ABES

Revista Brasileira de Ciências Ambientais
Brazilian Journal of Environmental Sciences

Risks to the environment and to the health of family farmers through the inappropriate use of pesticides: the case of the Union of Associations of the Salitre Valley, Juazeiro/BA, Brazil

Riscos ao meio ambiente e à saúde de agricultores familiares pelo uso inadequado de agrotóxicos: o caso da União das Associações do Vale do Salitre, Juazeiro/BA, Brasil

Israel Vieira de Souza[1], *Tâmara Almeida e Silva*[2], *Francisco Alves Pinheiro*[3]

ABSTRACT

In Brazil, the access and development of technologies for application in agriculture is a fact, highlighting the use of pesticides in crops, including family farming. However, some factors aggravate the risks related to the use of pesticides in family farming, such as the low educational level, the lack of knowledge about the risks, and the failure to follow safety instructions. Thus, the present work aimed to identify the pesticides used by family farmers in the Union of Associations of the Salitre Valley (*União das Associações do Vale do Salitre* – UAVS), analyzing the method of use employed and the possible risks that pesticides offer to the health of farmers. The work was carried out with 31 family farmers from the district of Junco (Juazeiro-BA) who use pesticides in their crops. The information was obtained from the application of semi-structured questionnaires. As a result, it was observed that 100% of the farmers are male, with an average age between 34–41 years, and that, despite the low educational level, no illiterate farmers were identified among the participants. Most of the pesticides used are toxicologically classified as extremely toxic, and are used by 68% of the interviewees. Furthermore, the practice of mixing pesticides was identified. It was also found that a large part of the pesticides used were applied on plants not indicated on the package leaflets. The findings of this study serve as guidance for actions of the society and the government, in order to provide a safer and more productive activity for family farmers.

Keywords: technical assistance; farmers; occupational exposure; health; intoxication.

RESUMO

No Brasil, o acesso e desenvolvimento de tecnologias para aplicação na agricultura é um fato, destacando-se o uso de agrotóxicos nas lavouras, mesmo na agricultura familiar. No entanto, alguns fatores agravam os riscos relativos ao uso de agrotóxicos nesta última, como baixo nível escolar, falta de conhecimento sobre os riscos e não seguimento de instruções de segurança. Assim, o presente trabalho visou identificar os agrotóxicos utilizados pelos agricultores familiares da União das Associações do Vale do Salitre (UAVS), analisando o método de uso empregado e os possíveis riscos que essas substâncias oferecem à saúde dos agricultores. O trabalho foi realizado com 31 agricultores familiares do distrito do Junco (Juazeiro/BA) que utilizam agrotóxicos em suas plantações. As informações foram obtidas com a aplicação de questionários semiestruturados. Como resultados, identificou-se que 100% dos agricultores são do sexo masculino, com média de idade entre 34 e 41 anos, e, que apesar da baixa escolaridade, não foram identificados agricultores analfabetos entre os participantes. A maior parte dos agrotóxicos (utilizados por 68% dos entrevistados) é classificada toxicologicamente como extremamente tóxica; além disso, foi identificada a prática da realização de misturas de agrotóxicos. Verificou-se também que grande parte dos agrotóxicos empregados era aplicada em plantas não indicadas nas bulas. Os achados deste estudo servem de orientação para ações da sociedade e do poder público, no sentido de prover uma atividade mais segura e produtiva para o agricultor familiar.

Palavras-chave: assistência técnica; agricultores; exposição ocupacional; saúde; intoxicação.

[1]Universidade do Estado da Bahia – Juazeiro (BA), Brazil.

[2]Universidade do Estado da Bahia – Paulo Afonso (BA), Brazil.

[3]Universidade Federal do Vale do São Francisco – Juazeiro (BA), Brazil.

Correspondence address: Israel Vieira de Souza – Avenida Sebastião Almeida Branco, 29 – Pedra do Lord – CEP: 48901-340 – Juazeiro (BA), Brazil. E-mail: israel_cnbp@hotmail.com

Conflicts of interest: the authors declare no conflicts of interest.

Funding: none.

Received on: 10/10/2022. Accepted on: 12/10/2022.

https://doi.org/10.5327/Z2176-94781469

Introduction

Agriculture is in a constant process of technological development, whether in relation to machinery, or in relation to the inputs used in crops. However, due attention should be paid to the use of pesticides, especially the those applied by family farmers' use, due to the fact that since there is evidence that the low knowledge and awareness of farmers about the risks related to the use of these products is a problem that threatens their health (Bagheri et al., 2018) and the environment (Damalas and Koutroubas, 2018; Bondori et al., 2019). It is also noteworthy that family farming plays an important role in the development of Brazil. Although its socioeconomic importance has been placed in the background by the State and dominantsectors (Picolotto, 2014), it emerges with the mission of reconciling aspects related to social, economic, environmental, and food security issues.

Brazilian farmers, in many cases, make use of pesticides without proper technical guidance, which starts from the purchase of the products and extends to their application in the field. In addition, they do not have the necessary knowledge of health and safety standards for the proper handling of pesticides (Adissi and Pinheiro, 2015), and this type of use constitutes a risk for users and their surroundings (Recena et al., 2006). Therefore, understanding the product that is being used and knowing its risks, the effects on health, and the appropriate means of risk control are fundamental to develop a safer activity (Brevigliero et al., 2020), both for the health of the rural worker and for the environment.

The risk classification of pesticides used in Brazil is based on Resolution DC/ANVISA No. 294, of July 29, 2019, which established the criteria for toxicological evaluation and classification of pesticides, components, related substances and wood preservatives. According to Article 39 of this Resolution, the classification according to acute toxicity must be determined and identified with the respective category names, where:

- Category 1: Extremely Toxic Product;
- Category 2: Highly Toxic Product;
- Category 3: Moderately Toxic Product;
- Category 4: Slightly Toxic Product;
- Category 5: Product Unlikely to Cause Acute Harm;
- Unclassified: Not Classified Product.

Access to this information and understanding its meaning are considered important and necessary factors for the safe use of agrochemicals.

However, despite regulations regarding pesticide labeling, many farmers do not follow these guidelines, either due to their low levels of education (Remoundou et al., 2015; Öztaş et al., 2018), or due to issues regarding risk perception (Bagheri et al., 2018). Thus, in many cases, increased occupational exposure to pesticides is linked to lack of attention to instructions on their use, and particularly to the failure to comply with basic safety regulations (Damalas and Eleftherohorinos, 2011), which are often not clearly accessible to the user. In addition to the access to information, the farmer must understand its meaning and fully comprehends the risks related to each piece of information. Additionally, one should be aware of the likely acute effects related to the use and ways to avoid contact with the chemical substance.

