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Invisibility or invisibilization of the chronic effects of pesticides on health? Challenges to science and public policy

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"No more new cases of cancer causing suffering and killing every day!
No more children born without limbs, or with heart and kidney problems!
No more children entering puberty with two or four years old."
(Movimento 21 – Manifest of April 21st 2015)

It emerges from territories affected by the expansion of the agricultural frontier in Brazil the perception of increasing cases of cancer and other chronic diseases among those who work and live in these areas and that they are related to the intensive use of pesticides. Similar complaints are made public by social movements such as those that are part of the Permanent Campaign against Pesticides and for Life[1], questioning the development model imposed to the country, its impact on health and the protection of rights by public policies.

Indeed, in the landmarks of the reprimarization of the economy and the intensification of the production of agricultural (and mineral) commodities in the global south, Brazil has been rising sharply the consumption of agrochemicals in the last two decades, reaching in 2008 the first place in the global ranking and has since remained in the lead of this expanding market, through which circulates around one million liters of pesticides, producing about 11.5 billion dollars in the country per year (Valor Econômico, 2013). Broad and diverse segments of the population, including workers, rural and urban residents and food consumers, are exposed to this risk, although in different contexts. Chronic toxicity of many active ingredients of pesticides,

1 See www.contraosagrotoxicos.org/.

in turn, is well established in the scientific literature, despite the many challenges related to this field. As we will see in this text, toxicological, clinical and epidemiological studies suggest associations between exposure to pesticides and different chronic effects of these biocides, such as endocrine disorders; effects on reproduction; immunological changes, which result in cancers; congenital malformations; neurological, liver, and kidney diseases; etc. Government agencies such as the Environmental Protection Agency, from the United States, and the International Agency for Research on Cancer also recognize these correlations.

However, if a few steps were taken in the health information systems of the country, in order to approach a little more the epidemiological scenario to the acute poisoning caused by pesticides, still is enormous the unawareness about the sickness and death profile related to chronic effects. How many of the 576,000 new cases of cancer estimated by the Brazilian Cancer Institute for the year 2014, for example, are associated with pesticides? To what extent active ingredients that act as endocrine disruptors influence the increasingly numerous cases of precocious puberty? What about birth defects? These questions are not answered satisfactorily, leaving these diseases in a gray zone of invisibility in the scientific and social fields.

In fact, the risk characterization – that has plenty evidences about pesticides – already indicates the probability of damage and it would not be necessary to prove the occurrence of injuries to trigger public policies to promote and protect health. We have, however, a scenario of scientific controversy, permeated by conflicts of interest and strong and powerful economic interests that actively focus on the State and its public policies. In the public sphere, the invisibility of the probable health problems related to pesticides compromises the debate and critical evaluation of the current development model: as to the silence of what is hidden, one diffuses the idea of success of the development model based on the supposed modernization of agriculture, providing feedback and legitimizing the perverse cycle of its expansion.

So in this text, we will talk about some issues that contribute to understand the social construction of invisibility of the chronic effects of the exposure to pesticides: to what extent cancers and endocrine deregulation relate to pesticides, according to scientific evidence? What are the implications of the episteme and the method of modern science in the assessment of risks related to pesticides? Who and how is exposed to pesticides in Brazil? How the political dispute by the State reflects in the performance of public policies related to the problem? What perspectives for tackling the problem can be considered?

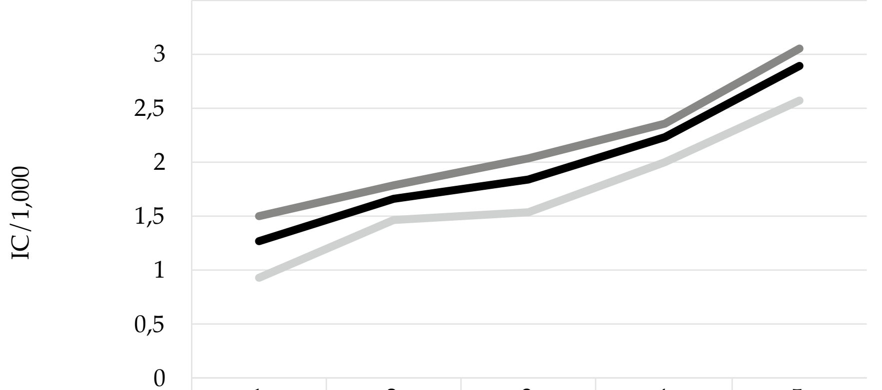
Diseases related to pesticides: a little of what we know

According to the Pan American Health Organization (OPAS, 1996), pesticides, after absorbed by the digestive, respiratory and/or dermal system, can trigger various effects on human health, of acute, subacute or chronic nature:

- Acute – symptoms appear quickly, a few hours after exposure, for a short period, to extreme or highly toxic products. It may be mild, moderate or severe, depending on the amount of absorbed poison. Signs and symptoms vary according to the active ingredient(s) (AI) and are clear and objectives, such as weakness, vomiting, nausea, convulsions, muscle contraction, headache, dyspnea, epistaxis, fainting;
- Subacute – occurs because of moderate or little exposure to high or moderately toxic products and has a slower onset. The symptoms are subjective and vague, such as headache, weakness, malaise, epigastric pain and drowsiness, among others;
- Chronic – is characterized by a delayed onset after months or years, due to small or moderate exposure to one or multiple products, resulting in irreversible damage, such as paralysis, cancer, kidney and liver damage, delayed neurotoxic effects, chromosomal changes, teratogenesis, endocrine deregulation, etc. In many cases, they may even be confused with other disorders or simply never be related to the causative agent.

Although underdiagnosis and underreporting of acute poisoning are recognized as relevant, between 2007 and 2011, according to data from the Notifiable Diseases Information System (SINAN), there was a rise by 67.4% of new cases of non-fatal occupational accidents due to pesticides, and the coefficient of intoxication increased by 126.8%, higher among women (178%) (UFBA, 2012), as can be seen in Graph 1.

Graph 1. Incidence coefficient of occupational accidents by pesticide poisoning in agricultural workers (IC/1,000) – Brazil, 2007-2011



	1	2	3	4	5
Women	0,92	1,46	1,53	1,99	2,56
Men	1,49	1,78	2,03	2,36	3,05
Total	1,27	1,66	1,84	2,22	2,88

Source: SINAN/MS, 2011; IBGE, 2006; UFBA, 2012.

An example of acute poisoning is the serious accident involving aerial spraying of pesticides, happened in 2013, in Rio Verde (in the state of Goiás), which produced acute intoxication in dozens of children, teachers and school staff and possibly also will cause chronic effects (Búrigo et al., 2015).

When we look back on the cases of diseases related to chronic effects of pesticides, the difficulties of obtaining reliable data are extended. Such effects can affect, for example, the nervous system, causing from neurobehavioral changes to encephalopathy or suicide; the respiratory system, causing asthma to pulmonary fibrosis; or chronic toxic hepatopathy. Further changes are described in human reproduction, as male infertility, miscarriage, birth defects, premature birth and low birth weight in babies, associated with the effects of endocrine and immunogenetic disrupting of some active ingredients (Fernández; Olmos; Olea, 2007; Grisolia, 2005; Koifman; Hatagima, 2003; Koifman; Mansour, 2004; Levigard; Rozemberg, 2004; Matos; Santana; Nobre, 2002; Meyer, 2002; Meyer et al., 2003; Peres; Moreira; Dubois, 2003; Queiroz; Waissmann, 2006).

