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Subjective production of exposure to agrochemicals. A scoping review

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Abstract *The intensification of agriculture in countries of the Southern Cone of Latin America has led to a significant rise in the use of agrochemicals. Scientific output in the field of health has concentrated on the epidemiological aspects of this issue and studies addressing the social dimensions of exposure to these substances remain scarce. The aim of this scoping review was to assess the scientific literature on the subjective production of groups exposed to agrochemicals. To this end, searches were conducted of the Scopus, PubMed, BVS, SciELO, and DOAJ databases for articles published between 1991 and 2016. A complementary search strategy drawing on references to other studies in the selected articles was also adopted. The findings show that the studies give subjective production different names and that the predominant themes covered by the literature were risk perception and health beliefs. With regard to understanding-explaining the subjective production process, a series of articles focused on individual lifestyles, while another group considered collective ways of life. The wide-ranging findings suggest that this area is a field of study in dispute, where positivist and functionalist approaches converge with historically situated studies that adopt a critical perspective.*

Key words *Social perception, Pesticide, Review*

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Introduction

The advance of technology and chemical-dependent agriculture has led to a growing body of research directed at generating knowledge to mitigate or transform its various effects. Environmental, agricultural, and epidemiological studies have revealed the limitations of this production model and the need to develop strategies that give precedence to public health. The countries of the Southern Cone of Latin America have witnessed a deepening and expansion of the agricultural frontier coupled with a marked increase in the use of agrochemicals[1-3]. The application of the herbicide glyphosate in Argentina for example increased by 1,400% between 1996 and 2006[4], while the amount of glyphosate applied to agricultural crops in Brazil rose from 57,600 tons in 2003 to 300,000 tons in 2009[5]. In Uruguay and Paraguay, on the other hand, imports of agrochemicals increased from 7,000 tons in 2002 to 24,000 in 2015 and from 9,000 tons in 2009 to 31,000 tons in 2015, respectively[6,7]. Part of these increases is linked to the application of technological packages to extensively cultivated crops, including direct drilling, the use of genetically-modified seeds, and chemical fallow[2,8].

These changes in agricultural practices have led to a large rise in the number of groups and communities exposed to these chemical substances and heightening concerns, denunciations, and fears regarding the health effects of agrochemical use. Publications addressing the links between agrochemicals and a range of health impacts have tended to concentrate on the epidemiological dimensions of the problem and are limited to works on the psychological and social aspects of exposure to these substances. The present study therefore explores this gap in scientific output, identifying articles addressing the subjective dimensions of exposure to agrochemicals published over the last 25 years. To capture the full scope of studies in the field of social sciences and health, a literature search of electronic databases was conducted guided by the following questions: what are the main features of the studies?; what conceptual categories do they use to define the subjective production of individuals or groups?; and to what extent do the studies consider the structural, collective and singular conditioning factors influencing the creation of meaning?

The establishment of an a priori definition of subjective production for the purposes of the literature search and terms used is a complex and difficult task. This complexity stems from the diversity of epistemological and ontological outlooks developed to conceptualize the mediation processes played out between groups and social facts[9]. This mediation confronts what Samaja[10] calls "ontological dispute", where three categorial repertoires represent, understand, and/or explain health situations in different ways: a) those who conceive these situations as entities and study the phenomena of naturalization; b) those who focus on social interactions and resort to comprehensive methods; and c) those framed in discursive constructions who attempt to elucidate the effects of truth. In keeping with the above, in her discussion of the lines of thought pursued by the social sciences within the field of health, Minayo[11] observes four ways of thinking that delineate particular objects, theories, and methods: sociological positivism, comprehensive theories, Marxism, and systemic thinking. Although different planes of analysis, both authors acknowledge the complexity of social studies within the field of health and the need to subscribe to a certain categorial repertoire.

Based on these considerations, for the purposes of this study subjective production is understood as the creation of meaning by individuals, groups or populations. These creations of meaning correspond to the imaginary processes of subjects and their representational abilities in the symbolic plane[12-14]. Moreover, they refer to individuals, groups, or populations in so much as subjective production is eminently cultural and conditioned by events, encounters, and experiences shared by subjects in their social life[15,16]. This definition therefore captures studies that address subjective creations in a broad sense and incorporates the different repertoires and theoretical traditions to which they are inscribed[10,11], while excluding a series of works addressing the cognitive and behavioral aspects of exposure to agrochemicals. Without doubt, subjective production is a facet of a subject's behavior and knowledge; however, this distinction attempts to capture the affective and imaginary elements of collective creations of meaning[14,15].

