

# Knowledge, attitudes and practices of the Brazilian family farmers on exposure to pesticides<sup>1</sup>

## Conhecimentos, atitudes e práticas de agricultores familiares brasileiros sobre a exposição aos agrotóxicos

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### Abstract

This paper discusses the knowledge, attitudes, and practices (KAP) of the Brazilian family farmers regarding the impact of pesticides on health and the environment. This mixed cross-sectional study was conducted in 2014 in São José de Ubá, Rio de Janeiro. It encompasses two stages: a qualitative one, based on field observations and interviews with 25 participants on KAP about the use of pesticides; and a quantitative one, assessing sociodemographic data and exposure to pesticides among 78 farmers. Despite partially recognizing the danger of pesticides, farmers face the risks of exposure and usually adopt inappropriate work practices. Lack of technical support and occupational training, low schooling, difficulty in understanding the instructions on pesticides labels and package inserts, high price and discomfort caused by the use of Personal Protective Equipment (PPE), and the belief in the need for using pesticides, partially explain the unsafe attitudes. Effective and immediate prevention of pesticides-related injuries and diseases requires promoting more sustainable agricultural practices, strengthening technical support and occupational training, improving communication and pesticides risk management, and reducing gender inequalities among the Brazilian farmers.

**Keywords:** Pesticides; Farm Workers; Family Farming; Knowledge, Attitudes, and Practices; Risk Perception.

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## Resumo

O artigo discute conhecimentos, atitudes e práticas (CAP) de agricultores familiares brasileiros a respeito dos impactos na saúde e no ambiente gerados pelo uso de agrotóxicos. Trata-se de um estudo transversal misto, realizado em 2014 em São José de Ubá, RJ. A pesquisa é composta por uma etapa qualitativa, baseada em observações em campo e entrevistas com 25 participantes sobre CAP, no que se refere ao uso de agrotóxicos. A etapa quantitativa abrange avaliação sociodemográfica e de exposição aos agrotóxicos de 78 agricultores. Apesar de reconhecerem parcialmente os perigos dos agrotóxicos, os agricultores enfrentam os riscos da exposição e comumente adotam práticas laborais inadequadas. Fatores como a carência de apoio técnico e treinamento laboral, baixa escolaridade, dificuldade de compreensão das orientações de bulas e rótulos dos agrotóxicos, valor elevado e desconforto causado pelo equipamento de proteção individual (EPI), além da crença da dependência do uso de agrotóxicos, explicam parcialmente as atitudes não seguras. É preciso promover práticas agrícolas mais sustentáveis, fortalecer o apoio técnico e treinamento laboral, melhorar a comunicação e o gerenciamento dos riscos e reduzir as desigualdades de gênero entre os agricultores brasileiros, como a forma mais eficaz e imediata de prevenir os agravos relacionados ao trabalho com agrotóxicos.

**Palavras-chave:** Agrotóxicos; Trabalhador Rural; Agricultura Familiar; Conhecimentos, Atitudes e Práticas; Percepção de Risco.

## Introduction

In Brazil, the agricultural sector is one of the main economic bases, both because of agribusiness in the production of commodities for export, and of family farming in food production, both with growth potential. This agricultural expansion has occurred through the significant increase in the use of pesticides and the relaxation of legislation, which made Brazil one of the largest consumers in the world (Almeida et al., 2017). Among farmers, exposure to pesticides can engender several acute and chronic health effects including weakness; spasms and muscle tremors; gastrointestinal, cardiovascular, respiratory, neurological, mental, cognitive, endocrine outcomes; and cancer (Mostafalou; Abdollahi, 2017). In Brazil, studies with farmers exposed to pesticides suggest respiratory (Faria et al., 2005) effects, mental effects (Campos et al., 2016), suicide (Faria; Fassa; Meucci, 2014), and cancer (Boccolini et al., 2014), among others.

Poisonings have been significantly increasing in Brazil in line with the trading of pesticides. In the period from 2010 to 2019, the *Sistema de Informação de Agravos de Notificação* (Sinan) recorded 10,745 work-related poisonings from pesticides. The incidence coefficient had a threefold increase in that period, from 4.0 to 12.5 cases per 100,000 workers (Brazil, 2020). Moreover, underreporting is estimated in approximately 50 cases for each poisoning notification (Carneiro et al., 2015). Underreporting may be even greater for records of the relationship between work and chronic diseases, hardly related to pesticides.