An emblematic case demonstrating the serious repercussions triggered by chronic exposure to pesticides was the death of a agribusiness worker in Ceará, who served for three years in the chemical warehouse of the company, the function of preparing a toxic mixture sprayed on crops and developed a chronic liver disease and died probably induced by toxic substances[2] (Rigotto; Lima, 2008).

From this wide range of chronic diseases involved with exposure to pesticides, this text will focus on two prevalent changes in world population: malignant neoplasms (cancers) and endocrine deregulation.

Cancer and pesticides

> "Cancer is killing
> A lot of people every month
> There is nothing left to do
> Only Jesus that is the king of Kings
> What incompetent politicians
> See and pretends not to see.
> (Fátima, 2014)

Acting on the human organism, pesticides have the potential to trigger direct cellular damage or prevent the suppression system of genetic

2 "Reaffirming the ruling of first instance, the Regional Labor Court (TRT) held yesterday a decision condemning the multinational Delmonte Fresh Produce by the death of rural worker Vanderlei Matos, contaminated by chronic exposure to pesticides in the Chapada do Apodi in Limoeiro do Norte. The company, which had filed appeal, will have to pay compensation for moral and material damages, as well as labor amounts to Mary Gerlene Silva Matos, widow of Vanderlei [...]. According to Cláudio Silva Filho, Vanderlei's family lawyer, the judgment of the company in this process is an unprecedented event in Ceará and rare in the country. 'In the face of all the scientific evidence, both from the University as the Public Prosecutor's Office expertise, there is no doubt the death was caused by exposure to the poison. This decision of the TRT is inspiring for the treatment of this issue throughout the country', believes Filho" (Júnior, 2014).

mutations of organisms to interrupt a chain of altered reactions, which might be the starting point for the development of various types of cancer (Grisolia, 2005).

Curvo et al. (2012) summarize in Table 1 a systematic review of the active ingredients described as carcinogenic in scientific literature.

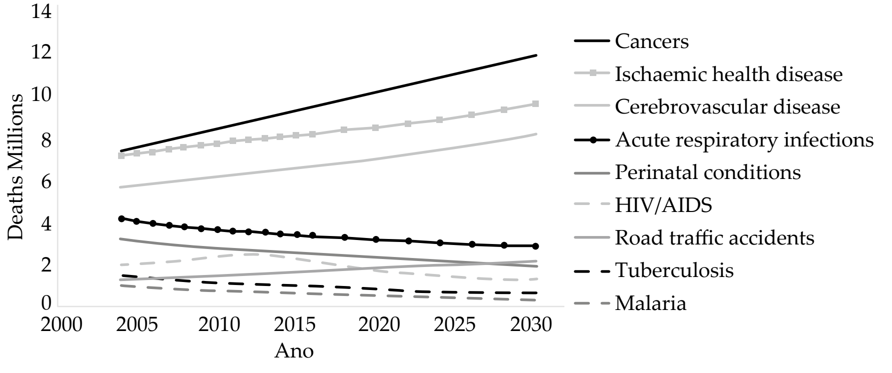
Table 1. Active ingredients of pesticides described as carcinogenic in scientific literature

Active ingredient	Class	Studies
Glyphosate	H	El-Mofty; Sakr, 1988; Monroy et al., 2005; Cox, 2004; Clapp, 2007
Endosulfan	I	L'vova, 1984; Anvisa, 2009; Nunes; Tajara,1998; Reuber, 1981
2,4-D	H	Matos et al., 2002; Miligi et al., 2006; Sulik et al.,1998; Hayes et al., 1995
Tebuconazole	F	Sergent et al., 2009; Usepa, 2006
Lactofem	H	Buttler ET al.,1988
Haloxyfop-P-methyl	H	IARC, 1972, 1987
Diuron	H	Ferrucio et al.,2010; Nascimento et al., 2009
S-metolachlor	H	WHO, 1996; Leet et al., 1996; Grisolia, 2005
Monosodium methyl arsenate – MSMA	H	Matanosk et al., 1976; Chen et al., 1992; IARC, 1980
Imidacloprid	I	Harris et al., 2010
Thiodicarb	I	USEPA, 2006; Hayes; Laws, 1991
Diafenthiuron	I	Wangenheim; Bolcsfoldi, 1988
Carbofuran	I	Bonner et al., 2005; Hour et al., 1988; Barri et al., 2011
Thiamethoxam	I	Grenn et al., 2005; Pastoor et al., 2005

Note: H – Herbicide; I – Insecticide; F – Fungicide.
Source: Curvo et al., 2012 (adapted).

According to the International Agency for Research on Cancer (IARC), in 2012 were recorded worldwide 14.1 million new cases and 8.2 million deaths by cancer (Ferlay et al., 2013). Projections by the WHO indicate cancer as the cause of death that will increase the most until the year 2030. Graph 2 compares the evolution of the causes of death, according to the year (2004-2030).

Graph 2. Projections of deaths worldwide by selected causes, 2004-2030



Source: WHO, 2004.

With this growth, the WHO estimates that by 2020 cancer will be the leading cause of mortality worldwide, accounting for 16 million new cases, and 70% of deaths caused by cancer will be located in countries from the global south. According to the institution, such an increase is related to factors such as population aging, new diagnostic and tracking techniques, obesity, smoking and alcohol, sedentary lifestyle, environmental, carcinogenic and genetic factors (WHO, 2008). For Brazil, the National Cancer Institute (Brazil, 2014) estimated 576,000 new cases of cancer for the year 2014. We could ask to what extent pesticides are adequately considered among these "environmental factors", and if was also taken into account all the international context of expanding the production of agricultural commodities, especially in the global south, guided by chemical-dependent model of the "green revolution"and agricultural modernization.

On the weight of the contribution of genetic and environmental factors in the genesis of cancer, an epidemiological cohort study by Lichtenstein et al. (2000) evaluated 44,788 pairs of twins in three countries (Sweden, Denmark and Finland) and concluded that the environment had the lead role as a cause of cancer in relation to hereditary factors, with the exception of prostate, colorectal and breast cancers, for which the inherited contribution was the most significant (42%, 35% and 27%, respectively).

Other epidemiological studies with varied approaches strengthen the relationship between hematological cancers and exposure to pesticides, including, leukemias (Keller-Byrne; Khuder, 1995; Schuz et al., 2000), multiple myeloma (Khuder et al., 1997), Non-Hodgkin lymphomas (Ibid.; Roulland et al., 2009; Schuz et al., 2000) and myelodysplastic syndrome (Nisse et al., 2001). In relation to malignancies of the hematopoietic system, in a case-control study carried out in France between 2000 and 2004, associations were observed between the incidence of Hodgkin lymphomas (HL) and occupational exposure to triazole-based fungicides and herbicides (Orsi et al., 2009).

