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Débora Tonon Schreiner

SOCIOECONOMIC DETERMINANTS OF SAFETY BEHAVIOR OF FARMERS IN THE PESTICIDE MANAGEMENT

Porto Alegre
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Master dissertation presented to the Graduate Program in Agribusiness of the Center for Studies and Research in Agribusiness of the Federal University of Rio Grande do Sul, as a partial requirement for obtaining the title of Master in Agribusiness.

Advisor: Prof. Dr. Homero Dewes

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I dedicate this dissertation to my Mother,
my Father and my Sister, who have always
encouraged me to pursue my dreams.
To João Pedro, the greatest
supporter I could
ever known.

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“Seja a mudança que você quer ver no mundo.”

Mahatma Gandhi.

DETERMINANTES SOCIECONÔMICOS DOS COMPORTAMENTOS DE SEGURANÇA N APLICAÇÃO DE PESTICIDAS POR PRODUTORES RURAIS

Na agricultura moderna, os agrotóxicos desempenham um papel importante na garantia de alta produtividade agrícola e são considerados um componente vital no controle de pragas e doenças. No entanto, a dependência aos agroquímicos é difícil de sustentar por causa de efeitos adversos não intencionais, causados em longo prazo ao meio ambiente e à saúde humana. Por isso, os agricultores devem ter comportamentos de segurança no uso dos agrotóxicos. O objetivo desta pesquisa foi identificar os fatores socioeconômicos que influenciam os diferentes comportamentos de segurança dos agricultores no manejo de agrotóxicos. Examinamos o manejo de agrotóxicos no Rio Grande do Sul, estado ao sul do Brasil. Os fatores socioeconômicos que levamos em consideração foram: ter estudos rurais, ser o dono da propriedade rural, trabalhar direto nas atividades agrícolas, fazer mistura em tanque, ter treinamento básico no uso de agrotóxicos, possuir assistência técnica, ter informações fornecidas com a compra de agrotóxicos e ler a bula dos agrotóxicos. Ponderamos a respectiva influência no comportamento dos agricultores com base nas respostas binárias, sim ou não. Os dados foram coletados através da aplicação de questionários presenciais e on-line para um grupo de 72 agricultores. O teste do Qui-quadrado revelou que a) os estudos rurais influenciam os agricultores no conhecimento sobre as propriedades doa agrotóxicos aplicados, na identificação das principais pragas e doenças das culturas, no conhecimento dos diferentes tipos de bicos e suas propriedades e na verificação do vento na pulverização; b) ser o dono da propriedade rural está relacionado à leitura e acompanhamento da receita agronômica (RA) de produtos agrotóxicos usados; c) trabalhar diretamente nas atividades da lavoura está relacionado com o conhecimento sobre as propriedades do agrotóxico aplicado; d) o treinamento básico no uso de agrotóxicos da aos agricultores conhecimento sobre as propriedades dos agrotóxicos aplicados, influencia na identificação das principais pragas e doenças das culturas e na verificação do vento durante a pulverização; e) informações com a compra de produtos influenciam na utilização de equipamentos de proteção individual (EPI); f) a leitura das bulas dos agrotóxicos melhora o conhecimento sobre as propriedades dos agrotóxicos aplicados, sobre a leitura e seguimento da RA de produtos agrotóxicos utilizados, regulagem da pressão durante a pulverização e o conhecimento dos diferentes tipos de bicos de aplicação e suas propriedades. Os fatores socioeconômicos “acesso a assistência técnica” e “fazer mistura em tanques” não foram relacionados a qualquer comportamento de segurança. A conclusão é que, apesar dos rigorosos regulamentos estaduais e fiscalização do uso de agrotóxicos, há traços comportamentais individuais que são modulados por um ambiente socioeconômico que vai além da legislação. Esses determinantes devem ser levados em consideração se quisermos esperar segurança pessoal e ambiental nas práticas de manejo de agrotóxicos.

Palavras-chave: Controle químico de pragas, uso de agrotóxicos, atitudes seguras dos agricultores, Brasil.