In this sense, it is essential to understand and fulfill the safety measures, which includes following the manufacturers' recommendations, described in the labels of pesticides (Soares and Souza Porto, 2009), and using the personal protective equipment (PPE) while handling the products (Weng and Black, 2015). Another important source of information is the MSDS (Material Safety Data Sheet), which is the basis for the risk management system, since it enables actions based on the conditions of use of the products, resulting in more efficient safety measures (Pinheiro, 2015).

However, following such guidelines, contained in package leaflets/labels, collides with the low educational level of farmers (Öztaş et al., 2018; Sapbamrer, 2018; Dalbó et al., 2019) and the use of PPE has as barriers the cost of acquisition, lack of information, resistance of farmers to its use and lack of access to it (Adissi and Pinheiro, 2015; Magalhães and Caldas, 2019), mainly due to the cost of acquisition thereof. In this context, it is asked: what is the situation of family farmers of the Union of Associations of the Salitre Valley regarding the use of pesticides?

The answer to this question is fundamental not only for the community studied, but it is also important for contributing to the debate and for new research on the conditions of family farming in Brazil, as well as for subsidizing government actions, in the sense of providing a safer and more productive activity for the family farmer.

Thus, this study aimed to identify the pesticides used by family farmers in the Union of Associations of Salitre Valley (União das Associações do Vale do Salitre — UAVS), analyzing the method of use employed and the possible risks that pesticides offer to the health of farmers. The hypothesis is that family farmers receive technical assistance and use pesticides according to technical guidance, preserving their health and the environment.

Methodology

The municipality of Juazeiro is inserted in the Integrated Region of Economic Development (IRED) of the pole Petrolina/PE and Juazeiro/BA (Cavalcante et al., 2018), and is prominent in irrigated agriculture. According to Junqueira et al. (2020), the city of Juazeiro-BA is located in the northeastern semi-arid region, within the Polygon of Droughts. The microregion of Juazeiro is located in the submedium of the São Francisco River basin, forming, with the neighboring municipality of Petrolina-PE, the largest urban agglomeration of the Brazilian semiarid region.

According to data from IBGE (2017), the district of Junco is part of the municipality of Juazeiro/BA. This district is located in the region known as the Salitre Valley, which stretches from the community of Passagem do Sargento (on the border with Campo Formoso) to Boca

RBCIAMB | v.57 | n.4 | Dez 2022 | 654-664 - ISSN 2176-9478

da Barra, situated on the banks of a portion of the Salitre River basin (UFBA, 2001). This locality is permeated by a history of conflicts over water and land, as a result of unequal access to them (Rossi and Santos, 2018), which became more acute after the implementation of the irrigated perimeters (Rossi and Santos, 2018), that aimed to develop irrigated fruit farming in the region, through the Salitre Project.

The Junco district has several associations, most notably the Union of Associations of the Salitre Valley (UAVS). The UAVS is composed of 10 local associations, totaling 397 members, which are distributed throughout the district as shown in Figure 1.

Of these 397 members, according to information from the presidents of the associations, most of them perform economic activities such as trade, passenger transportation, livestock industry, organic agriculture, agriculture with use of salaried labor, agricultural workers, among others, and few develop family-based agriculture. In this case, the criteria for inclusion in this study were: being a family farmer, being over 18 years old, producing with the use of pesticides, and being a member of the UAVS. The farmers participating in the interviews were selected through the snowball technique, which is based on the indication of the participants themselves, who nominate new participants, according to the inclusion criteria, until all have been interviewed (Baldin and Munhoz, 2011). From the application of the snowball technique, 35 farmers were identified, and 31 agreed to participate in the research. For data collection, interviews were conducted between April and June 2022, using a semi-structured questionnaire. This study was authorized by the Ethics and Research Committee of Universidade do Estado da Bahia, under number CAAE 36657720.9.0000.0057.

The questionnaire was comprised of both open and closed questions. The first part dealt with the socioeconomic survey of the study population. The second part contained questions that sought to identify the products grown on the farms, the type of pesticides used, the knowledge about health and environmental risks, the existing sources of information, the target crop, and the harmful effects of pesticides used on the health of the farmer and the environment.