Having delineated our understanding of subjective production, it is appropriate to discuss the definition of agrochemicals given that a variety of terms have been used to describe them. This is a rather controversial issue among those who emphasize the agricultural benefits of these substances -pesticides, phytosanitary products- and those who define them according to their environmental and health effects -agrochemicals,

agrotoxics-[17]. Despite this controversy, the Food and Agriculture Organization of the United Nations (FAO) adopts the generic term pesticides, classifying them according to their function: insecticides, fungicides, herbicides, defoliants, bactericides, and raticides[17,18]. For the purposes of this study the term agrochemicals will be used. While the toxicological effects of agrochemicals in humans and the environment are widely recognized, the toxicity of these substances depends on their conditions of use[19]. In this respect, conditions of use are closely linked to the dominant production model, which determines the toxicity and public health risks of agrochemicals[20].

This article presents a review of the literature on the subjective production of subjects and groups exposed to agrochemicals. Since the subjective approach is underpinned by an ontological and epistemological dispute[10,11], the study recognizes the different theoretical frames of reference used to conceptualize the production of subjectivity: the imaginary, perceptions, social representations, beliefs, etc. The study also aimed to gain insight into the way that subjective production of agrochemicals is understood-explained and to what extent its structural, collective and/or individual determinants are considered[21]. The elucidation of these aspects is intended to collaborate with more specific reviews and the promotion of empirical studies that depart from accumulated academic knowledge on this topic.

Method

A scoping review was conducted to respond the questions posed above, a method which allows mapping of a diversity of relevant literature and the identification of a wide range of study approaches[22,23]. Data sources centered on two areas: electronic versions of scientific articles available on different databases; and references to other studies in the selected articles. The following databases were searched: Scopus, PubMed, BVS, SciELO, and DOAJ. The searches were conducted between June 2015 and July 2016 and limited to articles published since 1991. This temporal limit was justified by the fact that 1991 was the year in which the International Agency for Research on Cancer (IARC- WHO) published its first monograph on the evaluation of carcinogenic risks to humans entitled Occupational Exposures in Insecticide Application, and Some Pesticides[24]. While previous studies had already addressed the dangers of agrochemicals, this report was the first to establish international parameters for assessing the acute health effects of these substances, and led to a sharp rise in studies investigating the link between agrochemicals and cancer[25] and other illnesses[26]. No specific criteria were set with respect to geographic limits since although the use of these substances is particularly intensive in periphery countries, their application constitutes a global process[1-3].

The databases were searched using a combination of free search terms and descriptors based on the guiding questions: subjective production and exposure to agrochemicals. For *subjective production* the following terms were used in Spanish and English: *representaciones* (representations), *representaciones sociales* (social representations), *creencias* (beliefs), *construcción social* (social construction), *imaginario social* (social imaginary), *producciones subjetivas* (subjective productions), *percepción social* (social perceptions) (DeCS); and *belief* (MeSH). The descriptors were combined with the semantic field *exposure* using the logical operator AND together with the following descriptors: *exposición a plaguicidas* (exposure to pesticides), *riesgos* (risks), *riesgo sanitario* (sanitary risk), *riesgo para la salud* (health risk), *vulnerabilidad* (vulnerability). Finally, terms linked to subjective production and exposure were also connected using the operator AND together with the different terms used to refer to agrochemicals: *agrotóxicos* (agrotoxics), *productos agroquímicos* (agrochemical products), *agroquímicos* (agrochemicals), *plaguicidas* (pesticides), *uso de plaguicidas* (use of pesticides), *pesticidas* (pesticides), *herbicidas* (herbicides), and *productos fitosanitarios* (phytosanitary products) . When this triple combination of descriptors and free terms did not yield results, all terms related to subjective production and agrochemicals were directly combined.