Another case-control study carried out in four US states, analyzed the occurrence of tumors in farm workers and concluded that after prolonged exposure to organophosphate pesticides, there was a 50% increase in the incidence of NHL (Waddell et al., 2001). The same workers were screened for exposure to carbamates and they concluded that the risk for developing NHL increased from 30 to 50% among exposed workers, particularly those who handled these products for 20 years or more (Zheng et al., 2001).

In a systematic review of the literature (Bassi, 2007) 83 scientific articles investigating the use of pesticides and the occurrence of cancer from 1992 to 2003 were evaluated. The author concluded that several studies showed the association between exposure to pesticides and the incidence of neoplasms such as leukemia and NHL and, to a lesser extent, the association between pesticides and some solid tumors, such as prostate and brain.

In addition to the extensive scientific literature that supports the relationship between pesticides and cancer of the hematopoietic system, in recent years there is also accumulated evidence about the relationships between these substances and cancer in various locations of the body, such as lung, stomach, melanoma, prostate, brain, testicles and sarcomas (Fontenele et al., 2010; Grisolia, 2005; Keller-Byrne; Khuder, 1997; Romano et al., 2008; Solomon; Schettler, 2000). In Brazil, an ecological study comparing the commercialization of pesticides in 1985 with various health outcomes between 1996 and 1998, in particular, mortality from different types of cancer, concluded that there were significant associations between mortality from breast cancer in women aged 40-69 years and the amount of commercialized pesticides (Koifman; Meyer, 2002).

A cross-sectional study conducted in Ceará, which evaluated the cancer registry between rural and non-rural workers, showed an increase of proportional incidence ratio for penile cancer (6.44/1,000), leukemias (6.35) and cancer of the testicles (5.77), besides other locations, with the risk ranging from 1.88 to 1.12 (urinary bladder, multiple myeloma, lymphoma, connective tissue, eye and its adnexa, esophagus, colon, rectosigmoid junction, kidney, larynx, prostate and thyroid) for these populations (Ellery; Arregi; Rigotto, 2008).

Also in Ceará, a comparative study of cancer mortality indicators in the municipalities of Limoeiro do Norte, Quixeré e Russas – where agribusiness and the use of pesticides is growing – using secondary data from 2000 to 2010, showed an increase by 38% in the rate mortality from cancer in these municipalities, compared to other 12 population group, where there is only traditional family farming of the semi-arid, in which the use of pesticides is small (Rigotto et al., 2013).

Research conducted by Ferreira Filho (2013) found chromosomal abnormalities in bone marrow cells in 25% of the group of workers exposed to pesticides used in banana cultivation in Ceará – aneuploidy; deletions of chromosomes 5, 7 and 11; monosomy; amplification of the TP53 gene –, abnormalities similar to those found in myelodysplastic syndromes and acute myeloid leukemias that are important for the prognosis of malignant diseases.

Due to the accumulation of evidence, in March 2015, the IARC released an official document in which classified the Glyphosate herbicide and malathion and diazinon insecticides in Group 2A, i.e., as probable carcinogens to humans, and tetrachlorvinphos and parathion insecticides in group 2B, i.e., as potential carcinogens to humans, a statement that has serious concerns for public health in Brazil, because Glyphosate is the most consumed pesticide in the country, accounting for 40% of sales; also malathion and diazinon are authorized and widely used in the country (Carneiro et al., 2012).

In turn, the INCA recognizes the relationship between exposure to pesticides and the emergence of cancer. In a document published in 2012, the institute says:

> Positive associations between hematological cancers and occupational exposures to chemicals were observed in case-control studies in the south of Minas Gerais for workers exposed to pesticides or wood preservatives and to workers exposed to organic solvents, lubricants, fuels and paints (Silva, 2008). Solomon et al. (2000) and Clapp et al. (2007) found a relationship between pesticides and cancer, including hematological, respiratory, gastrointestinal and urinary cancers, among others. Wijngaarden et al. (2003) describe the intrauterine exposure and the occurrence of brain cancer in children. Miligi et al. (2006) have associated the exposure to phenoxyacetic herbicides with increased risk for sarcoma, non-Hodgkin's lymphoma, multiple myeloma and leukemias; exposure to triazines (herbicides) with increased risk for ovarian cancer; exposure to organophosphate insecticides with increased risk for non-Hodgkin's lymphoma, leukemia and prostate cancer; and exposure to organochlorine with increased risk for breast cancer. Still on breast cancer, Snedeker (2001) observed conflicting results between cancer and blood levels or in adipose tissue for DDT pesticide and its metabolite dichlorodiphenyldichloroethylene (DDE). For the Glyphosate herbicide, widely sold in the country, studies have linked the occurrence of non-Hodgkin's lymphoma (Hardell et al, 2002; De Ross et al., 2003; Cox, 2004) and multiple myeloma (De Ross et al., 2005). Other studies indicate a positive association between the use of Carbofuran (benzofuranyl methylcarbamate) and the development of lung cancer (Bonner et al., 2005) and the use of the Paraquat herbicide and CNS tumors (Lee et al., 2005). In addition to the pesticides already mentioned, some contaminants in commercial formulations may also have an increased risk of cancer (Brasil, 2012a, p. 37-38).

These evidences led the INCA to launch, on April 8, 2015, public notice in order to "[...] mark the position of the INCA against current pesticide use practices in Brazil and highlight their risks to health, especially to causes of cancer" (Brasil, 2015, p. 2).

Given this scenario that makes explicit the magnitude of cancer as a public health problem increasingly at national and international levels, as commented previously, Brazil faces challenges to understand the implications of this development model on illness and sickness for public policies of care related to chronic diseases.

Endocrine disruption and pesticides

Several environmental pollutants have been studied most recently as potential endocrine disruptors. Of the 11 million substances known in the world, 3,000 of them are produced on a large scale; among them, many are used in domestic, agricultural and industrial environments and have proven hormonal activity (Fontenele et al., 2010).

The International Programme on Chemical Safety (IPCS) defines as endocrine disruptors (EDs) substances or mixtures in the environment that can interfere in the functions of the endocrine system, causing adverse effects in an intact organism or its offspring. Fontenele et al. (2010) cite as examples of endocrine disruptors: insecticides, detergents, repellents, disinfectants, fragrances, solvents, flame-retardants, etc.

The mechanisms and places of action of these EDs in organisms are varied, because they can act both in the binding of endogenous hormone to its receptor as in the steps of synthesis, transport and metabolism of the natural ligand, besides acting to a lesser extent, as agonists or antagonists (Ibid.). Damstra et al. (2008) point out that the effects of occupational exposure to these interferences can be reversed if workers are removed from that contact in time. However, exposure of certain population groups, during pregnancy or the first years of life, may bring irreversible damage.

Several pesticides can act as EDs and produce important endocrine deregulation. A classic example to demonstrate the performance of a pesticide as endocrine interfering can be the known case of dichlorodiphenyltrichloroethane (DDT), organochlorine compound effective as an insecticide, created in 1939, and increasingly used mostly after World War II, including in public health programs.