Especially in lower-income countries, where regulation and surveillance in health and environment are more lenient or precarious, and resources are limited, reckless and excessive use of pesticides may increase exposure and damages to health (Staudacher et al., 2020). In those countries, including Brazil, studies conducted with farmers have pointed out several factors that favor exposure to pesticides, such as low education and income, use of highly-toxic chemicals, living close to crops, insufficient technical support and training to manage hazardous substances, lack of knowledge about the exposure routes, inappropriate use of

personal protective equipment (PPE), and inadequate disposal of pesticide containers (Manyilizu et al., 2017; Negatu et al., 2016; Pasiani et al., 2012; Petarli et al., 2019; Staudacher et al., 2020).

However, good agriculture practices are not fully effective to prevent exposure to pesticides, notably in the context of family farming. Therefore, studies on knowledge, attitudes and practices (KAP) have recognized agroecological practices as complementary to sanitary and environmental controls (Petarli et al., 2019; Reus et al., 2017).

Attitudes and practices regarding the use of pesticides and the resulting level of human exposure are directly influenced by the farmers' knowledge and perception of risk. Therefore, understanding the farmers' KAP is key to the development and improvement of public policies, as well as to recommend safer, sustainable and responsive alternatives to the communities' demands. In this context, this article discusses the KAPs on health and environmental impacts ensuing from the use of pesticides, based on the findings of a risk assessment study. This research also provides complementary data on the perception and exposure to chemicals, and their potential health effects.

## Methods

The study was carried out in São José de Ubá (SJU), in the northwest of the state of Rio de Janeiro, Brazil. In this municipality of approximately 7,000 inhabitants, about 56% of the population live in rural areas, only 16% have formal jobs, and 40% have a monthly per capita income of up to 1/2 minimum wage. The average Municipal Human Development Index (MHDIndex) is 0.652 (IBGE, 2010).

The economy of SJU is based on agriculture, mainly tomato-growing. The municipality is one of the largest tomato growers in Brazil, with annual harvests ranging from 21,000 to 32,000 tons between 2007 and 2017 (IBGE, 2017). The mountainous terrain has few areas of natural vegetation cover, and severe processes of soil erosion and silting of rivers and streams, whose waters also suffer with the disposal of domestic sewage and pesticides, resulting in eutrophication and contamination (Leão et al., 2018).

This cross-sectional research used mixed methodology, and comprised two stages: (1) qualitative, approaching community's perceptions about the impacts of pesticides on health and the environment; and (2) quantitative, gathering the results of the assessment of exposure to pesticides and effects on farmers' health in SJU. Based on the results, information pertinent to the KAP of family farmers in SJU was integrated and discussed.

The qualitative stage was composed of semi-structured interviews with residents of the SJU rural area selected by non-probabilistic convenience in January 2014. Twenty-five individuals (E1 - E25) were interviewed, including farmers, family members, and community stakeholders. The most relevant sentences were transcribed by two observers and, at the end, reviewed and compared thus generating a single record. We decided not to record interviews, so that the participants would feel more comfortable. Interviews were conducted in the homes of the volunteers, and the number of participants was determined by the saturation point of responses, reached when patterns could be identified and some level of generalization could be set (Duarte, 2002). This article describes the respondents' profile, discloses their main statements, and discusses the statements in light of the scientific literature.

The quantitative stage included interviews with family farmers. Interviews were based on questionnaires about exposure to pesticides during the 2014 harvest (July and August), the period of more intensive contact with the product. Additionally, field observations, conversations with farmers, and image and audio records were used to discuss exposure to pesticides. In this stage, 78 farmers selected by convenience ("snowball" sampling) were assessed, whether or not they had participated in the qualitative stage. The sample size was limited by the project's time and budget constraints, and represented about 11% of the farmers involved in tomato growing in SJU.