The searches using this combination of free terms and descriptors resulted in a total of 514 articles (PubMed 305, Scopus 83, BVS 78, DOAJ 31, and SciELO 17). The complementary search strategy drawing on references to other studies in the selected articles resulted in an additional 108 works. Inclusion and exclusion criteria were applied to determine the final study selection. Inclusion criteria were empirical studies published between 1991 and 2016 addressing subjective production of occupational or environmental exposure to agrochemicals. Exclusion criteria were: a) studies about direct exposure to agrochemicals and their health effects; b) studies

about the evaluation of social knowledge concerning agrochemical use and management; and c) studies about the assessment of the environmental effects of agrochemical use. The review of articles for study inclusion resulted in a final study selection of 40 articles, 29 of which from the databases and 11 resulting from the complementary strategy. The article selection process is detailed in Figure 1. The data extracted from the final study selection was collated into a table and subjected to thematic analysis[10]. The following section details the results and is followed by a discussion of the main findings.

Results

The final study selection comprised 40 articles representing a wide range of research both in terms of disciplines and theoretical approach and backgrounds, study population, and types of production. Within this range, it is possible to identify common trends and characteristics in the topics, study objects, and approaches adopted to explain phenomena and processes. The main features of the selected articles are outlined below.

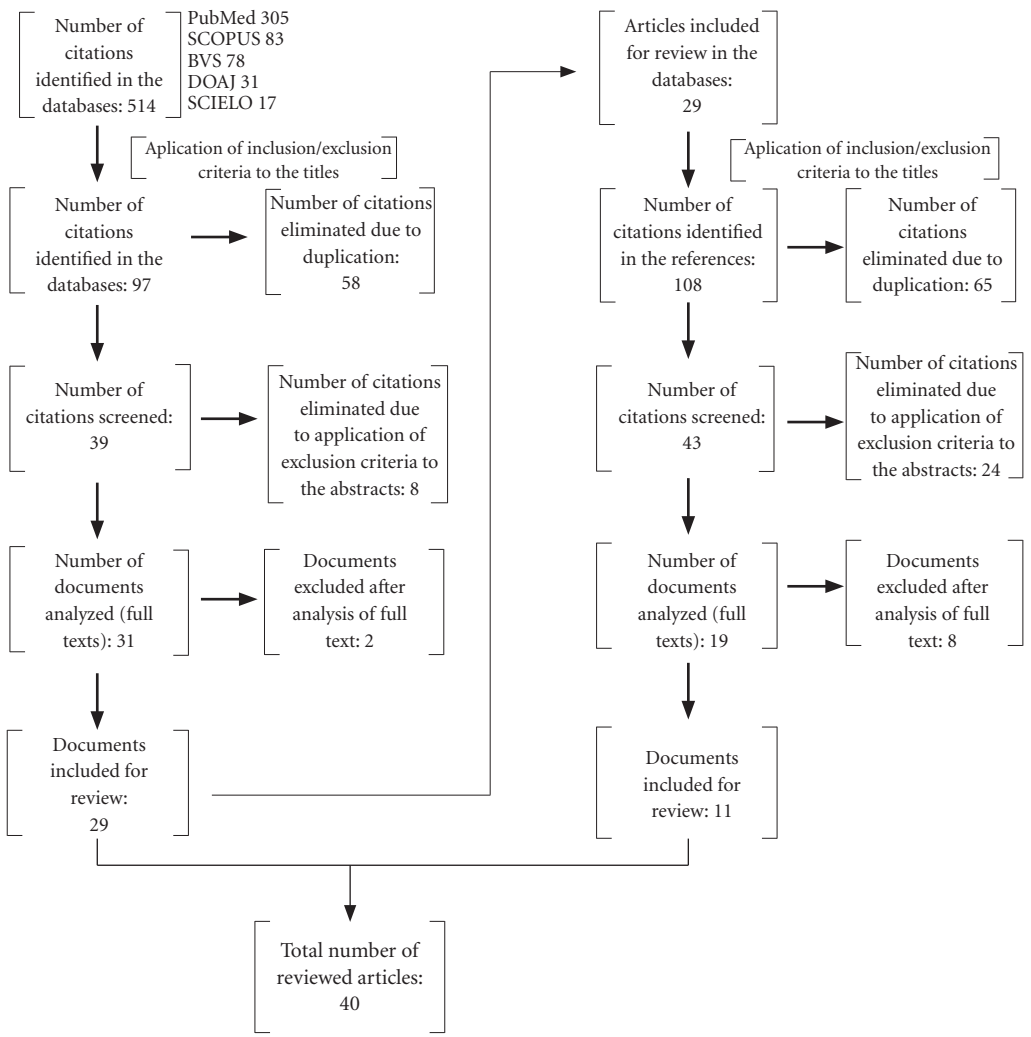

Figure 1. Flow diagram of the literature search. Author's elaboration based on Martinovich.