About DDT, Fontenele et al. state:

> Gray et al. (1999) demonstrated that DDT has estrogenic action and its metabolite p,p′-DDE, has antiandrogenic action in vitro and in vivo. The first adverse effects of DDT described were observed after major occupational exposures or industrial accidents. Recently, De Jager et al. (2006) conducted a cross-sectional epidemiological study involving 116 young men who lived in endemic areas of malaria in Chiapas (Mexico), where DDT had been sprayed until 2000. The plasma concentrations of p,p′-DDE was used as a exposure parameter to DDT and proved to be a hundred times higher than reported by unexposed people. A semen analysis revealed changes of various parameters that correlated positively with the concentrations of p,p′-DDE, such as a decrease in the percentage of mobile sperm and sperm with morphological defects in the tail, besides genetic defects, indicating adverse effects on testicular function and/or regulation of reproductive hormones. This was the first epidemiological study to show effect after non-occupational exposure to DDT (De Jager et al., 2006) (Fontenele et al., 2010, p. 10).

Although the Stockholm Convention and the Brazilian government have restricted the production and use of DDT against the vectors of diseases, like malaria, it will still cause various health problems to the population in the coming years, due to its long permanence in environments (Associação de Combate aos Poluentes Orgânicos, 2009).

The main systems affected by EDs are reproductive, nervous and immune. Regarding the impact of these substances on animals, Ross et al. (1995) and Sørmo et al. (2009) suggest that exposure to pesticides of Baltic seals has led to the decline of these populations due to interference of these substances on the reproductive and immune systems.

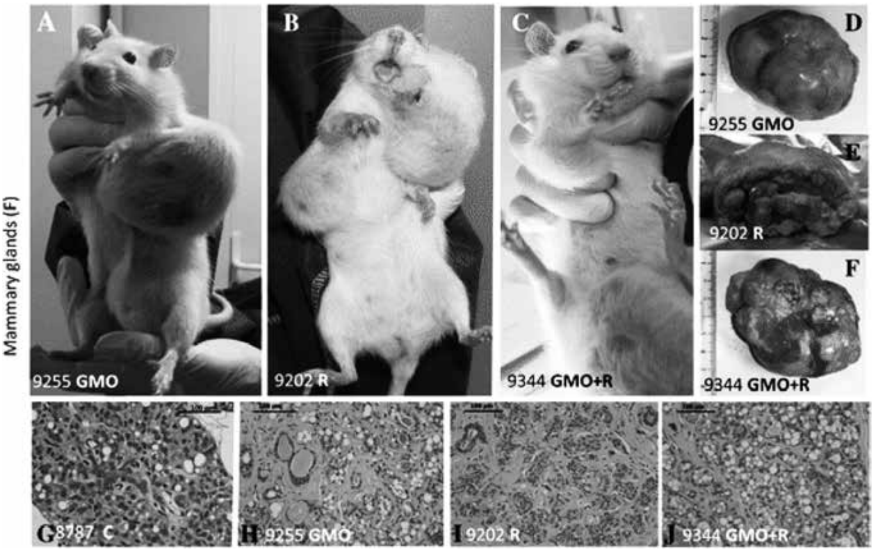
The exposure of alligators to dicofol pesticide, a xenoestrogen, resulted in the development of reproductive abnormalities and increased mortality of these animals (Semenza et al., 1997). Other studies with animals have shown that exposure to pesticides DDT, HCB and nonylphenol cause thyroid abnormalities – decreased T3 and free T4 and increased TSH (Boas; Main; Feldt-Rasmussen, 2009).

Regarding the exposure of humans to EDs, Fontenele et al. (2010) point out:

> In humans, exposure to EDs have been associated with oligospermia, changes in steroidogenesis, cryptorchidism, hypospadias, endometriosis, precocious puberty, abortion, infertility, behavioral disorders and autoimmune diseases (Fernandez et al., 2007; Queiroz; Waissmann, 2006; Strong et al., 2007; Buck Louis et al., 2008; Den Hond Schoeters, 2006). Exposure to xenoestrogens during intrauterine life, childhood or adolescence has been linked to increased cases of breast cancer, early or accelerated puberty (Landrigan; Garg; Droller, 2003) (Fontenele et al., 2010, p. 12).

Study conducted by Séralini's (2012) researcher team analyzed for two years, the exposure of 200 laboratory rats to Monsanto's NK603 transgenic maize and glyphosate, the herbicide used in combination with modified corn. It revealed a higher and more frequent mortality associated with both the consumption of transgenic maize and glyphosate. Hormonal changes found in this study were not linear and sex-related, such as, for example, development in females of numerous and significant mammary tumors, besides pituitary and kidney problems, while males died mostly of severe hepatorenal chronic deficiencies.

Figure 1. Examples of breast tumors observed in females



Obs.: Featured breast tumors: A, D, H – adenocarcinomas from the same animal (mouse) of a group exposed to GMOs; B, C, E, F, I, J – fibroadenomas in two animals exposed to Roundup and Roundup + GMO. All of these groups were compared with the control group. There are not in this figure photos representing the control group, where only a minority had tumors with over 700 days of life, unlike most animals with tumors of the groups exposed to Roundup and/or GMOs. G – histological control.
Source: Séralini et al., 2014; Búrigo et al., 2015.

This study is also important to highlight the relationship between different pesticides that act in endocrine disruption, as those responsible for the etiology of some cancers, such as those that have already been proven by scientific research: breast, prostate, testicular and others (Bradlow et al, 1995; Fucic et al., 2002; Garry, 2004; Mathur et al., 2002; Mills; Yang, 2005).

In Brazil, there are several registered pesticides that are associated with endocrine disruption: 2,4-D, acephate, atrazine, carbendazim, chlorothalonil, chlordane, cypermethrin, cyproconazole, diazinon, dicofol, dimethoate, epoxiconazole, fipronil, hexaconazole, malathion, mancozeb, metribuzin, propanil and tebuconazole (McKinlay et al., 2008).

Friedrich (2013) states that these pesticides are related to effects like

> agonism or antagonism of the functions of estrogen and androgen receptors, dysregulation of the axis of pituitary-hypothalamus

> hormone, prolactin inhibition or induction, progesterone, insulin, glucocorticoids, thyroid and induction or inhibition of the aromatase enzyme, which is responsible for the conversion of the androgen precursor in estrogens (p. 5).

In addition to the effects on the endocrine system, pesticides have the potential to lead to substantial changes on the immune system, through both mechanisms of stimulation and suppression of this system (Ibid.). With respect to stimulation of pesticides on the immune system, they can induce from hypersensitivity processes to autoimmunity (Burek; Talor, 2009; Duntas, 2011; Fukuyama et al., 2010).

About the role of pesticides as immunosuppressants, it is known that they decrease the resistance of organisms to agents such as viruses, bacteria and fungi, which increases the propensity of individuals exposed to the outbreak of infections caused by these pathogens (Cabello et al., 2001; Hermanowicz; Kossman, 1984). It is also proven that another mechanism responsible for increasing the vulnerability of individuals to infection is by the action of pesticides on the inactivation of vaccines (Barnett et al., 1992; Blakley, 1997; Salazar et al., 2005).