Information was collected regarding use of pesticides; knowledge, attitudes and practices that may influence exposure, such as: current or past contact; length of exposure; age when responded started farming; activities performed; household exposure (e.g. for domestic pest control or gardening,

or by having contact with contaminated clothing or equipment); previous poisoning; pesticides used; use of agronomic prescription; subject responsible for the prescription and dosage of pesticides; previous training and labor guidance; proximity between homes and cultivation areas; use of PPE (cloth mask or respirator, visor, hat, gloves, boots and overalls); hand washing and showering after work; consumption of food and water in cropping areas; respect for the preharvest interval; place of storage of agricultural inputs; and, handling and disposal of used pesticide containers.

This article presents absolute and relative frequencies to support the discussion of knowledge, experiences, attitudes, and practices. Further details on the study methodology (Leão et al., 2018), respiratory effects (Buralli et al., 2018), and mental and poisoning symptoms (Buralli et al., 2020) are presented in previous studies.

Only individuals who agreed to participate voluntarily in the research and signed the consent form were included. This study was approved by the ethics committee of the *Hospital Universitário Clementino Fraga Filho* of the *Universidade Federal do Rio de Janeiro* (CAAE: 30459814.5.0000.5257).

## Results

### **Perceptions about the impacts of the use of pesticides on health and the environment**

Farmers, family members, and community stakeholders interviewed in SJU ( $n=25$ ) responded about the use of pesticides and possible effects on human health and the environment. The participants resided in the region for an average of  $33.2 \pm 15.4$  years. The volunteer group was composed of 17 men (68%) and 8 women (32%), aged between 21 and 75 years, with a mean age of 56 and 51 years, respectively. Most of them had a low level of education, having only incomplete elementary school education (64%).

Approximately 70% of them worked in pesticides-based agriculture by the time of assessment; however, all of them claimed to have worked previously. Most respondents reported to have learned the agricultural work from relatives, mainly

parents, grandparents, brothers, cousins, and uncles, while only two learned from other farmers and one from specialized technicians.

Some respondents showed satisfaction in agricultural work, especially for the quality of life on the farm, autonomy and flexibility in working hours, pleasure in producing food, being considered by one of them as an advance for the country.

*“When I can no longer [work] I guess it will make me sad.”* (E16 - male, farmer, 69 years old)

*“Service never hurts anyone.”* (E20 - male, farmer, 60 years old)

*“I see no danger in working with prevention [...] there is danger everywhere.”* (E04 - male, farmer, 60 years old)

However, most farmers showed dissatisfaction with rural work, mainly due to work overload, difficulty in selling production, sale value of the products, exploitation by middlemen, lack of technical assistance, difficulty in acquiring/loaning machinery, and the use of pesticides. Some respondents pointed out the low level of education as one of the main conditioning factors for the lack of opportunities beyond rural work.

*“I don’t like the job, it’s very sacrificing, I do it because I have to.”* (E12 - male, producer, age not stated)

*“The middlemen take it directly, after it is consumed, we see the money [...] they say they will pay the value, but then they pay less.”* (E02 - male, farmer, 50 years old)

*“I grow tomatoes because I have no education, I don’t hope that tomatoes will make more money.”* (E09 - male, farmer, 55 years old)

*“It’s not worth it, working in the sun and then seeing nothing [...] I wanted my husband to get a job in the city, but he has no education.”* (E11 - woman, housewife and “helps” cropping, 51 years old)

*"There are few jobs here, few factories, people have no choice." (E05 - woman, general services assistant, 42 years old)*

Most respondents do not acknowledge - or accept - the risks of pesticides, or consider them indispensable to the agricultural production, downplaying the problem of exposure, minimizing or even denying its dangers. Some farmers take on the risks associated with the use of the products because they need them or depend on the work.

*"Don't mind if I like it or not, this is the work, it's what I have to do." (E04 - male, farmer, 60 years old)*

*"There is always lot of peoples who work in the field and get sick, but they have to work because they live on it." "Sometimes they are already sick and go work in the field because they need ." (E10 - male, former farmer, 63 years old)*

*"If I could, I wouldn't work [with pesticides] [...], but there isn't much chance of doing it differently." (E22 - male, farmer, 53 years old)*

*"I think that growers have to use [pesticides], who doesn't use it has nothing to harvest." (E04 - male, farmer, 60 years old)*

*"For me it is normal, it is my job, I know that I have to work with poison [...] if I tell you it is not bad, I'm lying. (E02 - male, farmer, 50 years old)*

Some respondents said that "*the medicine [pesticides] no longer have any effect*", "*they became weaker*" and that "*it seems we haven't even used it*", while others reported an increase in pest resistance leading to the need to apply stronger and larger quantities of pesticides, stating that "*Pests are more resistant*" and "*[pests] got used to the poison*". Three participants considered pesticides as indispensable for agricultural production.