Source: V. Martinovich [personal communication]. PhD in Public Health. UNLa, Argentina. April 17, 2015

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The first aspect relates to the history of research into the subjective elements of exposure to agrochemicals and the characteristics of scientific output over time. The first studies on this topic emerged in the 1990s, focusing on agricultural workers, farmers and their families. Research approaches do not partake in the same theoretical traditions and the conceptual depth of the studies is by no means homogenous. One of the works is based on risk perception studies[27], while others focus on beliefs without providing a precise definition of the concept[28,29]. Research in this field became more dynamic in the twenty-first century, and 2005 saw a sharp rise in the number of publications. Research was carried out in a variety of countries, but principally in Latin America, where 20 studies were produced, 10 of which in Brazil. A total of 12 studies were undertaken in North America, all of which in the United States, while Europe, Asia, and Africa accounted for four, three, and one study, respectively. Study populations varied, but were predominantly actors directly involved in agricultural production at different scales and involving different production models: poor farmers[30]; family farmer[31]; farmers[32-43]; indigenous communities[44,45]; and farm workers, where studies investigated the subjective dimensions of exposure to agrochemicals[27,28,46-55]. It is interesting to note that the majority of studies involving the latter group were undertaken in North America and involved immigrant farm workers, principally Latin Americans[27,28,46,48,51,52,54,55]. A number of studies investigate a combination of study populations, either to compare results or describe the particular subjective productions of each group[29,56-66], including farm workers' families, housewives, health professionals, extensionists, agricultural settlers, urban populations, experts, and officials. Overall, the studies cover a wide range of types of production, from extensive farming to small plot and greenhouse-based intensive agriculture. In short, in general terms, studies involving farmers, farm workers, and a combination of different study populations were predominant.

With respect to research approach, studies can be classified according to the type of research process used: qualitative, quantitative, or mixed[67]. Studies were primarily qualitative in nature estudios[28,31-36,38,41,47-51,55,56,60,63-66], followed by quantitative studies[27,30,37,39,40,42-46,54,57,58], with mixed methods research accounting for only a small proportion of the total number of studies[29,52,53,59,61,62]. An analysis of the selected articles by country and research approach shows that studies from core countries used predominantly quantitative approaches, while those from periphery countries tended to adopt qualitative research designs.

Conceptualizations surrounding the subjective production of risk

The findings show that the object of study has been given various names over the two decades of research into the subjective production of exposure to agrochemicals. Some studies provide a precise definition of the term used, while others fail to define the psychosocial category, using different terminologies and paying little attention to conceptual precision. The dominant theme in the literature was *perception and social perception* of exposure to and/or risks associated with agrochemicals[27,31,31,35,36,38-44,49-53,56,58-62,65,66]. Another group of studies addressed *beliefs* about these chemical substances and human health[28,29,33,34,51,54,55], using the Health Belief Model to study this field of problems. Some articles studied both beliefs and perceptions[30,33], while other isolated works investigated *social representations*[37], *meanings and significations*[45,63], and *perceived psychosocial factors*[46] linked to exposure to or use of agrochemicals.

Precise terms are anchored in theoretical developments in the area and/or studies that provide an empirical framework for the research. Frames of reference used by studies exploring the social perception of risk included the theoretical developments made by M. Douglas[27,31,38,44,50]. Other studies drew on a variety of theories and models related to risk perception: Theory of Social Knowledge[39], the social construction of scale[65], Schoell and Binder's structured mental model approach[61], and conceptual developments made by Jansen[59,60], Widemann[36], and Sjöberg[56]. The studies investigating beliefs about agrochemicals show a certain degree of homogeneity, with the majority drawing on the Health Belief Model mentioned above[33,34,51,54,55]. Finally, isolated works used the Cultural Consensus Theory[63], an ecological framework[48], and the theory of social representations developed by Serge Moscovici[37].