The immunosuppressive effect of pesticides also weakens the organisms in fighting cells that mutate, so many of these substances, which have mutagenic and carcinogenic actions, besides the effect on the immune system, contribute significantly to the etiology of cancer; among them, the methamidophos, methyl parathion and the phorate (Crittenden; Carr; Pruett, 1998; Kannan et al., 2000; Selgrade, 1999).

Pesticides in the Brazilian context

In the international division of labor imposed worldwide by major economic corporations, it is the role of countries from the global south, in this capitalist cycle, the reprimarization of their economies, focusing it on the exploitation of natural resources for export. The subordination to this policy by Brazilian governments has led to reduced exports of manufactured goods (58.4% in 2000 to 37.1% in 2010), when the share of primary goods, such as minerals and food, grew, especially for China (Carneiro et al., 2012).

Regarding agricultural commodities, the "green revolution" and the conservative modernization of agriculture delineate the productive model of agribusiness, focused on achieving increased productivity from the monoculture that is intensive, mechanized and dependent on pesticides and chemical fertilizers. This model, since it affects profoundly the ecological balance, creates the conditions for disproportionate growth of some components of flora and fauna – the "plagues" that would require the intensive use of pesticides.

Indeed, the Brazilian Agricultural Census (IBGE, 2006), according to Bombardi (2011), indicates that 80% of farms with over 100 hectares use pesticides. It also shows that 27% of the smaller properties (up to 10 hectares) and 36% of properties from ten to 100 hectares use these products.

Thus, sales of active ingredients of pesticides grew by 194.09% between 2000 and 2012. Glyphosate still leads sales, with 39.03% of the total traded AIs, followed by 2,4-D, Atrazine, Acephate, Diuron, Carbendazim, Mancozeb, Methomyl, Chlorpyrifos, Imidacloprid and Paraquat dichloride (Brasil, 2013a). Búrigo et al. (2015) report that in 2013 the industry moved US$ 11.454 billion, an increase by 18% over 2012. In addition, they found that, in terms of volume, 823,226 tons of chemicals were sold to Brazilian crops, 12.6% more than in 2011 (Valor Econômico, 2013).

Brazil achieved a consumption correspondent to 5.2 liters of agricultural poison per inhabitant per year (Sindicato Nacional das Indústrias de Defensivos Agrícolas, 2011). Despite that, this average must not hide the uneven distribution of risk among population segments, as evidenced in true sacrifice zones, as Lucas do Rio Verde, Mato Grosso, where this indicator reaches 136 liters of pesticides per inhabitant/year (Moreira et al., 2010). In addition to consuming huge amount of these substances, the country also widely used pesticides that have been banned in many parts of the world (Carneiro et al., 2012).

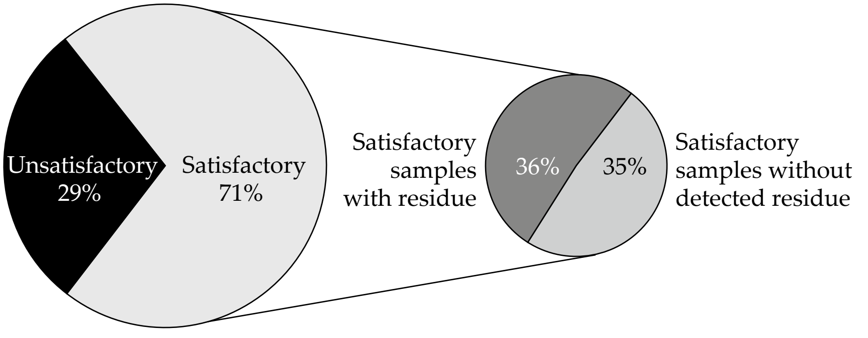
Of all the pesticides sold in Brazil, commodity crops such as soybeans, corn, cotton and sugarcane account for 80% of total industry sales (Sindicato Nacional das Indústrias de Defensivos Agrícolas, 2012). The average consumption of pesticides in relation to the planted area increased from

10.5 liters per hectare (l/ha) in 2002 to 12 l/ha in 2011 (Brasil, 2010; IBGE, 2012). Thus, the increase in consumption is related to several factors such as the expansion of the planting of transgenic soy, which extends the use of glyphosate and other herbicides; increasing resistance of weed, fungi and insects, requiring larger doses or other AIs; and/or the increase of diseases in crops such as soybean rust, which increases the consumption of fungicides. An important stimulus to consumption comes from the absurd tax exemption of pesticides, granted by federal and state governments (Brasil, 2005; Pignati; Machado, 2011; Teixeira, 2011).

Exposure to pesticides can occur at work, either in factories or companies that transport and commercialize it; in agricultural and livestock production – distinguishing here the contexts of differentiated risks for employees of agribusiness, farmers and peasants –; in public health campaigns – including of dengue –; the treatment of wood, the fumigation, in urban weeding; among others. Also occurs environmental exposure to pesticides, especially in the case of people living around those rural or urban enterprises contaminated by air, soil and water.

It should also be noted that the entire Brazilian population is exposed to that risk. According to data from the Program on Pesticide Residue Analysis in Food (PARA), in 2012, only 35% of samples did not show any residues of pesticides, which means that 65% of products contained agricultural poisons (when you add 29% of unsatisfactory results – because they have residues of unauthorized or authorized products, but in concentrations above the MRL – with 36% who had residues, but at concentrations below the MRL (Graphic 3)). It should be noted, however, that are excluded from the list of pesticides analyzed, for example, glyphosate and paraquat – widely used herbicides, suggesting that these percentages may be significantly underestimated.

Graph 3. Distribution of samples analyzed according to the presence or absence of pesticide residues – PARA, 2012



Source: Anvisa, 2013.

Regarding the presence of pesticides in water for human consumption in Brazil, the Sanitation and Health Atlas by IBGE shows that among the municipalities that declared pollution or contamination, pesticides are among the main three causes, including sanitary sewer and inadequate disposal of garbage (in 72% of causes of pollution in the catchment of surface waters, 54% in deep wells and 60% in shallow wells (IBGE, 2011)

Data from the Ministry of Health analyzed by Neto (2010) report that of the total Water Supply Systems registered in the Information System, designed for monitoring water quality for human consumption in 2008, only 24% had information about the control of water quality for pesticide parameters and only 0.5% have information on the monitoring of water quality for such substances (whose responsibility belongs to the health sector). The author states "[...] It should be noted also that the data refer to the average of 16 Federation Units, since 11 states did not carry out such analyzes and/or did not fed this information system with data from 2008" (Ibid., p. 21).

Research conducted in an irrigated area producer of fruit for export in Ceará revealed the presence of 3 to 12 active ingredients in all 23 samples collected, involving waters from the Jandaíra aquifer and those distributed by the municipal service for household consumption (Marinho, 2010). In Mato Grosso, there was a contamination with residues of various pesticides in 83% of 12 drinking water wells of the examined schools; 56% of rain water samples; and 25% of air samples (patio of the schools), monitored for two years (Moreira et al., 2010).

