and an alternative operational model are required, taking into account the scale and magnitude of production, the consumption of these hazardous substances, and the current context in which regulatory practices further amplify these harmful effects.

Scientific evidence is ample concerning the harmful effects of agrotoxics, covering toxicological, pathophysiological, clinical, and epidemiological aspects, along with the socio-environmental vulnerabilities that intensify these impacts. This provides a strong foundation for health surveillance to effectively protect both health and the environments where people live and work. Applying the precautionary principle is essential to prevent exposure and the onset of early health effects.

There is a pressing need for broad discussion on improving infraconstitutional legislation to enhance surveillance and care in response to the harms caused by agrotoxics.

It is necessary to move beyond the term 'exogenous intoxications', as defined by SINAN and VSPEA, to describe the acute, sub-chronic, chronic, and reproductive health harms caused by exposure to agrotoxics. The terms acute and chronic intoxication should be replaced with acute and chronic harm resulting from chemical exposures, thereby improving the diagnosis and reporting of suspected cases.

It is necessary to reformulate SINAN's current instruments for notification, registration, and investigation to better identify those exposed to agrotoxics and the resulting health harms. Furthermore, it should be considered that the Notification/Investigation Form is filled out only when a symptomatic clinical case arises, which generally restricts reporting to acute harm and does not account for exposure situations based on risk and health assessments. These instruments should describe the different modes of exposure and illness among population groups, enabling the establishment of priority planning, without, of course, excluding other exposed and affected individuals. The residence and workplace of the reported case should serve as sentinel sites for detecting other similar cases. This approach would promote active case finding, allowing for collective surveillance of exposed groups.

It is crucial to foster innovative collaboration between states and municipalities, which hold the prerogative to conduct health surveillance of populations exposed to agrotoxics. This involves tailoring broad federal guidelines to the unique characteristics of each territory. For instance, joint technical inspections could be conducted in the most vulnerable areas to gain an on-the-ground understanding of local realities. Such inspections should be coordinated by professionals from multiple government sectors and include active participation from affected communities, their union representatives, and social movements.

The National Household-Based Health Survey (PNSD), along with other nationwide studies, is an important source of data, but currently

provides limited information to assess and characterize contexts of exposure to agrotoxics. Therefore, it is recommended to periodically adapt the survey to broaden the scope of indicators needed for improved health surveillance of exposed populations. For instance, expanding questions related to exposure pathways and potential health effects, including reproductive health, mental health, the nervous system, and other issues commonly found among vulnerable groups exposed to these harmful agents.

It is essential to improve the main secondary databases, enhance their accessibility at regional levels to enable population-based estimates of agrotoxic exposure, infer associated risks and harms, and consequently plan effective prevention and care strategies.

The spraying of agrotoxics over communities has been increasing, not only due to spray drift from agricultural applications but also through intentional actions, resulting in harm to public health, the environment, and the economic livelihoods of those affected. In such contexts, public officials must be trained and empowered to assist in gathering evidence and initiating legal proceedings as a means to seek redress for the damages caused. In cases where social organization is insufficient or where local institutions are weak or resistant to intervention, higher-level government bodies should assume a protective role, necessitating specialized training for public agents to effectively fulfill these responsibilities.

Enhancements to the Agrotoxic Residue Evaluation Program (PARA) are needed, including stricter safety standards, conducting regular assessments, and ensuring public participation (social control). Additionally, the results obtained and the program's implementation process should be widely disclosed.

Broadening the perspective of health surveillance within the SUS, in coordination with community-based health monitoring, is essential to effectively implement preventive strategies in settings affected by exposure. This also demands approaches that enhance the understanding of social inequities and the vulnerabilities and risks inherent to these environments.

It is essential to ensure public access to information systems regarding agrotoxic usage and the crops for which their application is recommended, as well as to provide periodic updates on health harms resulting from exposure. There exists a process of invisibility surrounding the risks and dangers of agrotoxics for society, which hinders research and problem identification. Health surveillance should actively curb advertising and narratives that conceal these risks and dangers, such as claims of 'safe use of agrotoxics', that 'agrotoxics are medicines', or that there is a 'safe dose' below which it is permissible to consume foods and drinks containing agrotoxic residues.

There is a pressing need to expand support for research on health, environment, and labor concerning the harms caused by agrotoxics. The SUS should promote research lines that, beyond focusing on exposure to mixtures of agrotoxics, also consider other related processes such as syndemic, particularly those involving nutrition, endocrine disruption, reproductive health, chronic and psychoneurological effects. These areas remain under-researched, contributing to their invisibility in Brazil's health prevention and health care policies. Adequate funding within the SUS is essential to empower local health services to operate effectively, fostering collaboration across diverse competencies and knowledge within the health sector, other governmental and non-governmental entities, multilateral organizations, civil society, and other stakeholders committed to health and environmental protection.

Conclusions

The approach to health surveillance within the SUS remains vertical and centralized, failing to effectively reduce exposure situations, enable early detection of effects, and provide integrated health care.

Given the serious public health issues resulting from exposure to agrotoxics in Brazil, this essay highlights key concerns regarding their harmful effects on health and underscores the urgent

need for a profound shift in the conception and practice of health surveillance. This shift must recognize its broad scope, which integrates the traditional sanitary and epidemiological surveillance with elements from the National Workers' Health Policy and the National Environmental Surveillance System. It is essential to critically rethink the current model of health surveillance for populations exposed to agrotoxics—still largely limited to reporting acute cases—and to fully implement the guidelines set forth by the SUS and the VSPEA, emphasizing territoriality, integration, and participation.

To accomplish this, it is crucial to transcend the prevailing dose-response or cause-and-effect paradigm in public health; to embrace a critical approach that considers the full context of individuals' lives and work in the development of illnesses; to prioritize the precautionary principle alongside the presumption of risk and harm; to democratize access to information systems; to strengthen the technical capacity of health services across all levels of SUS; and to promote meaningful dialogue with affected communities, empowering them to actively engage in health surveillance through their lived experiences and knowledge.

Acknowledgments

We extend our gratitude to the participants of the workshop 'Reproductive Health and Agrotoxics' held at the 9th Brazilian Symposium on Sanitary Surveillance – SIMBRAVISA (João Pessoa-PB, November 20–24, 2023), the authors of the dossier 'Harmful Effects of Agrotoxics on Reproductive Health', the research groups' investigators, and those who contributed to the preparation of the figure and the review of this essay, especially Mariana Rosa Soares and Marcus Vinícius Corrêa dos Santos.

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Received on 06/14/2025
Approved on 07/16/2025
Conflict of interest: Non-existent
Data availability: Research data are contained in the manuscript itself
Financial support: Center for Reproductive Rights (CDR) – Bogotá, Colombia; ABRASCO; ENSP/FIOCRUZ; Intersectional Network on Reproductive Health and Agrotoxics

Editor in charge: Maria Juliana Moura Corrêa