A number of articles falling within the area of risk perception[30,32,35,41,43,47,58,62,65,66] are based on empirical studies and do not present a theoretical conceptualization of the conceptual category they use. Notable studies in this respect include work conducted by the National School of Public Health at the Oswaldo Cruz Foundation in Río de Janeiro, Brazil, where F. Peres and other academics have developed a specific line of research

focusing on exposure to agrochemicals[32,35,36,47,50]. In the United States, a team headed by T. Arcury and S. Quandt at the Wake Forest University School of Medicine in North Carolina has developed a number of studies in this area that have served as a point of reference for other investigations[28,30,54,55,66]. On a smaller scale, but with a relatively significant presence in Central America, the Technology and Agrarian Development Group at Wageningen University in the Netherlands has developed a series of joint studies with research teams from Mexico and Costa Rica[59,60].

Finally, as mentioned above, another group of studies neither conceptualize the conceptual category used to refer to the subjective, nor make empirical references that clearly define the object of study: perceived social factors, myths, perceived causality, meanings, risk perception, significations[34,40,42,45,46,53,57,64]. These are neither pioneering studies, nor do they resort to grounded theory, but rather depart from an understanding of the theoretical category in question, despite the range of approaches that converge in this field of problems. In certain cases, this lack of conceptual clarity was due to the fact that perceptions and meanings associated with agrochemicals were not the main focus of the study[34,38,40]. Although not a dominant trend in the selected articles, it is important to emphasize these articles given that they account for a significant portion of the total.

In short and bearing in mind the multiple conceptual frameworks adopted by the studies, this review shows the main frames of reference and certain academic groups who conduct research in this area. The most notable frames of references were the social and cultural construction of risk[68], developed by M. Douglas, and the Health Belief Model, a behavioral approach to understanding people's health perceptions[69]. The findings also show that several research teams have been working on this theme throughout the world for around ten years, with varying degrees of connection. The discussion of the findings below analyzes the conditioning factors influencing these processes of knowledge production and the challenges faced by social research in this field of study.

Dimensions of understanding-explaining the phenomenon under study

As mentioned above, exposure to agrochemicals may be analyzed from three dimensions that enable the problem to be understood at different levels of complexity. These dimensions refer to the singular aspects of lifestyles, particular collective ways of life and general aspects of economic-production logic[21]. There is a certain degree of parity between the studies that deal solely with the lifestyles of subjects and gr oups[28-30,33,34,39-41,45,50,55,57,62,63,66] and those that address one or more aspects of collective ways of life[27,31,32,35,37,43-46,51-54,56,58,59,61]. Those studies that include all three analysis dimensions account for a smaller proportion than the first two[36,38,45,47-49,60,61].

The studies that explain perceptions, beliefs or representations solely through lifestyles are fundamentally descriptive and are limited to the specificities of the individuals, groups and communities studied; while those exploring ways of life address multiple variables and categories that allow certain recurrences to be identified. The studies that refer to collective ways of life tend to describe between one and three conditioning factors influencing the production of subjects regarding agrochemicals. The most mentioned factors include the relation between subjective production and education of the study groups, both in terms of level of education and training in the use of agrochemicals[32,44,54,56,58,59,61]. Other collective conditioning factors include the labor process and organization of work[43,46,50,51], followed by geneder[31,43,58], ethnic background[27,43,52], the direct production context[35,37,61], age[53,58], and subsistence needs[50].

Finally, the production of knowledge that makes up the three analysis dimensions encompasses different processes ranging from individual or collective lifestyles to the economic, social, and political logic involved in the use of agrochemicals. In this respect, one of the studies links past histories of poisoning of subjects with the location of housing on farms and the environmental toxicity of the chemicals used[47], while another associates the process of blaming workers with collective defensive strategies and the role played by the agrochemical industry in these processes[36]. Gasparini and Freitas[38] articulate the pragmatic use of these products with gender constructions and policies that promote technology-dependent farming. Although this type of study was not predominant, these studies show that it is possible to study this topic using an approach that integrates dimensions and levels.

The various studies that consider lifestyles and collective ways of life differ in terms of their origin, methodology, and study population. However, those that encompass all three analysis dimensions have two common features: a) they were conducted predominantly in Latin Ameri-

ca (except for two studies undertaken in Canada[65] and the United States[48]); and b) they adopt a qualitative research approach.

Chart 1 presents a descriptive summary of the key features of the selected articles.