ABSTRACT

In modern agriculture, pesticides play an important role in ensuring high agricultural productivity and are considered a vital component of agriculture in pest and disease control. However, pesticide dependence is difficult to sustain because of unintended long-term adverse effects on the environment and human health. Because of this, farmers should have safety behaviors in the use of pesticides. The aim of this research was to identify the socioeconomic factors that influence the different safety behaviors of farmers in the pesticide management. We examine the management of pesticides in the Brazilian Southern State of Rio Grande do Sul. The socioeconomic factors we took into consideration were: rural studies, being the land owner, working directly in the farm activities, applying pesticide mixture, basic training in pesticide use, access to advice, information provided with pesticide purchase, and reading pesticide labels. We pondered their respective influence on the farmers' behavior based on the binary answers yes or no. Data was collected through applications of face-to-face and online questionnaires to a group of 72 farmers. The Chi-square revealed that a) rural studies influence the farmers in the knowledge about the properties of the sprayed pesticide, in the identification of major pests in crops, in the knowledge of different types of nozzle and their properties and in checking the wind when spraying; b) being the land owner is related to reading and following the agronomic recipe (AR) of used pesticide products; c) working directly in the farm activities is related with the knowledge about the properties of the sprayed pesticide; d) basic training in pesticide use gives the farmers knowledge about the properties of the sprayed pesticide, the possibility of identifying major pests in crops and about checking the wind when spraying; e) information with purchase of products influences the use of complete personal protective equipment (PPE); f) reading pesticide labels improves the knowledge about properties of the sprayed pesticide, about reading and following the AR of used pesticide products, the calibration of pressure when spraying and the knowledge of different types of nozzle and their properties. The socioeconomic factors access to advice and applying pesticide mixture were not related to any safety behavior. The conclusion is, in spite of the strict state regulations and enforcement in pesticide use, there are fine individual behavioral traces that are modulated by a socioeconomic environment which goes beyond legislation. These determinants must be taken into consideration if we want to expect personal and environmental safety in the pesticide management practices.