*"I think they are making the medicine [pesticides] weaker to sell more. In the old days the medicine killed right away." (E02 - male, farmer, 50 years old)*

*"If you don't use strong poison, it doesn't kill. If you don't use very strong poison you don't harvest anything. In the beginning, the poison didn't even exist, now we use poison for everything, it harms, right?" (E20 - male, farmer, 60 years old)*

When asked about the dangers of agricultural work, 14 respondents (56%) mentioned pesticides, and two mentioned accidents with animals (8%) and risk of falls (8%). The majority of respondents recognized the acute and chronic effects of pesticides on human health; 24% reported having been intoxicated at least once, and 52% reported cases of poisoning with relatives and pals. Different terms were used to refer to the chemicals, such as "pesticides," "poison," "pesticide," "medicine," and "crop protection products".

*"The medicine [pesticides] does a lot of harm. This has to stop, evil poison, some people eat it, right, it has to stop." (E11 - woman, housewife and "helps" cropping, 51 years old)*

*"Irrigated medicines are the most dangerous in our work." (E08 - male, farmer and president of the farmers' association, 42 years old)*

*"Every work has its risks, but the part of crop production products is the worst." (E21 - male, farmer and middleman, 48 years old)*

*"I've had health problems, I was intoxicated with the poison." (E18 - male, former farmer, 54 years old)*

*"Very, very dangerous [working with poison], people have already died because of the poison. I've lost fellows [...] didn't actually take the poison, it got into him. When preparing the syrup sometimes the hand tightens a bit [uses more pesticides than recommended]." (E16 - male, farmer, 69 years old)*

*"[The use of pesticides causes] lung problems, cancer problems, problems with everything [...] people are very exposed." (E01 - male, farmer, 58 years old)*

*"I think it's bad for your health. The person who works a long time with poison, in old age will have damaged health.* (E04 - male, farmer, 60 years old)

*"I don't think it's bad at the time [to use pesticides], but it accumulates and harms later on.* (E10 - male, former farmer, 63 years old)

Some volunteers highlighted the lack of care in handling and spraying pesticides, the non-use of PPE, and the lack of technical support as important risk factors for getting sick in the rural work.

*"I think it is dangerous to work in the tomato fields, a lot of poison. We see many people working unprotected. The instruction is to wear long sleeve shirts, masks, long pants, but nobody does that, they apply the medicine wearing nothing on the face, pick the tomato on the stalk and eat it.* (E13 - woman, housewife who "used to help" cropping, age not stated)

*"Tomato crops present many dangers, growers are unequipped, don't wear mask, go cropping wearing no shirt."* (E10 - male, former farmer, 63 years old)

*"I think it is dangerous [the grower's work] because there is no support, no guidance."* (E23 - woman, teacher and former farmer, 55 years old)

*"I am the chemist"* (E02 - male, farmer, 50 years old).

Regarding diseasing and the link with rural work, some respondents claimed to have no illnesses ( $n=10$ ; 40%), some claimed to have health problems, while others claimed to be in good health after having ceased working with pesticides. The health conditions most commonly mentioned were: cancer, hypertension and diabetes, by 15 (60%), 12 (48%) and 10 (40%) participants respectively, followed by respiratory diseases and "viruses" ( $n=3$ ; 12%), headaches and orthopedic problems ( $n=2$ ; 8%). One key informant and one farmer spontaneously related "viral" conditions to poisoning from pesticides.