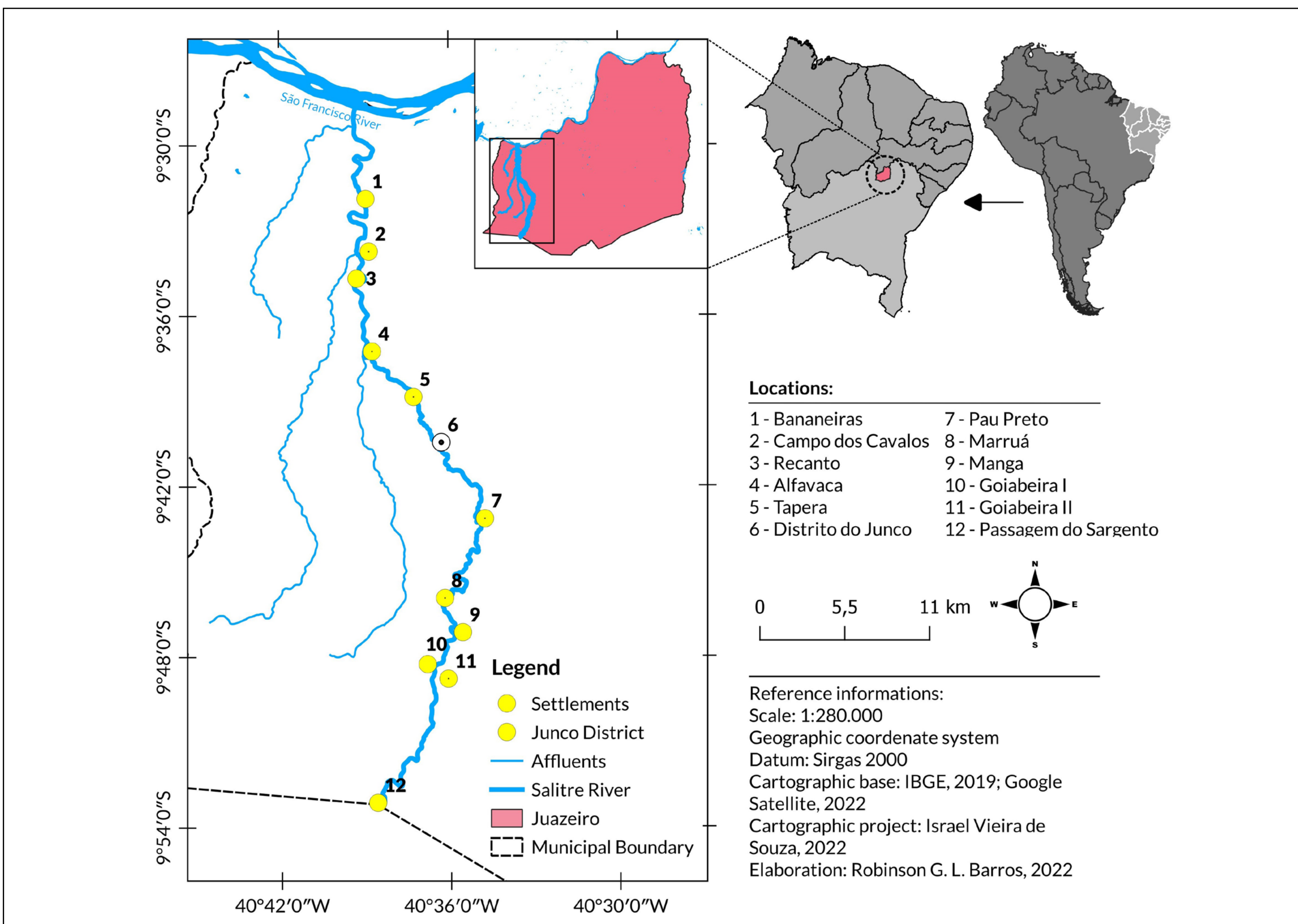

Figure 1 – Distribution of UAVS members in the Junco district, Salitre Valley, Juazeiro-BA.

The interviews were conducted in the production site, which made it possible, through non-participant observation, to verify the storage site for pesticides, the use of personal protective equipment (PPE) and the pesticides employed. Through literature searches, consultations of chemical material safety data sheets (MSDS) and pesticide labels, we evaluated the effects of the used pesticides on the health of farmers and the environment, whether the chemicals are being applied in accordance with the guidelines contained in the labels and with the crop for which it is intended, as well as whether the product is approved for use in our country.

The data collected underwent descriptive statistical analysis to verify socioeconomic characteristics of the participants, the representativity of a given pesticide in relation to the overall use, the rate of correct and incorrect use relative to the target crop of the pesticide and the number of pesticides used. It also served as basis to relate the possible damage to the health of farmers.

Results and Discussion

Socioeconomic aspects

From the analysis of the data collected, it can be stated that 100% of the respondents are male, similar data being found in the region of Juazeiro-BA and Petrolina-PE (Corcino et al., 2019). Regarding the age of the farmers, they presented a distribution between 20 and 62 years of age, with the most frequent range being the interval between 34 and 41 years of age (23%). The work of Corcino et al. (2019) found a higher frequency in the age range distributed between 40 and 59 years, while in the work of Petarli et al. (2019) the main age range was between 30 and 39 years, quite similar to that found in the present work. Barring methodological issues, it can be stated that the majority of these farmers, in general, has its largest distribution among men under 60 years old (94%), which indicates a mature population, but with few young people, only 6%.

Concerning the level of education, it is important to note that there was no record of illiteracy among the farmers interviewed, and that 35.5% claimed to have completed high school. Such information differs from the latest census data from IBGE (PNUD, 2010), for the municipality of Juazeiro/BA, where the illiteracy rate was approximately 51,14%, and is also distinct from the study conducted by Corcino et al. (2019), which found an 8.8% illiteracy rate among agricultural workers and landowners in the region of Juazeiro-BA and Petrolina-PE. Despite the positive data, most farmers have complete (38.7%) and incomplete (22.6%) elementary school level. Other studies point to the low educational level of farmers, such as illiteracy (Remoundou et al., 2015) and incomplete elementary level education (Dalbó et al., 2019), as a factor that generates health and safety risks in relation to the use of pesticides, as it contributes to their inappropriate use (Dalbó et al., 2019), in addition to affecting the development of family farming production (Souza et al., 2019). The results obtained in the study conducted by Magalhães and Caldas (2019), in the Federal District, further corroboates this statement, in which almost half of the farmers assisted in outpatient care, in connection with the use of pesticides, had only elementary school level education.

Therefore, it is important to understand that the educational level of the population under study is an important factor to understand the type of use that they make of pesticides, and from then on to suggest control measures that are contextualized with the environment and the individuals involved.This is mainly due to the fact that illiteracy rates of farmers in underdeveloped countries contribute to their difficulty in understanding the safety regulations in the use of pesticides (Remoundou et al., 2014), as observed in the study conducted by Wahlbrinck et al. (2017), in the municipality of Imigrante-RS, where 83.1% of farmers had incomplete high school education, and only 33.1% claimed to read or understand what was written on the pesticide labels.

Internet access was confirmed by 93.5% of the respondents, who cited cable and mobile data connection as their main means of connection. These results confirm that farmers have means of access to important information, such as television and internet, which, if well used, can be an important means of obtaining information about the products used in the field.

Part of the interviewees (32%) highlighted the participation of up to two people from the family unit in agricultural activities, with greater relevance for the participation of the wife, who was pointed out in 35.5% of the interviews, followed by the children, who accounted for 22.5%, reinforcing and further characterizing this agricultural activity being developed as family work. Other farmers also point out parents, nephews, brothers and sisters, in-laws, and neighbors as individuals who work in the field to help them out. Only 16.1% claim to rely on the labor force of rural day laborers to help at some point during the farming season.

The main data from the interviews and questionnaire application are presented in Table 1.

Besides the agricultural activity, 68% of the farmers state that they perform other economic activities to complement their income, the main ones being: commerce (29%) (grocery stores and bars), activities governed by the Brazilian Consolidation of Labor Laws (the CLT) (19%), day labor for other farmers (14%), and raising goats and sheep (14%).

An important element for the health of farmers and their families is access to a source of drinking water. In this case, only 48% indicated as a source thereof the Water and Environmental Sanitation Service (SAAE), without any treatment of effluents and waste disposal, of the municipality of Juazeiro / BA, another 48% have access to drinking water through cisterns, which are supplied by tanker cars, and 4% point to artesian wells as their sources of drinking water. Taking into account that contaminated drinking water is a source of contamination by pesticides (Damalas and Eleftherohorinos, 2011), the use of water from artesian wells, which are in or near cultivation areas, increases the probability of contamination of farmers, their families, domestic animals, and possibly neighbors who use this water domestically, since the intensive use of pesticides in agricultural systems causes environmental contamination of water, soil, food, and organisms (Sapbamrer, 2018).

Table 1 – Socioeconomic characteristics of family farmers in the Union of Associations of the Salitre Valley, (UAVS), Junco district, Juazeiro-BA, in June 2022 (N = 31).