Keywords: Chemical Pest Control, Pesticide use, Farmers' safe attitudes, Brazil

LIST OF ABBREVIATIONS

ANVISA – National Health Surveillance Agency

AR – Agronomic Recipe

GDP - Gross Domestic Product

ha – hectares

LC – Lethal Concentration

LD – Lethal Dose

MAPA - Ministry of Agriculture, Livestock and Supply

PHI – Pre-harvest Interval

PPE - Personal Protective Equipment

PPPs – Plant Protection Products

SB – Safety Behavior

SEAPDR – Secretary of Agriculture, Livestock and Rural Development

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SUMMARY

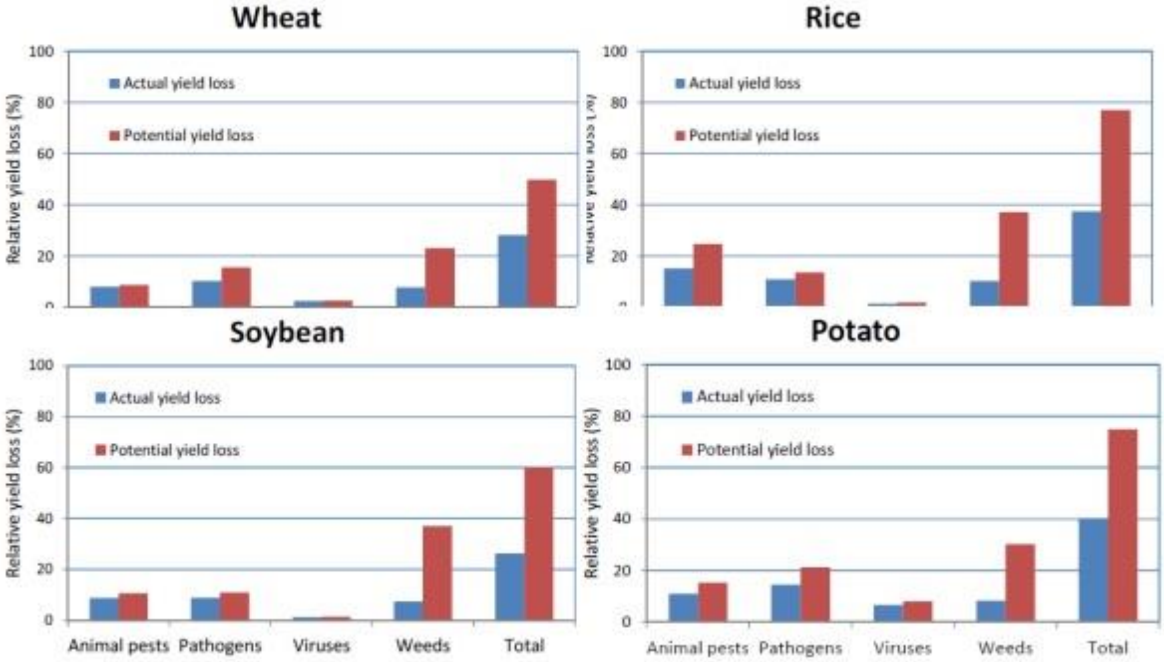
1 INTRODUCTION

Pesticides have long been used to control pests and diseases in modern agriculture (BHATNAGAR, 2001; PRETTY, 2005; REKHA; NAIK; PRASAD, 2006; ZHANG; JIANG; OU, 2011) and are considered a vital component of farming, playing a major role in maintaining high agricultural productivity (TILMAN et al., 2002). Indeed, global grain production has doubled in the past 40 years, mainly from the increased yields resulting from greater inputs of pesticides, fertilizer, water, new crop strains, and other technologies of the 'Green Revolution' (FAO, 2001; TILMAN, 2001; WORLD HEALTH ORGANIZATION, 1990). This has raised the global per capita food supply (FAO, 2001), reducing hunger, improving nutrition (and thus the ability of people to better reach their mental and physical potential) and sparing natural ecosystems from conversion to agriculture (WAGGONER, 1995). However, the expectations to 2050 is a global population projected to be 50% larger than at present, and therefore global cereal demand is projected to double (AGORAMOORTHY, 2008; ALEXANDRATOS, 1999; CASSMAN, 1999; FAO, 2005; FEDOROFF; COHEN, 1999) and consequently, high-input intensive agricultural production systems with greater and widespread use of pesticides to manage pests might emerged as a dominant feature (TILMAN et al., 2002).

From the 1960s onwards, further increase in food production was allowed by the introduction of synthetic crop protection chemicals. The researcher Oerke (2006) is one that has greatly studied crop losses in agriculture and is considered as the reference in this field. Crop losses can be due to weeds, pathogens, viruses and pests. The total crop loss without any crop protection is called the potential loss. In practice losses will be lower due to the use of synthetic plant protection products - PPPs (conventional agriculture), which include agrochemicals as pesticides; biopesticides (organic and conventional agriculture); and other cultivation measures, such as mechanical weed control, crop rotation, biological control and resistant cultivars. The actual losses are those that occur when plant protection was carried out by PPPs and/or by other cultivation measures. Actual losses can be high by non-efficient crop protection or low by adequate crop protection. Crop protection becomes more important at high potential yields. Under these conditions the impact of PPPs is high and will substantially decrease potential crop losses and increase crop yield (AKTAR;

SENGUPTA; CHOWDHURY, 2009). Worldwide potential and actual crop losses differ considerably according to crops (Figure 1) but also according to regions (OERKE, 2006).

Figure 1 – Effect of weeds, diseases, animal pests and viruses on worldwide potential crop losses and actual losses in different crops.



Source: (STOA, 2019 based on OERKE, 2006)

STOA (2019) constructed a table (Table 1) comparing the food losses with and without protection plant protections, potential food losses and gains by using PPPs for 5 major crops. Food losses were estimated by SAVARY et al. (2019) and potential food losses were based on OERKE (2006). It is difficult to prove with experimental data the exact relations between yield and PPP use. Effects are based on simulations, assumptions and/or interpretations of PPP application schemes by experts. Rough estimates of the reduction in yield losses are around 80% of the potential loss when PPPs are banned and crop protection is carried out by other cultivation measures. This percentage depends to a very large extent on crop, region and potential yield.