*"When I stopped planting [health] is very good, before I had a headache, malaise. One day I was*

*feeling good, the other I was sick."* (E18 - male, former farmer, 54 years old)

*"When we didn't grow tomatoes not so many people died of serious diseases [...] 40 years ago the worst thing was tuberculosis, now it is not anymore, there is more cancer."* (E10 - male, former farmer, 63 years old)

*"Health sweep away certain things. From when we started growing tomato here to now, people started dying of cancer, I think because of the pesticides."* (E14 - male, farmer, 74 years old)

*"A lot of people already got intoxicated and don't even know what happened, they think it's a virus."* (E22 - male, farmer and middleman, 48 years old)

When asked about the health of children in the region, most participants ( $n=20$ ; 80%) reported good health and "smartness", attributing it to the good nutrition offered in schools, prohibition of child labor, and construction of daycare centers as a way to prevent parents from taking their children to the crops. Among the aforementioned respondents, four (16%) contradicted themselves by stating that there are "lots of special children" and "with learning disorders". This information was restated by three other participants, including a teacher (female, 55 years old) who reported many cases of children with learning disabilities, whose special needs are ignored by their parents.

When asked about the environmental impacts caused by pesticides, 10 respondents (40%) reported concern about water, soil, and air contamination from the improper disposal of pesticides containers and residues. Some reported that habits have improved, and that farmers are more conscious about how to manage used containers.

*"The water from the ditches is so bad because of the pesticides, it goes down to the dams, ditches. There is no assistance to control pesticides in the water."* (E07 - male, organic farmer, 53 years old)

*"Water is very poor, dirty, later on it will be bad for our health."* (E10 - male, former farmer, 63 years old)

*“People were not careful, they threw water from washing pesticides containers into the ditches, polluting the water.”* (E18 - male, former farmer, 54 years old)

*“It has improved a lot, people are more conscious... Today containers are collected. It’s very rare to see someone burning, burying or throwing it anywhere.”* (E25 - woman, community health agent, 21 years old)

When asked who should be held responsible for the reported problems, some respondents (n=8; 32%) named the government (not referring to a specific sphere or manager), the farmers themselves, the mayor, technicians and secretary of the environment, to a lesser extent.

*“The government is responsible [...] There are too many laws, they are only enforced for some, not for others.”* (E03 - male, farmer, 48 years old)

*“We had to take a scrub [rural worker] to Congress to talk about these things [the region’s problems].*

*“They [the rulers] have to preserve, it doesn’t bring many votes, but it gives life, it gives health.”* (E16 - male, farmer, 69 years old)

*“The responsibility is of each farmer.”* (E08 - male, farmer/president of a farmers’ association, 42 years old)

*“Responsibility is of the farmer’s, who deals with this on a daily basis and must be aware.”* (E25 - woman, community health agent, 21 years old)

### **Attitudes and practices as risk factors for exposure to pesticides**

Among the 78 participants in the quantitative stage, the mean age was  $44.1 \pm 13.2$  years (SD) and the mean time of engagement in agricultural work was  $27.0 \pm 14.3$  years. Half of the respondents (50%) started working or helping with crops at less than 12 years of age, and another 30% started between 13 and 17 years (Table 1).

**Table 1 - Risk factors conditioning exposure to pesticides influenced by knowledge, attitudes and practices among family farmers in São José de Ubá - Rio de Janeiro, Brazil, 2014 (n=78).**

Variables of interest	Total	
	%	n
Age (mean in years $\pm$ SD) <sup>a</sup>	$44.1 \pm 13.2$	
Years of rural work (mean in years $\pm$ SD) <sup>a</sup>	$27.0 \pm 14.3$	
Age at which started working on crops		
≤12 years	50.0	39
13–17 years	29.5	23
≥18 years	20.5	16
Sex		
Male	57.7	45
Female	42.3	33
Marital Status		
Single or divorced	14.1	11
Married or Living Together	85.9	67

continue...