Characteristic	Frequency	Percentage (%)
Gender		
Female	0	0
Male	31	100
Age		
20 |—27	2	6.5
27 |—34	5	16.1
34 |—41	7	22.5
41 |—48	6	19.4
48 |—55	6	19.4
55 |—62	5	16.1
Number of children		
0	6	19.4
1	6	19.4
2	8	25.8
3	7	22.5
4 or more	4	12.9
Educational level		
Illiterate	0	0
Complete elementary school	12	38.7
Incomplete elementary school	7	22.6
Complete middle school	0	0
Incomplete middle school	0	0
Complete high school	11	35.5
Incomplete high school	1	3.2
Average family income		
Less than 1 minimum wage	3	9.8
1 minimum wage	19	61.2
Between 1 and 2 minimum wages	4	12.9
Between 2 and 3 minimum wages	4	12.9
Between 3 and 4 minimum wages	0	0
Between 4 and 5 minimum wages	1	3.2
More than 5 minimum wages	0	0
Performs another activity besides agriculture		
Yes	21	67.7
No	10	32.3
Internet access		
Yes	29	93.5
No	2	6.5

Source: Prepared by the author (2022) based on interviews using a semi-structured questionnaire, between April and June 2022.

Aspects related to the production process

Regarding the production process, it is noteworthy that the area used for planting is mostly owned by the farmer himself (51.6%), and planting occurs in areas that have between 1-2 hectares (41.9%), less than 1 hectare (16.1%) and 1 hectare (12.9%), whereas only 16.1% had access to bank financing for their current production. These results corroborate the research conducted by Pereira et al. (2009), in the region of Petrolina-PE and Juazeiro-BA, which already pointed out the difficulty in obtaining financial resources to fund production. According to Souza et al. (2019), the obstacles to access financial resources limit the access of family farmers to more efficient production technologies.

The products most grown by family farmers of the UAVS are presented in Figure 2, with emphasis on melon, lemon, pumpkin, bell pepper and passion fruit, as the most cultivated. It is worth noting that most farmers grow an average of two products, with some of them producing three to four agricultural products at the same time.

The commercialization of all production is performed, in 87% of cases, through the middleman, a common figure in wholesale markets who defines the flow of agricultural products (Moraes et al., 2018). These data differ from those found by Nascimento et al. (2016), in Mato Grosso do Sul, where family farmers who used the services of middlemen were approximately 47%. These results demonstrate the need for action, together with family farmers and public authorities, in order to streamline the process of direct selling, which brings greater financial return to the farmer.

An interesting practice that deserves to be highlighted is the fact that 3 family farmers (6% of the participants) who use water from artesian wells for irrigation through small dams for water storage also fatten Nile tilapia (Oreochromis niloticus Linnaeus, 1758) in these storage dams. This activity, in addition to generating income and being a source of protein for the family, also potentially contributes to the process of crop fertilization (Baioni et al., 2017).

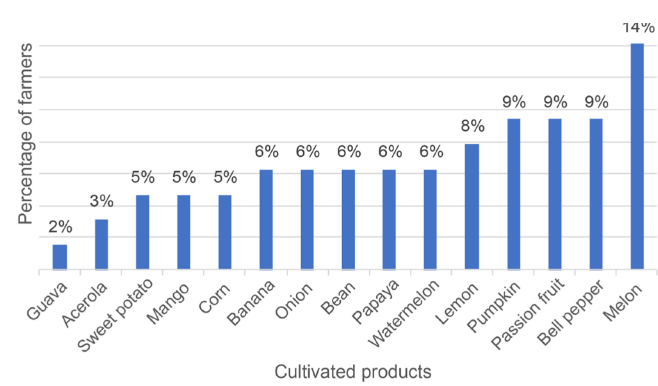

Figure 2 – Relationship between farmer's rates and the varieties of crops grown by family farmers in the UAVS.
Source: Prepared by the author (2022) based on interviews using a semi-structured questionnaire, between April and June 2022.

However, there is a probability that this water source is contaminated by pesticides and these fish are another source of contamination for those who consume them. Because, as stated by Santana and Cavalcante (2016), the toxic effects of pesticides on fish represent a threat to the health of their consumers, including humans.

Brazil has been presenting, in recent years, an increase in the consumption of pesticides in the field, as shown in the study by Ribeiro et al. (2022), in which between 2000 and 2014 there was an increase of 213% in the commercialization of pesticides, with the Northeast region showing an increase of 97.5% in sales, the state of Bahia standing out in the sales average.

In this respect, regarding the main pesticides used by family farmers in UAVS, the seven (7) most cited by family farmers are shown in Table 2, with Vertimec 18 EC (68%) and Klorpan 480 EC (35.0%) standing out. It is worth noting that, on average, each farmer claimed to use at least three (3) different pesticides during cultivation, less than the five (5) used by farmers in Santa Maria do Jetibá-ES (Petarli et al., 2019). Other pesticides cited were: Amistar Top, Avatar, Capataz, Cercobin 700 WP, Curacron 500, Curyon 550 EC, Dimexion, Glyphosate Notox SL, Karate Zeon 50 CS, Manzate WG, Polytrin, Potenza Sinon, Premio, Tifmine, Trigard 750 WP and Voraz. Among these, glyphosate stands out as one of the most commercialized worldwide (Pestizidatlas, 2022).

In developing countries, like Brazil, farmers use highly toxic pesticides, many of them banned from the producing countries (Bondori et al., 2019). In this study of the most used pesticides (Table 2), the majority is toxicologically classified as extremely toxic, used by 68% of the respondents. Similarly, 88% of family farmers in Santa Maria de Jetibá-ES also use pesticides in this classification (Petarli et al., 2019). Such information warns of the danger existing in the handling thereof, both for man and for the environment. However, it is a fact that most farmers have little knowledge of the risks to their health related to the use of pesticides (Weng and Black, 2015), which corroborates the need for actions intended to provide information to farmers, in such a way that there are changes in behaviors in the field.

Regarding the chemical groups to which the 7 (seven) most cited pesticides belong, they are divided into: Avermectins (42.9%), Pyrethroid (20.6%), Organophosphate (23.8%) and the Oxine Methylcarbamate (12.7%). The active ingredients (AI) and their chronic effects are presented in Table 3. In the study by Corcino et al. (2019), in Juazeiro-BA and Petrolina-PE, pyrethroids (18.4%) and organophosphates (17%) were also highlighted.

All identified Ais (Table 3) present acute and chronic effects related to exposure during handling thereof, with Abamectin, Cypermethrin and Methomyl classified as extremely toxic. According to Remoundou et al. (2014), in general, exposure to pesticides causes acute effects to human health, such as: headaches, nausea, eye irritation, skin rashes and flu-like symptoms, most of which are related to all the Ais identified in this study. Additionally, some Ais exhibit potentially carcinogenic effects and reduced human reproductive function (Carneiro, 2015), information that is not present in the package inserts provided by manufacturers.

Data from the interviews conducted point out that 38.7% of family farmers have experienced some discomfort during pesticide application, with complaints related to irritation of the throat, eyes and nostrils, and headache, indicated as the most common acute effects experienced by family farmers. Similar results were found in studies in Rio de Janeiro (Leão et al., 2018) and in the region of Juazeiro-BA and Petrolina-PE (Corcino et al., 2019).However, 61.3% of the respondents reported that they had never experienced any discomfort during, or after, pesticide application. Nevertheless, as stated by Berg et al. (2019), farmers may feel the harmful effects of pesticides years after being exposed and not make the cause and effect relationship with the exposure experienced in the past.