Discussion

It is interesting to focus first of all on those studies that only describe subjective production and its association with the singular lifestyles of subjects[28-30,33,34,39-41,45,50,55,57,62,66], without critically interpreting these processes and their multiple conditioning factors. This element observed in the articles seems to correspond to the contemplation-transformation contradiction[70], that permeates scientific discourses and research practices in different ways. This contradiction demonstrates the role of science as a primary productive force in the reproduction of the instituted system and/or its functionality for the transformation of situations and contexts[71]. For highly socially sensitive topics such as agricultural production and the use of agrochemicals, the difference between contemplate or interpret in a critical sense creates abysmal gaps in knowledge production. This is a concern not only due to the effect of this knowledge production on the preservation of the health of groups and communities, but also because it is essential to gain a clear insight into this issue to effectively tackle the negative effects of agrochemicals. The articles that embrace the different dimensions of understanding-explaining the problem[36,38,45,47-49,60,61] allow the implementation of preventive practices that address the singular aspects of lifestyles, particular collective ways of life, and general aspects of the dominant production system to be considered necessary[21].

A second element that warrants reflection is the imprecise way in which the articles conceptualize the subjective, either because they allude to the conceptual category through previous empirical studies[30,32,35,41,43,47,58,62,65,66], or due to the complete absence of a theoretical definition[34,40,42,45,46,53,57,64]. In this respect, a positivist tendency can be observed in the articles, in as much as they address social and subjective elements as if they were natural, essential, and easily objectifiable phenomena[11]. If we consider the notion of *ontological dispute* outlined in the introduction[10], this positivist tendency threatens, to a certain extent, the advance of critical and holistic theories in the sphere of public health and the complexities entailed in all aspects of the production of subjectivity. By reducing the subjective to a natural fact, the collective and historical elements of the creations of subjects are denied[13,16] and therefore the conditions of production and multiple levels and dimensions that make up the subjective fail to be taken into account. The theoretical devices adopted shed light on and enunciate certain things, but fail to capture others[72], meaning that findings tend to be partial or fail to explain the issues involved in the subjective production of exposure to agrochemicals in their entirety.

Chart 1. Key features of the selected articles. Author's elaboration.

Dimensions of scientific productions	Key features
Study population	Farmers Farm workers Rural population
Research approaches	Qualitative Quantitative
Country of origin	United States Brazil
Reference research teams	Wake Forest University School of Medicine, North Carolina (US) National School of Public Health - FIOCRUZ (Brazil) Technology and Agrarian Development Group - Wageningen University (Netherlands)
Theoretical category used to refer to the subjective	Risk perception Health beliefs Undefined
Dimensions of understanding-explaining the problem	Individual lifestyles Collective ways of life

A final element of the review that requires problematization is the exponential growth in the publication of studies in the first decade of the 21st century and the concentration of studies in the United States and Brazil. In this respect, Minayo[73] asserts that economic and social transformations affect both internal processes within science and the conditions for its development. The externalities of science, primarily changes in production and the world of work, influence ways of producing knowledge and the institutional conditions under which it is produced. Thus, the advance of agribusiness as a production model[2,8] and the regionalities formed in different parts of the world at the beginning of the twenty-first century[74] may explain the increase in publications on this topic over the last 15 years. Although study approaches and aims may be different (modify agricultural practices, create environmental and health monitoring programs, and the development of palliative measures), knowledge production is situated and seeks to address a production model for which clear health alternatives do not yet exist. Assessing how studies of subjective production have collaborated in the search for alternatives to the exposure to agrochemicals is an area that warrants further research in the form of literature reviews and empirical studies.

Final considerations

The findings of this literature review reveal a heterogeneous field of studies adopting a variety of theoretical perspectives and analytical approaches. This diversity results from the wide range of positions on this issue anchored in different traditions shaping the study of population health. In face of the advance of chemical-dependent mechanized agriculture and the weakening of policies to control its health effects[75], it is necessary to review the contribution of social research to this issue. To this end, it seems appropriate to start to link the growing body of critical research into the social dimensions of exposure to agrochemicals to the design of singular, collective, and structural preventive strategies directed at public health. As this type of research is still emergent in a field dominated by the chemical-dependent model of agricultural production, the contribution of this area of knowledge remains limited, meaning that it is difficult to associate it with concrete health programs. Therefore, connecting different critical perspectives and guiding and enhancing knowledge production seems to be one of the main challenges in this field of study.

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