**Table 1 – Continuation**

Variables of interest	Total	
	%	n
Monthly family income <sup>b</sup>		
Up to two minimum wages	71.8	56
More than two minimum wages	28.2	22
Education (years of school; IIQ) <sup>c</sup>	4.0 ; 3.0 – 8.0	
Home exposure (if yes)	87.2	68
Distance from residence to cropping sites		
Up to 1 km	84.6	66
More than 1 km	15.4	12
Got work training or technical support	14.1	11
Use of Personal Protective Equipment (PPE) (if yes)		
Any PPE	67.9	53
Boots	53.8	42
Gloves	52.6	41
Mask	50.0	39
Apron	39.7	31
Hat	37.2	29
Face Shield	14.1	11
Consumes water and food at the crop site	91.0	71
Washes hands after working on crops	80.8	63
Takes bath after working on crops	60.3	47
Previous poisoning (if yes)	17.9	14

<sup>a</sup> Data with normal distribution, presented as mean and standard deviation (SD); <sup>b</sup> Family income in minimum wages, being R\$ 724.00 in 2014; <sup>c</sup> Data with abnormal distribution, presented as median and interquartile range (IQR 25-75%).

Most participants were married, had low education and family income, lived up to 1 km away from cropping areas, never received technical support or training, and were domestically exposed to pesticides, either by using these for pest control in and around homes, or through contact with contaminated clothing and equipment (Table 1). Women were the main ones in charge of washing the clothes used in farming, and some stated to even wash clothes together with the family's clothes.

About 58% of the respondents were men who were mainly engaged in pesticides handling and application activities, while women (42%) usually performed other activities such as sowing, fertilizing, harvesting, and “pulling the hose” during irrigation and spraying of pesticides. Respondents reported using 49 pesticides from 31 different chemical groups, most of which were classified as extremely and highly toxic, and some even prohibited for tomato growing in Brazil. These

pesticides were sprayed in mixtures formulated with multiple pesticides 1-3 times (85.7%) or 4-7 times (11.9%) weekly during the harvest period.

Approximately 68% of participants reported using some type of PPE, with boots, gloves, and mask being the most commonly used, while visors was the PPE least cited (Table 1). However, during field visits, it was found that workers were wearing cloth masks, rather than the recommended respirator. In addition, no workers were seen using full PPE. Some respondents said they did not use PPE because they considered them “expensive,” “hot,” and “uncomfortable”. Regarding other attitudes and practices that may increase exposure to pesticides, 91% of the farmers said they consume water and food on the cropping sites, including on days when pesticides are applied. Respectively, about 80% and 60% of them said they wash their hands and shower after working in crops (Table 1), although these practices are more common after the workday and not between cropping activities.

Some study participants did not answer some questions for their own decision, because they were unaware of the answer, or because they did not perform the activity asked. Regarding the use of agronomic prescriptions, 48% of the respondents said they never use it or do not know how to use it. When asked whether they read (or asked someone to read) the labels and instructions of pesticides, 44% said they frequently read, 42% reported never reading, and 14% said they read them sometimes, usually when it was a new product.

Regarding who recommended which pesticides to use, 30 farmers (39%) said it was the salespersons or agronomists, 15 (19%) said it was themselves, other farmers or crop owners and eight respondents (10%) said they did not know. About 30% of those who applied pesticides did not know which products they used, because they sprayed the mixture prepared by others (Buralli et al., 2020). Regarding who recommended the doses and frequency of application, of the participants (n=58), 29 respondents (50%) mentioned salesperson and agronomists, 15 (26%) said they did it by themselves, other farmers or owners and 14 (24%) said they followed what was recommended in the product labels and leaflets. When asked about the preharvest interval between

the last pesticides application and harvest, among those who answered the question, only five (11%) claimed to always respect it, while 22 (50%) said they obeyed it frequently and 17 (39%), occasionally.

About 58% of the farmers claimed to store pesticides in specific areas for inputs on the crop sites, 37% in a reserved place externally to their homes, and 5% inside their homes. When asked about the place of disposal of used pesticide containers, 56% said they deliver or wait for the collection by the municipality for disposal in a municipal warehouse (built in 2013), while the remaining respondents declared they returned to the points of purchase. Regarding the procedures adopted with the containers prior to disposal, 42% said they washed it and kept it in plastic bags, 28% said they kept it in bags or in a reserved environment until disposal, and 19% assumed they washed it, punctured it and kept it in plastic bags. Only 11% claimed to perform triple washing, puncture the containers and store them in appropriate environments until disposal, as recommended by the Brazilian legislation.