Table 2 – Main pesticides mentioned by family farmers from the UAVS, Junco district, Juazeiro-BA.

Trade name/chemical group	Action	Toxicological classification	Environmental Hazard Classification	Registration Holder
Abamex Br 18 Group 6 – Avermectins	Acaricide, Insecticide and Nematicide	Class I – Highly Toxic	Class III – Environmentally Hazardous Product	Sumitomo Chemical Brasil Indústria Química S.A
Cyptrin 250 CE Group 3a - Pyrethroid	Contact and ingestion insecticide	Class I – Highly Toxic	Class I – Highly Hazardous to the Environment	Nufarm Indústria Química e Farmacêutica S/A
Kaiso 250 CS Group 3a - Pyrethroid	Contact and ingestion insecticide	Class III – Moderately Toxic Product	Class II – Very Hazardous to the Environment	Sumitomo Chemical Brasil Indústria Química S.A
Klorpan 480 EC Group 1b – Organophosphate	Contact and ingestion insecticide	Class III – Moderately Toxic Product	Class II – Very Hazardous to the Environment	Nufarm Indústria Química e Farmacêutica S/A
Lannate BR Group 1a - Oxime Methylcarbamate	Systemic and contact insecticide	Class I - Highly Toxic Product	Class II - Very Hazardous to the Environment	Corteva Agriscience do Brasil Ltda.
Malathion 1000 EC Group 1b - Organofosforado	Inseticida de contato e ingestão	Class V – Product Unlikely to Cause Acute Harm	Class II – Very Hazardous to the Environment	FMC Química do Brasil Ltda.
Vertimec 18 EC Group 6 – Avermectin	Acaricide, Insecticide and Nematicide	Class IV – Mildly Toxic Product	Class II – Very Hazardous to the Environment	Syngenta Proteção de Cultivos Ltda.

Source: based on ADAPAR (2022) and Agrolink websites (2022).

Table 3 – Information about the health effects on humans, related to the Active Ingredients (AI) of the 7 pesticides most used by family farmers in the UAVS.

Trade name	Active Ingredient (AI)	Symptoms of chronic intoxication
Abamex Br 18 Vertimec 18 EC /	Abamectin	*The active ingredient has not been found to be mutagenic, teratogenic or carcinogenic to humans. ** Acute toxicity and suspected reproductive toxicity of the active ingredient (AI) and its metabolites
Cyptrin 250 CE /	Cypermethrin	* Unidentified. **Mutagenic and genotoxic potential, decreased sperm count.
Kaiso 250 CS /	Lambda-Cyhalothrin	*Unidentified. ** Neuromotor disorders.
Klorpan 480 EC /	Chlorpyrifos	*No carcinogenic potential, and no potentially teratogenic effects or reproductive disorders in experimental animals. ** Neurotoxicity, endocrine disruption and decreased male reproductive function.
Lannate BR /	Methomyl	*Unidentified. ** Neurotoxicity, endocrine dysregulation, thyroid ultrastructural changes, genotoxic effect, immunosuppressive effect, and chromosomal changes.

*Prepared by the author (2022) based on ADAPAR (2022) and Agrolink websites (2022); **Dossiê ABRASCO 2015 (*apud* Carneiro, 2015).

A worrisome fact is related to the practice of mixing two (2) or three (3) different pesticides, because no package insert consulted indicates the need for this mixture, highlighting that the critical point is the concentrations used by farmers in the mixtures (Belchior et al., 2014). The process of mixing pesticides in the field is a problem pointed out in several studies (Damalas and Eleftherohorinos, 2011; Gazziero, 2015), and, according to research by Yassin et al. (2002), in the Gaza Strip, farmers who performed mixing had a higher prevalence of toxicity symptoms. According to Castro (2009), due to the reality of the mixtures that occur in the field, it is necessary to understand the toxic potential of these mixtures, in order to determine the advantages and disadvantages of their use, "because mixtures involve greater risk" (Majolo and Rempel, 2018, p. 16), despite being a common practice in Brazil, information about mixtures is insufficient (Gazziero, 2015).

The problems reported above c"n be justified by the fact that over 87.1% of the interviewees stated that they did not receive any type of technical assistance to help with production. Added to this fact, the source of information about pesticides used in the field by family farmers comes from the father (45%), neighbors (29%), other family members (10%), and pesticide sellers (16%), as found in the study by Petarli et al. (2019). The data obtained from the application of the questionnaires prove, for the most part, that the knowledge about the use of pesticides is related to the transfer of knowledge from father to son.

Other sources are neighbors and vendors, also observed in a study conducted in Pakistan (Damalas and Khan, 2016), making it clear that most of the information is contained within the farmers' family cycle, which in turn does not guarantee correct use and consequently puts the farmers' health and the preservation of the environment at risk. According to Soares and Souza Porto (2009, p. 2725), "the guidance of an agronomist when purchasing pesticides, the mandatory use of an agronomist's prescription, and the use of substances that are less toxic to human health considerably reduce health costs for farm workers." Furthermore, there is evidence of a correlation between access to rural technical assistance and the viability of family farms (Souza et al., 2019).

When we evaluated whether farmers apply the pesticides on target plants correctly, comparing the indications contained in the pesticide package leaflets with the use that family farmers perform in the field, it was found that only the pesticide Kaiso 250 CS is used 100% following what is stated in its package insert. The others, in addition to not respecting the directions on the package leaflets, are all used on plants not indicated by the manufacturers, as can be seen in Table 4.

This problem may be related to the lack of technical assistance, since 87% of the respondents claimed not to receive it, added to the low educational level, which may interfere in understanding the information contained in the leaflets (Carvalho et al., 2016; Wahlbrinck et al., 2017), and economic pressure. Because, as stated by Remoundou et al. (2015), factors such as economic pressures also influence human behavior related to the inherent risks of pesticide use. As a result of this behavior, pesticides can harm non-target organisms, causing an ecological imbalance in the environment (Belchior et al., 2014).

Thus, the use of pesticides not indicated for a particular crop may also explain the mixtures, considering that farmers are not following the manufacturer's guidelines and the expected effect may not occur, since the indiscriminate use of pesticides can cause the development of pest resistance (Yassin et al., 2002; Carvalho et al., 2016), thereby leading to the need to increase the amount of applications and, consequently, greater dependence on these products by farmers (Yassin et al., 2002). In France, protection policies dictate that farmer protection depends on the farmer's ability to follow a set of recommendations, such as the information contained in pesticide leaflets (Jouzel and Prete, 2015).

Table 4 – Level of correct use as indicated on the label of the pesticides, compared to their use by farmers.