Table 1 - Potential food losses, food losses with and without plant protection products (PPPs), and gains by using PPPs for five major crops. Losses are calculated at the global scale and are caused by pathogens, pests, viruses and weeds. Crop protection without PPPs include crop rotation, biological control, soil management, resistant varieties and others

Crop	% losses with PPPs*	% losses without PPPs ** (own estimation)	% potential losses ***	Yield gain by PPPs
Wheat	21% (10.1-28.1)	40%	50%	19%
Rice	30% (24.6-40.9)	62%	77%	32%
Maize	22% (19.5-41.1)	55%	69%	33%
Potato	18% (8.1-21)	60%	75%	42%
Soybean	21% (11-32.4)	48%	60%	27%

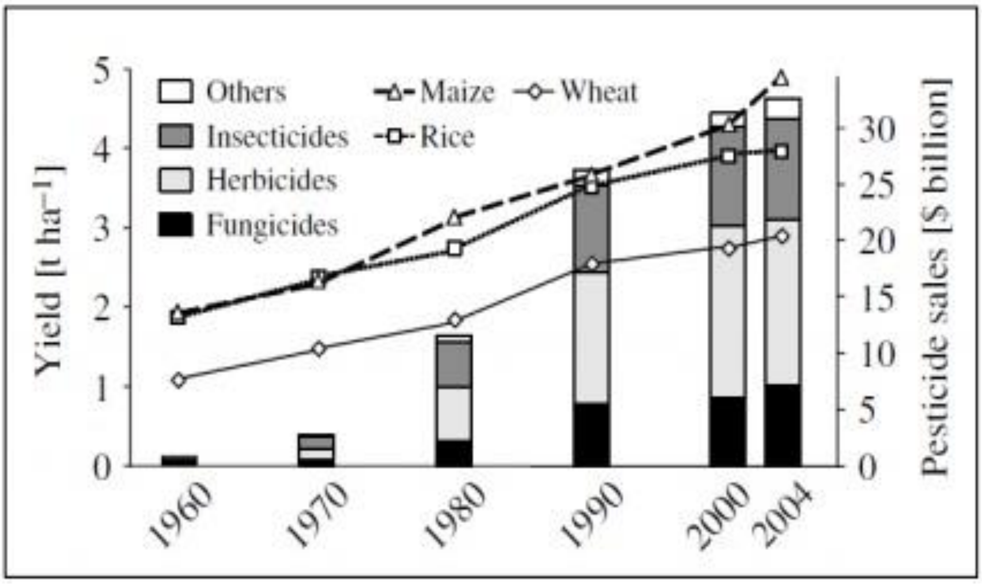
*: Savary *et al.*, 2019; **: estimated at 80% of the potential losses; ***: Oerke, 2006

Source: (STOA, 2019)

It is expected that climate change will result in a temperature rise of 1.5-2 °C and in more irregular precipitation with more rainfall in some regions and more drought periods in other regions. According to Deutsch et al. (2018), global yield losses are projected to increase by 10 to 25% per degree of average global surface warming. Crop losses will be most acute in areas where warming increases both population growth and metabolic rates of insects. These conditions are centered primarily in temperate regions, where most grain is produced. Moreover, it is likely that new pests and diseases will threaten crops in the future, at least at the local scale. More and new infestations will stress an adequate crop protection with (new) PPPs, where pesticides are included, unless alternatives can be developed. To STOA (2019), plant protection products are an indispensable tool to the farming, because without them, the crop yield will reduce by around 20-40% depending on the crop and are an insurance risk or the farmer.

Due to high demand for pesticide use, worldwide pesticide production increased at a rate of about 11% per year, from 0.2 million tons in 1950s to more than 5 million tons by 2000 (FAO, 2019). The parallel increase of yield and PPP use during the past decades is illustrated in Figure 2, proving that without pesticides and non-chemical controls, the damage inflected by pests would be much more severe than it is at present. Oerke et al. (1994) estimated that world crop losses would increase from 40 to 70%. Such an increase would cause an estimated economic loss of about $ 500 billion per year and would significantly reduce the world's food supply and increase the current world malnutrition of more than 66% (WHO, 2000). Similarly, U.S. crop losses would increase from the current 37% to about 70% and represent an economic loss of about $ 500 billion (OERKE et al., 1994).