Regarding this alarming diagnosis, we notice there is an economic and political context that makes the health of the population vulnerable to contamination by pesticides. It should be noted also that the distribution of risks and damage does not occur homogeneously among the different population groups, characterizing the production of inequalities or environmental injustices that penalize especially peoples and traditional communities of the field, employees of large agricultural enterprises, workers and residents in true sacrifice zones where these chemicals are manufactured or consumed, in the countryside and in urban peripheries (Rede Brasileira de Justiça Ambiental, 2001).

Chronic effects of pesticides: scientific knowledge and invisibility

Human societies face complex contemporary social and environmental problems. Among them, the massive diffusion of production and use of chemicals such as pesticides. One must question to what extent the epistemological and methodological frameworks that modern science and its technoscience use are appropriate and sufficient to address these problems, to which genesis they contributed.

Chemical extermination technologies developed in the context of World War II were directly transplanted into agriculture as a strategy to open a new market for the industrial park then installed. The public legitimacy argument, however, was that such chemicals would be added to the mechanization of farming in the design of a new production model of food that would raise productivity and end world hunger. War tanks to tractors, chemical weapons to"pesticides": on this basis is built the modernization of science-based agriculture (Abreu, 2014).

Rachel Carson starts in 1962 a series of studies that question this model by demonstrating its deleterious effects on human health and ecosystems. The hegemonic science then breaks the complexity of the problem – which involves economic, political, social, ecological and technical relations – and responds with reductionism and simplification. It focuses on defining maximum quantities of pesticides that are supposed to be compatible with health and the environment, and establishes numbers for ADI (acceptable daily intake), MRL (maximum residue limit) and TL (tolerance limit). About this perspective and these "numbers", rules and regulations are constructed to enable the "safe use" of pesticides, supported by monitoring and tracking of contaminated food, use of personal protective equipment by "trained" workers and environmental monitoring.

As Petersen (2015) argues, an epistemological shield is built, which produces public confidence that we are protected that also results in a legal shield for corporations responsible for the spread of agrochemicals, to enable the accountability for injuries and impacts to be transferred to the victims themselves. More than that, this scientific approach apparently neutral and an enunciation of truth, constitutes the basis for the development of public policies that should protect constitutional rights to health, work and balanced environment.

Taking into account critics by Funtowicz and Ravetz (1997) to normal science, we explain next some aspects related to uncertainty and to values and interests at stake, commonly hidden by the hegemonic approach also regarding the evaluation of toxicity of pesticides.

In Brazil, about 434 active ingredients and 2,400 pesticide formulations are registered and authorized in the regulatory system composed of the ministries of Agriculture, Livestock and Food Supply; Health; and Environment (Carneiro et al., 2012). The criteria for these studies involve tests on acute toxicity – by oral, dermal and inhalation routes –; and chronic toxicity, such as effects on reproduction, prenatal development, reverse mutation tests in bacteria and carcinogenicity in rodents (Brasil, 2002).

According to Augusto et al. (2011), the intensive use of pesticides in Brazil imposes the risk of developing diverse and highly deleterious toxic effects, but tests recommended by national and international guidelines have

> limitations for a complete predictive evaluation of the broad spectrum of molecules, receptors, cells and target organs of pesticides with these properties. In addition, the interaction

> between the nervous, endocrine and immune systems makes it difficult to study the effects that can affect reproduction, metabolic processes, resistance to pathogens and the fight against tumors (p. 264).

The authors also criticize the reductionist application of science by taking as a basis for the toxicological classification of pesticides experimental studies with animals and indicators such as the Lethal Dose 50 (LD50) – statistical estimate of the dose that is not a biological constant but that through a "mathematical abstraction" is extrapolated to humans. Highlighting that these indicators deal with the death effect (mortality) and not of health protection, the authors argue that such an estimate cannot be considered as a security reference, especially for chronic effects.

Friedrich (2013) analyzes the limits of the regulatory systems in the establishment of levels considered safe for the environment and human health (such as ADI, MRL and TL):

- risk assessment based on toxicological studies from laboratory animals or in vitro systems, whose results are extrapolated to the effects on human health;
- separate assessment of a single AI, disregarding the health effects in multiple exposure conditions to different mixtures and their possible interactions, including synergisms, either in the environment or in living tissue. It should be noted that the multiple exposure is the most common situation for the workers, who handle complex toxic mixtures, and for consumers of food, since the presence of several AIs have been identified in a single sample;
- disregard of the effects produced by low doses of pesticides that are not able to trigger the protective mechanisms of detoxification, inactivation or repair, but that can trigger toxic effects of endocrine disruption and on the immune system, mainly in stages considered critical to development;
- disregard of the aggregate risk resulting from total exposure to one or more AIs by different sources, such as the environment, employment and food;

- disregard of the interaction between active ingredients and other chemical substances, such as veterinary medicinal products, fertilizers, heavy metals, genetically modified organisms, etc.

Such limits of the established parameters for exposure to pesticides are not reported to society; on the contrary, the parameters are presented as scientific standards, true, neutral and safe. Also, are not explicated the uncertainties related to the fact that these standards reflect the knowledge available at that time, which could be replaced by more precocious detection techniques of effects or new studies that warn to unconsidered risks. This is the case of glyphosate herbicide, which was registered two decades ago as a class IV – slightly toxic – and recently was recognized as a probable carcinogen by IARC: How much profit did Monsanto have with its sales so far? How many cancer cases could have been caused?

The question is how long it will take to ban glyphosate in the country, since law does not establish periodic reevaluation of registered AIs, unlike the drug registration system. It must be brought up only when there is new scientific evidence or alerts by international organizations. This leads to the situation where, of the 50 active ingredients most used in Brazilian crops, 22 are banned in the EU because of evidence of harm to the environment and human health. Based on this, the Anvisa began in 2004 a revaluation process of 14 AIs, including glyphosate (Carneiro et al., 2012). This process, however, has been affected by conflicts with the chemical industry:

> In a recent publication by Caroline Cox is an important question about whether the registration system of pesticides is sufficient to ensure safe use. When recently we experienced the review of the registration process of 14 pesticides by the Brazilian Health Surveillance Agency (Anvisa), we were able to uncover the huge conflict of interest involved in the matter and the difficulties that normative science has to offer to society effective health and environment protection measures (Augusto et al., 2011, p. 267).

Such pressures of the chemical industry and agribusiness allies on the executive, legislative and judicial branches in order to inhibit re-evaluation process of course aim to protect their billionaire market in Brazil, not health and the environment. They also pressure for rapid registration of new AIs, since, to create them, they invest about US$ 256 million to, in about ten years, combine 150,000 components[3]. Therefore, there is urgency to recover this investment and make a profit. In addition, they finance academic studies whose results are compatible with their interests:

> The agrochemical industries invest in co-opting mechanisms of researchers to produce scientific evidence to legitimize the use of its products with financial resources for research. This strategy generates conflicts of interest once it risks the protection of health and social welfare at the expense of financial interests by opening doors to the violation of citizenship rights (Rigotto et al., 2012, p. 246-7).