Trade name	Crop application, as indicated in the package insert, carried out by farmers	Application to crops which are not listed in the package insert and are carried out by farmers	Rate of farmers using pesticides according to the package insert (%)	Rate of farmers using pesticides without following the package insert (%)
ABAMEX BR 18	Lime	Mango, onion, corn, passion fruit, melon	28.57	71.43
CYPTRIN 250CE	Corn	Mango, lime, melon, onion, bell pepper, banana, pumpkin, papaya, beans, watermelon	7.69	12.31
KAISO 250 CS	Pumpkin, mango, watermelon, melon, beans, onions, bell pepper	-----	100	0
KLORPAN 480 EC	Citrus, corn	Melon, papaya, mango, bell pepper, passion fruit, onion, banana	11.76	88.24
LANNATE BR	Corn	Lime, papaya, mango, melon, bell pepper, passion fruit, pumpkin	9.09	90.91
MALATHION 1000 EC	Citrus	Onion, melon, passion fruit, banana	20	80
VERTIMEC 18 EC	Citrus, beans, mango, watermelon, papaya, melon, bell pepper	Pumpkin, guava, onion, passion fruit, banana, corn	55	45

Source: Prepared by the author (2022) based on ADAPAR (2022) and Agrolink websites (2022).

Another point that should be considered in this analysis is the place where pesticides are stored, for 58.1% of the farmers interviewed store pesticides in the field, under trees and covered by tarpaulin, 35.5% store them at home, in external storage, and, very worryingly, 6.5% of family farmers store pesticides inside their homes. These types of errors are characteristic of agriculture, and the storage of pesticides in an inappropriate place is a problem that threatens the health of farmers (Bagheri et al., 2018) and family members. In this regard, it can be said that these storage methods expose farmers, their families, and domestic animals to the risks of contamination. Thus, the harmful effects of pesticides on human health and the environment assume very extensive positions that go beyond the cultivation area, reaching the homes of farmers and their neighborhoods.

All farmers interviewed irrigate their crops. However, there is a very distinct situation in this region regarding access to water for irrigation, since only 29% have access to water from the Salitre irrigation project, whereas 51.6% use artesian wells and water from the Salitre river during the rainy season, and 19.4% use a canal with water from lixiviation arising from sugar cane irrigation. The lack of access to the waters of the Salitre Project is pointed out by the interviewees as limiting the number of farmers currently producing.

Regarding the use of PPE, 61.3% of farmers claimed to use it during the preparation and application of the grout. However, only 19.4% made use of all PPE required for the activity, a number well below the 56.9% found by Corcino et al. (2019), in the Juazeiro-BA and Petrolina-PE region, and the 28% found by Petarli et al. (2019), in Espírito Santo. That is, the non-use of PPE during the handling of pesticides is a common practice in family farming (Petarli et al., 2019), which leads to a more aggravating occupational exposure. A sign that demonstrates that the provision of agricultural technical assistance has the potential to change this type of inappropriate behavior is in the data found by Corcino et al. (2019), which verified that 56.9% of the respondents made use of all PPE, this same study pointing out that 83.5% of the respondents received specialized technical assistance.

From the analysis of the data collected during the interviews, it can be stated that farmers use a wide variety of pesticides, and these products are used indiscriminately, ignoring the manufacturer's guidelines, whether they relate to their action on cultivated plants, or in relation to safety recommendations. Such practices can lead to environmental degradation (Wahlbrinck et al., 2017), and can generate resistance of certain pests to pesticides (Damalas and Eleftherohorinos, 2011), thus requiring more intensive use thereof, which worsens the effects on the health of farmers and the environment.

Conclusions

The family farmers who participated in this study showed a low average income, lack of access to federal government benefits, and difficulty in accessing rural financing, which represent barriers to the development of agricultural activity. In relation to education, the panorama shows an improvement in the level of schooling, which in isolation does not solve the problems identified, but creates possibilities for a policy of inclusion and sustainable development.

The methods of storage of pesticides are another point of attention. It is necessary to define a safe place with limited access for the storage of these products, so that the risks related to their use are not increased, much less domiciliated.

The limitation of access to water, both for irrigation and domestic consumption, is an issue that goes beyond food production; it is a public health issue, and a long-standing demand in this region. Water, in this context, is an essential element of inclusion, since several UAVS members do not produce due to lack of access to water.

As demonstrated in the results of this research, family farmers do not receive technical assistance, which results in the inappropriate use of pesticides in the field, promoting increased exposure to pesticides with risks to their health and environment. Therefore, it is important to promote public policies that provide proper guidance on the handling of pesticides, in order to protect family farmers and the environment. Furthermore, the results presented here can serve as a basis for the development of actions and technical assistance programs, at local and national levels, covering other communities of family farmers, and thus strengthening family farming.

Contribution of authors:

SOUZA, I. V.: Conceptualization; Data Curation; Formal Analysis; Funding; Acquisition; Investigation; Methodology; Project Administration; Resources; Writing — Original Draft; Writing — Review & Editing; SILVA, T. A.: Conceptualization; Methodology; Supervision; Validation; Visualization; Writing — Review & Editing; PINHEIRO, F. A.: Conceptualization; Methodology; Supervision; Validation; Visualization; Writing — Review & Editing.

References

Adissi, P.J.; Pinheiro, F.A., 2015. Análise de risco na aplicação manual de agrotóxicos: o caso da fruticultura do litoral sul paraibano. Sistemas & Gestão, v. 10, (1), 172-179. https://doi.org/10.7177/sg.2015.v10.N1.A14.

Agência de Defesa Agropecuária do Paraná (ADAPAR), 2022. Agrotóxicos no Paraná (Accessed June 5, 2022) at:. https://www.adapar.pr.gov.br/Pagina/Agrotoxicos-no-Parana.

Agência Nacional de Vigilância Sanitária (ANVISA), 2019. Resolução da Diretoria Colegiada nº 294, de 29 de julho de 2019. Dispõe sobre os critérios para avaliação e classificação toxicológica, priorização da análise e comparação da ação toxicológica de agrotóxicos, componentes, afins e preservativos de madeira, e dá outras providências. Diário Oficial da União, Seção 1, v. 146, 78-31 (Accessed December 9, 2020) at:. http://www.cvs.saude.sp.gov.br/zip/U_RS-MS-ANVISA-RDC-294_290719.pdf.

AGROLINK, 2022. Portal do Conteúdo Agropecuário. Agrolinkfito (Accessed June 5, 2022) at:. https://www.agrolink.com.br/agrolinkfito.

Bagheri, A.; Emami, N.; Allahyari, M.S.; Damalas, C.A., 2018. Pesticide handling practices, health risks, and determinants of safety behavior among Iranian apple farmers. Human and Ecological Risk Assessment, v. 24, (8), 2209-2223. https://doi.org/10.1080/10807039.2018.1443265.