Many symptoms compatible with poisoning from pesticides were self-reported (Buralli et al., 2020), although only 18% of respondents claimed to have been intoxicated during rural work (Table 1).

## Discussion

Most family farmers assessed in SJU recognized exposure to pesticides as a health risk, corroborating other studies approaching Brazilian farmers (Gregolís; Pinto; Peres, 2012; Pasiani et al., 2012; Petarli et al., 2019). Despite that, many respondents considered the contact as inevitable and inherent to the agricultural work, in an attitude of minimization and denial of the risk. Self-attribution regarding environmental and health damages due to the use of pesticides was clearly identified in the participants' reports, and none of them related the problem to the conventional agriculture system. The participants of this study live in a setting of high socio-environmental vulnerability, and presented several effects on respiratory health, including symptoms and changes in lung function (Buralli et al., 2018), mental outcomes, and poisoning symptoms (Buralli et al., 2020) associated with contact with the products. Farmers'

knowledge about the effects of pesticides on health and the environment does not necessarily influence their attitudes and practices, and does not ensure the prevention of exposure and deleterious effects. Contact with pesticides, especially in the dynamics of work approached, compromises the health and quality of life of farmers and their families, the agricultural workforce, food production, and gives rise to individual and collective damage, with huge social and economic costs to families, the health system and social security (Brazil, 2020).

In Brazil, other studies with family farmers point out some common aspects, such as low education and income, poor sanitation conditions, exposure to multiple highly toxic pesticides, little or no technical support and training (Carneiro et al., 2015; Pedlowski et al., 2012; Petarli et al., 2019). About 15% of the Brazilian farmers have never been to school, 24% have only primary schooling, and 19% have fundamental schooling (IBGE, 2017). Education is a determinant of income and adherence to safety and health prevention measures (Brazil, 2020). Low education may hinder the reading and understanding of safety guidelines on the use of pesticides. Moreover, information on package leaflets and labels is ambiguous and difficult to understand, some of it unfeasible in the context of family farming (Pedlowski et al., 2012; Waichman; Eve; Nina, 2007).

In another study, farmers complained that fonts are small, instructions are long, and the language is too technical. No participant could tell the toxicity of pesticides based on the colors on the labels, and few understood the informative images (Waichman; Eve; Nina, 2007). This reinforces the relevance of improving the communication of pesticides-related risks among Brazilian farmers, and of providing training on how to use these chemicals. In SJU, most participants had low education, little or no technical support and training in occupational safety, and were unaware of the pesticides they used, thus limiting their perception of risk and adoption of protective measures.

Some habits, attitudes, and practices observed in SJU are of particular concern and may increase occupational and environmental exposure to pesticides, such as: use of mixtures of many

pesticides of high toxicity, frequent and repeated exposure, domestic and peri-domestic use, partial use or absolute no use of PPE, consumption of food and drink on cropping areas, bathing only at the end of the workday, non-use of agronomic prescriptions, incompliance with the recommended preharvest interval, storage of products in inappropriate places, and residences near cropping areas. These attitudes have also been observed in other studies with Brazilian farmers (Carneiro et al., 2015; Gregolis; Pinto; Peres, 2012; Pasiani et al., 2012; Pedlowski et al., 2012; Petarli et al., 2019) and farmers from different lower-income countries (Manyilizu et al., 2017; Negatu et al., 2016; Staudacher et al., 2020). In Costa Rica and Uganda, for example, although most pesticides used are highly toxic and 90% of farmers are aware of health effects, only 11% and 2% of them, in their respective countries, used PPE when handling pesticides (Staudacher et al., 2020).

Rural work in Brazil, especially in small and medium farms, is passed from parents to children from an early age, determining the organization of families around the agricultural activity, and exposing all the core family's members to the high risks of contact with pesticides (Gregolis; Pinto; Peres, 2012; Reis et al., 2017). In SJU, while men handle and spray pesticides, women perform agricultural activities considered of "lesser exposure", often concomitantly or on the same day as the application of pesticides, such as pulling the hose for spraying, tying the sprouts, harvesting fruit, among others. Additionally, they are responsible for washing the clothes and equipment used. In the same line, most of the female farmers assessed in SJU did not use PPE, had less training compared to male farmers, and reported more self-reported symptoms suggestive of acute and chronic poisoning from pesticides (Buralli et al., 2018, 2020).