There are also pressures on independent research. A striking example is the intervention of Monsanto on the editorial board of the journal Food and Chemical Toxicology, after the publication of the article mentioned previously *Long-term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize*, by the French researcher Gilles-Eric Séralini and his team. The study demonstrated the induction of tumors and endocrine problems in rats exposed to Monsanto NK603 transgenic maize and glyphosate. In addition to "unpublish" the article, the magazine welcomed in its editorial board a former employee of Monsanto (who developed the NK603 maize) as editor for biotechnology (Búrigo et al., 2015). The study coordinator manifests:

> We are forced to conclude that the decision for the withdrawal of our article was unscientific and that the publisher adopted the standard *two weights and two measures*. This pattern can only be explained by the pressure of GMOs and pesticide industries to force the acceptance of their products (Séralini, 2014 apud Búrigo et al., 2015, p. 448, emphasis added).

3 Information disclosed by economist Horácio Martins (Seminário Agrotóxicos, 2010).

A situation of pressure also affected the embryology lab researcher at the Faculty of Medicine of the University of Buenos Aires Andres Carrasco, who published a study in *Chemical Research in Toxicology* (Carrasco et al., 2010) showing congenital malformations induced by glyphosate in amphibian embryos. The scientist was the victim of threats, disqualification campaigns and suffered political pressures (Búrigo et al., 2015).

Regarding epidemiological studies in populations and regions where there is intensive use of pesticides, important evidence of its impact on human health have been brought to the public, as we saw previously. However, in many cases, remain sharp positivism marks in the epidemiological method, and often the studies are considered inconclusive by peer aligned to domesticated academia and,"in the name of good science," new research are demanded, with larger samples, sophisticated techniques and high cost. As denounces Petersen,"thus the power system that maintains the irrationality of pesticides is institutionally secured, ensuring the continuity of billionaires private businesses at the expense of the public interest" (2015, p. 29).

In turn, the diagnosis of cases of chronic effects of pesticides regarding sick individuals finds limits also in science and medical practice, through which chronic diseases, usually, are considered of multifactorial origin, involving genetic, environmental, nutritional, and immunological factors, among others. To consider its association with an eventual exposure to environmental risks of chemical nature, such as pesticides, would depend on health professionals trained to include in the clinical medical history the investigation of occupational and environmental history of the patient – and with institutional conditions of care that could provide this deepening, retrieving information to characterize possible exposures occurred years or decades ago, given the latency period between exposure and the clinical manifestation of chronic effects.

Therefore, the patient should have this information, which often is not simple, given the bias of memory and limits of access of exposed people to information about the different active ingredients used, doses and exposure conditions. Although this hypothesis is raised by a professional, he would have difficulties to confirm it through, for example, biomarkers, either because they are scarce or too little accessible in public laboratories of toxicological analysis, but mainly because it is not expected that active ingredients, its metabolites or biological effect indicators are still detectable long after the exposure. Even though this process of creating a link between injury and exposure is carried out, it will always be possible, in positivism, to question the role of genetic inheritance or the patient's habits in the genesis of the case, the possible exposure to other cancer, etc., in order to hinder that there is a relationship between pesticides and the emergence of cases of cancer, which strengthens the invisibility of these diseases.

Still we need to mention the problems in relation to health information systems – such as the Notifiable Diseases Information System and the National System of Toxicological Information –, which commonly do not allow nor identifying the occupation of the patient – that could contribute to the establishment of important relationships – nor the exposure to environmental risks. Another difficulty presented by these systems, especially as a database for studies that seek to identify possible concentrations of patients in known contamination areas, concerns the reliability of information on the provenience of the cases, since is frequent the registration of addresses located in urban centers, where there are more technological resources in the health care network – it works as a patient strategy to facilitate access to services.

These are some of the limits of the epistemological and methodological framework of modern science, which simplifies the complexity of the problem and hides uncertainties; as well as of scientific practices, spanned by positivism and conflicts of interest. We must add the business strategies, limited by the values of economic productivism to focus on the scientific field and the social regulation of pesticides, producing invisibility of the victims.

Chronic effects of pesticides: State and invisibility

It is necessary to look briefly into the State's role in the issue of pesticides. In general, governments in the last two decades have been subordinated to the international division of labor imposed by large economic corporations, defining development models that insert the agricultural production system of the country in the global commodities market. The recent appointment of a representative of agribusiness and defender of pesticides as minister of Agriculture, Livestock and Food Supply and the strengthening of Congressional rural caucus are a clear example of this process. Therefore, public development policies are being developed. They lead to agribusiness financing with public funds (BNDES, for example); the promotion of the production of technical and scientific knowledge that serves this model of agricultural production (as at EMBRAPA); the legal and institutional adaptation to the accumulation needs of these agents, as in the case of the Brazilian Forest Code or the authorization of AIs not allowed in the country, in cases of phytosanitary emergency (Law 12873/2013 and Decree 8133/2013), the operation of the National Biosafety Technical Commission or tax exemption for pesticides (Federal Decree nº 6006/1997).

This option has fomented territorial disputes involving indigenous peoples, Afro-descendants and different traditional communities of peasants. It is compromising the country's biodiversity; consuming, exporting and polluting our waters; contaminating, sickening and killing people.

It is in fact a perverse process of violation of rights already assured by the Federal Constitution and a wide infra-constitutional legislation, rights conquered with the struggle of various segments of civil society, such as social movements organized by the men and women directly affected by the current development model in the country, in defense of the guarantee and effectiveness of their rights. Table 2 shows some of these laws.

Table 2. Some existing regulations applicable to the protection of health and the environment in relation to pesticides

Legal document	Subject
Law 8080/1990	The conditions for promotion, protection and recovery of health, organization and functioning of corresponding services
Law 7802/1989 and Federal Decree nº 4074/2002	Research, experimentation, production, packaging and labeling, transportation, storage, commercialization, advertising, use, import, export, waste disposal and packaging, registration, classification, control, inspection and surveillance of pesticides, their components and others
Decree nº 7794/2012	Promotion of the production of organic food and agro-ecological free of contaminants that pose a health risk
Law 11346/2006 and Decree 7272/2010	Create the Food and Nutrition Security System (SISAN) and establish the National Policy on Food and Nutrition Security (PNSAN)
Ordinance nº 01/1986	Assessment of impacts on health and the environment in environmental licensing of projects
Ordinance nº 2866/2011	Establishes the National Comprehensive Health Policy of the Rural and Forest Populations
Ordinance nº 254/2002	Establishes the National Policy for the Health of Indigenous Peoples (PNASPI)
Ordinance nº 2446/2014	Redefine the National Policy of Health Promotion
Ordinance nº 1823/2012	Establishes the National Health Policy of Workers
Ordinance 2914/2011	Establishes the procedures and responsibilities relating to the control and surveillance of water quality for human consumption and its potability standards
Ordinance nº 2728/2009	Establishes the National Network of Integral Attention to Worker's Health (RENAST)
Ordinance nº 2978/2011	Extends the RENAST with the creation ten Reference Centers in Worker's Health (CEREST), geared primarily for the rural population
Ordinance nº 1378/2013	Defines actions of Health Surveillance
Ordinance nº 2938/2012	Sets funding for the implementation of the Health Surveillance among Populations Exposed to Pesticides
Ordinance nº 86/2005	Regulatory Norm for Security and Health at Work in Agriculture, Livestock, Forestry, Forest Exploration and Aquaculture – NR-3

Source: elaborated by the authors (Brasil, 1989, 2002, 2005, 2011, 2012b, 2012c, 2013b).