Baioni, J.C.; Squassoni, G.H.; Souza Cultri, G.R.; Silva, J.D.T.; Dias, L.T.S., 2017. Efluente de piscicultura na produção consorciada de cebolinha e coentro. Nucleus Animalium, v. 9, (1), 143-150. https://doi.org/10.3738/21751463.2809.

Baldin, N.; Munhoz, E.M.B., 2011. Educação ambiental comunitária: uma experiência com a técnica de pesquisa snowball (bola de neve). Revista Eletrônica do Mestrado em Educação Ambiental, v. 27, 46-60. https://doi.org/10.14295/remea.v27i0.3193.

Belchior, D.C.V.; Souza Saraiva, A.; López, A.M.C.; Scheidt, G.N., 2014. Impactos de agrotóxicos sobre o meio ambiente e a saúde humana. Cadernos de Ciência & Tecnologia, v. 34, (1), 135-151. https://doi.org/10.35977/0104-1096.cct2017.v34.26296.

Berg, Z.K.; Rodriguez, B.; Davis, J.; Katz, A.R.; Cooney, R.V.; Masaki, K., 2019. Association between occupational exposure to pesticides and cardiovascular disease incidence: The Kuakini Honolulu Heart Program. Journal of the American Heart Association, v. 8, (19), e012569. https://doi.org/10.1161/JAHA.119.012569.

Bondori, A.; Bagheri, A.; Allahyari, M.S.; Damalas, C.A., 2019. Pesticide waste disposal among farmers of Moghan region of Iran: current trends and determinants of behavior. Environmental Monitoring and Assessment, v. 191, (1), 30. https://doi.org/10.1007/s10661-018-7150-0.

Brevigliero, E.; Possebon, J.; Spinelli, R., 2020. Higiene Ocupacional: agentes biológicos, químicos e físicos. São Paulo: Editora Senac.

Carneiro, F.F. (Ed.), 2015. Dossiê ABRASCO: um alerta sobre os impactos dos agrotóxicos na saúde. Rio de Janeiro: EPSJV; São Paulo: Expressão Popular.

Carvalho, C.R.F.; Ponciano, N.J.; Souza, C.L.M., 2016. Levantamento dos agrotóxicos e manejo na cultura do tomateiro no município de Cambuci-RJ. Revista Ciência Agrícola, v. 14, (1), 15-28. http://dx.doi.org/10.28998/rca.v14i1.2327.

Castro, V.L.S.S., 2009. Uso de misturas de agrotóxicos na agricultura e suas implicações toxicológicas na saúde. Journal of the Brazilian Society of Ecotoxicology, v. 4, (1-3), 87-94. https://doi.org/10.5132/jbse.2009.01.012.

Cavalcante, R.E.T.R.; Santos, J.S.; Bernardes, J.R.; Souza, W.D.; Guerra, C.J.O.; Souza, F.A., 2018. Análise do controle interno na gestão de recursos humanos: Uma análise empírica nas Câmaras Municipais da RIDE-Polo Petrolina-PE e Juazeiro-BA. In: Anais do Seminário Científico do UNIFACIG, (3).

Corcino, C.O.; Teles, R.B.D.A.; Almeida, J.R.G.D.S.; Lirani, L.D.S.; Araújo, C.R.M.; Gonsalves, A.D.A.; Maia, G.L.D.A., 2019. Avaliação do efeito do uso de agrotóxicos sobre a saúde de trabalhadores rurais da fruticultura irrigada. Ciência & Saúde Coletiva, v. 24, (8), 3117-3128. https://doi.org/10.1590/1413-81232018248.14422017.

Dalbó, J.; Filgueiras, LA.; Mendes, A. N., 2019. Effects of pesticides on rural workers: haematological parameters and symptomalogical reports. Ciencia & asúde Coletiva, v. 24, n. 7, 2569-2582. https://doi.org/10.1590/1413-81232018247.19282017.

Damalas, C.A.; Eleftherohorinos, I.G., 2011. Pesticide exposure, safety issues, and risk assessment indicators. International Journal of Environmental Research and Public Health, v. 8, (5), 1402-1419. https://doi.org/10.3390/ijerph8051402.

Damalas, C.A.; Khan, M., 2016. Farmers' attitudes towards pesticide labels: implications for personal and environmental safety. International Journal of Pest Management, v. 62, (4), 319-325. https://doi.org/10.1080/09670874.2016.1195027.

Damalas, C.A.; Koutroubas, S.D., 2018. Farme's' behaviour in pesticide use: A key concept for improving environmental safety. Current Opinion in Environmental Science & Health, v. 4, 27-30. https://doi.org/10.1016/j.coesh.2018.07.001.

Gazziero, D.L.P., 2015. Misturas de agrotóxicos em tanque nas propriedades agrícolas do Brasil. Planta Daninha, v. 33, n. 1, 83-92. https://doi.org/10.1590/S0100-83582015000100010.

Instituto Brasileiro de Geografia e Estatística (IBGE), 2017. IBGE: Cidades. IBGE (Accessed May 24, 2022) at:. https://cidades.ibge.gov.br/brasil/ba/juazeiro/historico.

Jouzel, J.; Prete, G., 2015. Becoming a victim of pesticides: legal action and its effects on theobilizationon of affected farmworkers. Sociologie du Travail, v. 57, suppl. 1, e63-e80. https://doi.org/10.1016/j.soctra.2015.09.010.

Junqueira, H.S.; Almeida, L.M.F.; Souza, T.S.; Santos Nascimento, P., 2020. Análise da variação sazonal e de tendências na precipitação pluviométrica no município de Juazeiro-BA. Revista Brasileira de Geografia Física, v. 13, (6), 2641-2649. https://doi.org/10.26848/rbgf.v13.6.p2641-2649.

Leão, R.S.; Marques, R.C.; Buralli, R.J.; Silva, D.S.; Guimarães, J.R.D., 2018. Avaliação de saúde pública por exposição a agroquímicos: uma experiência com a agricultura familiar no noroeste do Rio de Janeiro. Sustentabilidade em Debate, v. 9, (1), 81-94. http://doi.org/10.18472/SustDeb.v9n1.2018.26956.

Magalhães, A.F.A.; Caldas, E.D., 2019. Occupational exposure and poisoning by chemical products in the Federal District. Revista Brasileira de Enfermagem, v. 72, Suppl. 1, 32-40. https://doi.org/10.1590/0034-7167-2017-0439.

Majolo, F.; Rempel, C., 2018. Impact of the use of pesticides by rural workers in Brazil. Brazilian Journal of Environmental Sciences (Online), (50), 1-25. https://doi.org/10.5327/Z2176-947820180357.