Compared to men, women in this study showed greater concern about the potential negative health effects of pesticides. This perception, however, was not translated into stronger protective actions, given the cultural conditioning of production in the gender light. Female family farmers are key in the organization and performance of agricultural work and, thus, are more exposed to pesticides. They become more vulnerable because they are also in

charge of domestic chores that include application of pesticides at and in the home, and the washing of clothes and accessories used in the field. Female farmers also move more frequently between the cropping sites and the residence, having contact with a larger number of workers (London et al., 2002). Therefore, public policies aimed at female farmers could contribute toward safer production, echoing in the protection of families involved in agriculture.

In general, it is essential to improve the technical support and training of the Brazilian family farmers on the measures of protection against the dangers of agricultural work, especially related to the use of pesticides as the most effective and immediate way to prevent chemicals-related injuries. For that, it is necessary to strengthen the inter-institutional actions of surveillance and health care focused on farmers' populations, such as the *Política Nacional de Saúde Integral das Populações do Campo, Floresta e Águas* (National Policy for the Integral Health of Farmers, Foresters, and Waters, PNSIPCF) and *Vigilância em Saúde de Populações Expostas a Agrotóxicos* (Surveillance in the Health of Populations Exposed to Pesticides, VSPEA).

More sustainable production models responsive to family farming should also be supported and encouraged for the reduction of environmental and social liabilities, especially in a setting of fast expansion of agricultural production and use of pesticides. A study found strong similarities between the trends of increasing productivity of agricultural commodities and poisonings from pesticides, especially since the 1990s (Porto; Soares, 2012). The research points out that the risks of acute poisoning would be even greater on small farms since risk factors, such as the use of knapsack sprayers, non-use of prescriptions and PPE, and lack of technical assistance, among others, are more present. The claim of SJU farmers that pesticides "became weaker" and "it seems that they were not even applied" also represents an important risk factor, considering the need to use more products and in larger quantities.

In Brazil, the notification of pesticides-related diseases is underestimated, and evaluations of contact and health effects on family farmers are still scarce, hindering the accurate quantification of

acute and chronic effects arising from the complex exposure scenarios. In SJU, for example, there are no health surveillance mechanisms with professionals trained to identify and report poisonings. Therefore, it is also urgent to improve the recording of occupational diseases resulting from the use of these chemicals, and promote epidemiological studies to explain the exposure settings and health effects on farmers, especially with longitudinal monitoring and sensitive biomarkers, evaluating acute and chronic diseases, effects of mixing multiple pesticides, among others.

## Final considerations

Despite partially recognizing the risks of exposure to pesticides, farmers historically adopt unsuitable work practices, considerably favoring their contact with chemicals. The belief that the use of pesticides is inherent to agricultural production, added with the condition of high socio-environmental vulnerability contribute to attitudes of risk minimization and resistance to adhere to more sustainable farming practices.

To prevent risks, promote health, well-being and sustainability in family farming, a key element is the access to quality education in rural areas, technical assistance and occupational training for Brazilian farmers to change knowledge, attitudes and practices about the impacts of pesticides on health and the environment. For that, surveillance, promotion, and health care actions should be strengthened, as well as specific policies and programs for those populations.

The grant or subsidies for purchasing PPE, and the design of models that provide more ergonomic and thermal comfort could increase the adherence of workers to good practices, and thus reduce human exposure. We should also acknowledge the gender inequity that stems from the traditional organization of agricultural work, and induces women to a higher risk of exposure to pesticides. The recognition that women's "help" in agriculture is true work can be translated into greater health security and protection for family farming itself.

Finally, it should be emphasized that the promotion of more sustainable agricultural practices

and the restriction of pesticides use (especially the most toxic ones) are the most effective ways to reduce exposure. Therefore, public and credit policies in this light are much needed.

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### Contribution by the authors

Buralli, Leão, Marques and Guimarães were responsible for the design and planning of the study. Buralli, Ribeiro, Leão, Marques and Guimarães drafted and revised the manuscript. All of them collected, reviewed, and interpreted the data, and performed the critical review and approval of the final version.

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