To illustrate it, the National Comprehensive Health Policy of the Rural and Forest Populations has among its objectives:

> Promote the health of rural and forest populations through actions and initiatives that recognize the specificities of gender, generation, race/color, ethnicity, sexual orientation and religion, in order to access health services, *to reduce risks and hazards to health due to work processes and agricultural technologies* [emphasis added] and to improve health indicators and quality of life; [...] To reduce accidents and injuries related to work processes in the field and forest, particularly *the illness arising from the use of pesticides* [emphasis added] and mercury, the one arising from ergonomic risk of working in the field and in the forest and continuous exposure to ultraviolet rays (Brasil, 2011, p. 1-5).

In turn, the goal of the National Health Policy of Workers is

> the development of comprehensive care to workers' health, with emphasis on surveillance, aimed at promoting and protecting the health of workers and the reduction of morbimortality resulting from development models and production processes (Brasil, 2012b, p. 1).

The NR-31 (Brasil, 2005, p, 1) stipulates that employers are responsible, among others:

> a) to ensure proper working, hygiene and comfort conditions, defined in this norm, for all workers, according to the specificities of each activity;
> b) to promote improvements in the environment and working conditions in order to maintain the level of safety and health of workers.

In turn, the Ordinance on Health Surveillance (Brasil, 2013b, p. 1) lists among its actions:

> IV – the surveillance of chronic diseases, accidents and violence;
> V – the surveillance of populations exposed to environmental risks in health.

Of course, for these and other conquered rights to became concrete policies in the territories, it is necessary an articulated operation between not only the various areas of the health sector, as well as between this sector and other areas, according to the National Health Policy of Workers:

> The promotion of health and environments and healthy working processes must be understood as a set of actions, coordinated intra- and intersectoral, which allows intervention in the determinants of the health-disease process of workers, acting in vulnerable situations and violation of rights and ensuring worker's dignity at work [...] The inseparability of production, labor, health and environment shows that the health of workers and of the general population, is closely related to forms of production and consumption and exploitation of natural resources and its impacts on the environment, including work. With that in mind, the precautionary principle should be incorporated as a guide to actions of health and environment promotion and healthy working processes, especially on issues relating to social and environmental sustainability of production processes (Brasil, 2012b, p. 29).

However, these laws do not receive the same support as the State gives to economic agents for their effective implementation as public policy: there is a lack of professionals in public services, infrastructure and training, autonomy, resources, and intersectoral coordination that could bring efficiency to the actions and qualified mechanisms of participation of social groups made vulnerable by this model in decision-making processes.

Final considerations: some lines of flight to break the invisibility of the chronic effects of pesticides and prevent them

We have gathered in this text elements that characterize the intense use of pesticides in the country and the context in which this happens; the amplitude of the population exposed to this risk; toxicological, clinical and epidemiological evidence on some of the chronic effects caused by them – already recognized even by international agencies –; and the growing perception of those exposed to it on the increased occurrence of chronic diseases related to pesticides.

This situation contrasts sharply with the invisibility of these effects on morbidity and mortality from chronic diseases of the population in the official information systems, in public policies, socially and even in the academic and professional field. Reasons for this have been identified in the very process of knowledge production, skewed by the limits of modern science and the pressure of high economic interests, and in the State, in which such interests articulate and advance, influencing sharply in public policies, legal frameworks and the judiciary.

Therefore, it is not a characteristic invisibility of the problem, but rather a process of social invisibilization, politically constructed and with clear function: deviate from public debate one of the most sensitive and serious impacts of the conservative agricultural modernization, in order to sustain the development model adopted in the country and protect the significant economic interests involved in it.

Thus, the challenge to unveil the chronic effects of pesticides on public health should be recognized in its complexity, and does not take simple or easy solutions: the lines of flight are certainly being built, but in the context of profound asymmetry of power – economic, political, of knowledge and information, etc. – and in a process perhaps too slow when it comes to (the fragility of) life, human and non-human.

Thus, the prospects of coping with this sickening system are certainly mediated by political and deeply related to the expansion of the public debate on the subject, the production and dissemination of critical and contextualized information – which also involves the issue of democratization of the media – among others, to build political force able to redirect the State action.

Important initiative in this direction is the Permanent Campaign against the Pesticides and for Life, launched by Via Campesina on World Health Day in 2011, which already brings together hundreds of organizations, networks and social movements:

> the campaign has become an effective popular mobilization tool where individuals step out of invisibility to turn into collective subjects visualized in the set of actions of the campaign and in other initiatives produced by it, as materials, debates, films, etc. (Carneiro et al., 2015, p. 261).

The Campaign was supported by the Brazilian Association of Collective Health to organize the Dossier Abrasco – a warning about the impacts of pesticides on health[4], bringing together researchers from the collective health field to debate about reflections and scientific evidence to contribute to this matter. There are many challenges facing the scientific field, especially pointing and helping to overcome the limits of modern technoscience, as they reflect directly in the production of necessary knowledge to unveil and prevent the chronic effects of pesticides.

As recognized by the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), it is required"a review of the current model of knowledge, science and technology in agriculture, from the recognition of the complexity and diversity of production systems and agricultural knowledge in different regions of the world"(Búrigo et al., 2015, p. 509).

In this sense, the Report of the United Nations Special Rapporteur on the Right to Food points the potential of Agroecology as"a form of agricultural development that not only has narrow conceptual connections to the human right to food, but also has presented results in the realization of this right next to vulnerable social groups in various countries"(ONU, 2010, p. 1).

4 Available at: www.abrasco.org.br/dossieagrotoxicos.

An important role in this direction is being developed through the promotion of dialogue between traditional and scientific knowledge, as occurs between the Brazilian Association of Agroecology (ABA) and the numerous and diverse consigned accumulations between farmers, organizations and social movements that constitute the Brazilian Articulation of Agroecology (ANA). Among its most important contributions is the construction and affirmation of alternative ways to produce healthy food, very different from those imposed by the current development model[5].

Such movements have also focused on the democratization of public policy and acted decisively in the construction of the National Policy for Agroecology and Organic Production (Decree nº 7794/2012). Under the National Plan from which it derived is the preparation of the National Program for Pesticide Use Reduction (PRONARA), focusing on six lines of action to be taken by the Government: (1) registration; (2) control, monitoring and accountability of the production chain; (3) economic and financial measures; (4) development of alternatives; (5) information, participation and social control; and (6) education and training.

In this scenario information, mobilization and struggle of broad social segments affected by pesticides and social sectors allied to them will be determinant.

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5 See, for example, the Policy Letter from the III National Meeting of Agroecology, available at www.agroecologia.org.br/index...ao-iii-ena/650-carta-politica-do-iii-ena.

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