Moraes, J.G.; Balensifer, P.H.M.; Pires, M.L.L.S., 2018. Agricultura Familiar e especificidades dos mercados atacadistas: O caso da CECAF/CEASA e Feira do feijão de Capoeiras–Pernambuco. Cadernos de Ciências Sociais da UFRPE, v. 2, (13), 106-123.

Nascimento, J.S.; Bezerra, G.J.; Schlindwein, M.M.; Padovan, M.P., 2016. Produção agropecuária, agregação de valor e comercialização pela agricultura familiar no estado do Mato Grosso do Sul. Redes: Revista do Desenvolvimento Regional, v. 21, (3), 320-334. https://doi.org/10.17058/redes.v21i3.6219.

Öztaş, D.; Kurt, B.; Koç, A.; Akbaba, M.; İlter, H., 2018. Knowledge level, attitude, and behaviors of farmers in Çukurova region regarding the use of pesticides. Biomed Research International, v. 2018, 6146509. https://doi.org/10.1155/2018/6146509.

Pereira, E.; Rola, S.; Freitas, M.; Rosa, L.P., 2009. Irrigation for food production in the semi-arid region of northeast Brazil: case studies in Petrolina, Juazeiro, Vale do Açu and Agrovila Canudos in Ceará-Mirim. WIT Transactions on Ecology and the Environment, v. 125, 537-551. https://doi.org/10.2495/WRM090481.

Pestizidatlas, 2022. Daten und Fakten zu Giften in der Landwirtschaft. Fundação Heinrich Böll, Bund für Umwelt und Naturschutz Deutschland, PAN Germany e Le Monde Diplomatique (Accessed June 29, 2022) at:. https://www.boell.de/de/pestizidatlas.

Petarli, G.B.; Cattafesta, M.; Luz, T.C.D.; Zandonade, E.; Bezerra, O.M.D.P.A.; Salaroli, L.B., 2019. Exposição ocupacional a agrotóxicos, riscos e práticas de segurança na agricultura familiar em município do estado do Espírito Santo, Brasil. Revista Brasileira de Saúde Ocupacional, v. 44, e15. https://doi.org/10.1590/2317-6369000030418.

Picolotto, E.L., 2014. Os atores da construção da categoria agricultura familiar no Brasil. Revista de Economia e Sociologia Rural, v. 52, (suppl. 1), 63-84. https://doi.org/10.1590/S0103-20032014000600004.

Pinheiro, F., 2015. FISPQ e responsabilidade social das empresas. Revista Intertox de Toxicologia, Risco Ambiental e Sociedade, v. 2, (1), 117-120. https://doi.org/10.22280/revintervol2ed1.21.

Programa das Nações Unidas para o Desenvolvimento (PNUD), 2010. Atlas Brasil. PNUD (Accessed May 24, 2022) at:. http://www.atlasbrasil.org.br/perfil/municipio/291840

Recena, M.C.P.; Pires, D.X.; Caldas, E.D., 2006. Acute poisoning with pesticides in the state of Mato Grosso do Sul, Brazil. Science of the Total Environment, v. 357, (1-3), 88-95. https://doi.org/10.1016/j.scitotenv.2005.04.029.

Remoundou, K.; Brennan, M.; Hart, A.; Frewer, L.J., 2014. Pesticide risk perceptions, knowledge, and attitudes of operators, workers, and residents: a review of the literature. Human and Ecological Risk Assessment, v. 20, (4), 1113-1138. https://doi.org/10.1080/10807039.2013.799405.

Remoundou, K.; Brennan, M.; Sacchettini, G.; Panzone, L.; Butler-Ellis, M.C.; Capri, E.; Charistou, A.; Chaideftou, E.; Gerritsen-Ebben, M.G.; Machera, K.; Spanoghe, P.; Glass, R.; Marchis, A.; Doanngoc, K.; Hart, A.; Frewer, L.J., 2015. Perceptions of pesticides exposure risks by operators, workers, residents and bystanders in Greece, Italy and the UK. Science of the Total Environment, v. 505, 1082-1092. https://doi.org/10.1016/j.scitotenv.2014.10.099.

Ribeiro, S.D.D.M.; Siqueira, M.T.D.; Gurgel, I.G.D.; Diniz, G.T.N., 2022. A comercialização de agrotóxicos e o modelo químico-dependente da agricultura do Brasil. Saúde em Debate, v. 46, (spe. 2), 210-223. https://doi.org/10.1590/0103-11042022E214.

Rossi, R.A.; Santos, E., 2018. Conflito e regulação das águas no Brasil: a experiência do Salitre. Caderno CRH, v. 31, (82), 151-167. https://doi.org/10.1590/S0103-49792018000100010.

Sapbamrer, R., 2018. Pesticide use, poisoning, and knowledge and unsafe occupational practices in Thailand. New Solutions, v. 28, (2), 283-302. https://doi.org/10.1177/1048291118759311.

Santana, L.M.B.M.; Cavalcante, R.M., 2016. Transformações metabólicas de agrotóxicos em peixes: uma revisão. Orbital, v. 8, (4), 257-268. https://doi.org/10.17807/orbital.v8i4.856.

Soares, W.L.; Souza Porto, M.F., 2009. Estimating the social cost of pesticide use: an assessment from acute poisoning in Brazil. Ecological Economics, v. 68, (10), 2721-2728. https://doi.org/10.1016/j.ecolecon.2009.05.008.

Souza, P.M.D.; Fornazier, A.; Souza, H.M.D.; Ponciano, N.J., 2019. Diferenças regionais de tecnologia na agricultura familiar no Brasil. Revista de Economia e Sociologia Rural, v. 57, (4), 594-617. https://doi.org/10.1590/1806-9479.2019.169354.

Universidade Federal da Bahia (UFBA), 2001. Plano de gerenciamento dos recursos hídricos da bacia do Rio Salitre. UFBA (Accessed May 26, 2022) at:. http://www.grh.ufba.br/download/Rel%20Final%20Salitre-%20Res%20Executivo%20-%2025-02-2003.pdf.

Wahlbrinck, M.G.; Bica, J.B.; Rempel, C., 2017. Percepção dos agricultores do município de imigrante (RS) sobre os riscos da exposição a agrotóxicos. Brazilian Journal of Environmental Sciences (Online), (44), 72-84. https://doi.org/10.5327/Z2176-947820170128.

Weng, C.Y.; Black, C., 2015. Taiwanese farm workers' pesticide knowledge, attitudes, behaviors and clothing practices. International Journal of Environmental Health Research, v. 25, (6), 685-696. https://doi.org/10.1080/09603123.2015.1020415.

Yassin, M.M.; Mourad, T.A.; Safi, J.M., 2002. Knowledge, attitude, practice, and toxicity symptoms associated with pesticide use among farm workers in the Gaza Strip. Occupational and Environmental Medicine, v. 59, (6), 387-393. https://doi.org/10.1136/oem.59.6.387.