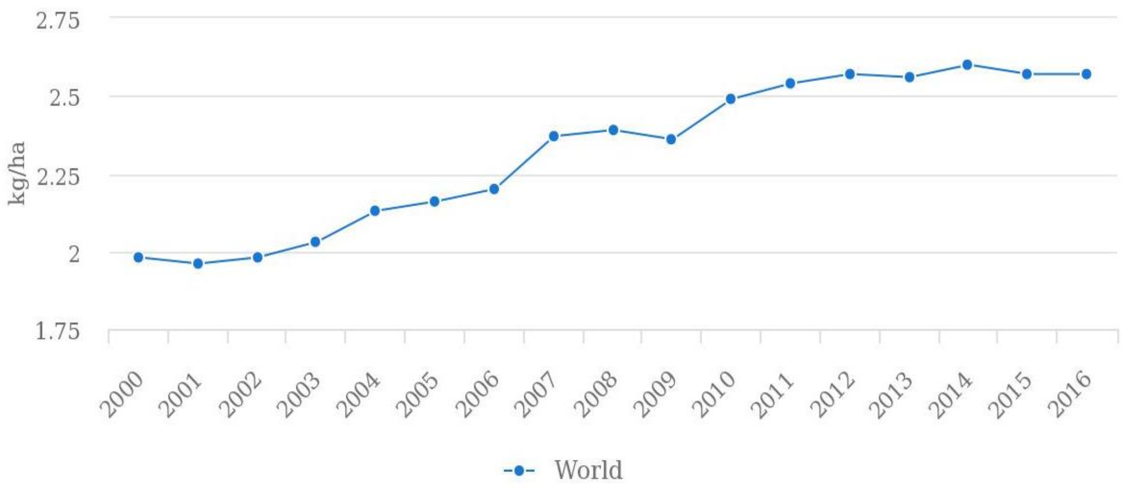
Figure 2 - Increase in yield of three major crops and increase in plant protection products sales.



Source: (OERKE, 2006)

In most developing countries, pesticide use has continued to increase over the last two decades, e.g. Thailand during the 1990s and 2000s (PRANEETVATAKUL et al., 2013) and Pakistan during the 1990s (KHAN et al., 2002). Moreover, contrary to what is commonly believed, pesticide use has remained stable in several developed countries, e.g. the United States (OSTEEN; FERNANDEZ-CORNEJO, 2013), mostly due to an increase in herbicide use (SCHREINEMACHERS; TIPRAQSA, 2012). Overall the average pesticide consumption was 1,98 kg/ha in 2000 and had a growth to 2,57 Kg/ha in 2016, as showed in Figure 3 (FAO, 2019), being in 2014, 45 % of all pesticides used in Europe, 25 % in the United States, 4 % in India and 26 % in the rest of the world (DE et al., 2014). Total expenditure on pesticides is about US$40 billion per year (Popp et al. 2013). Although the use of pesticides has contributed to an increase in the supply of food, there are health-related problems of farmers who use these products that are indispensable to a successful crop production. Reliance on pesticides is difficult to sustain because of unintended long-term adverse effects on the environment and human health (PIMENTEL, 2005) and to minimize the risk associated with the application of this products, farmers must have safety behaviors in the use of pesticides.

Figure 3 - World average of pesticide use per area of cropland 2000-2016.



Source: FAOSTAT (2019)

Measures such use of personal protective equipment (PPE), avoidance of health risks, hygiene practices and appropriate use of pesticides during and after handling are identified as ways of safety behavior that can reduce the severity of pesticide effects on farmers' health and on the environment (FAN et al., 2015; HASHEMI et al., 2012; HOUBRAKEN et al., 2016; PHUNG et al., 2013). Some scientific papers study the conduct among farmers around the world, trying to identify what leads for a special care of the use of agrochemicals and if there is a safe use of them. There are many articles published, especially in developing countries that relate pesticide problems and their consequences. For example, in Iran (ABADI, 2018; BONDORI et al., 2018; REZAEI; DAMALAS; ABDOLLAHZADEH, 2018; SHARIF et al., 2019) and China (FAN et al., 2015), working on the attitude of farmers, the risk, knowledge and safe behavior of pesticides can be found. In Nepal and China, the factors that affect farmers and the risks of pesticide standards are studied (BHANDARI et al., 2018; KHANAL; SINGH, 2016; YANG et al., 2014). Other papers report about Ethiopian, Pakistani and Tanzanian farmers in the knowledge of pesticide use practices and the circumstances that affect application (DAMALAS; KHAN, 2017; LEKEI; NGOWI; LONDON, 2014; MEKONNEN; AGONAFIR, 2002; MENGISTIE; MOL; OOSTERVEER, 2017) where farmers lack training and access to awareness programs (DAMALAS; KHAN, 2017; KHANAL; SINGH, 2016). In Brazil, data suggest that both chronic and recent occupational exposure to contemporary pesticides is related to problems such as affect male thyroid function at the peripheral level (PICCOLI et al., 2016), cases of poison in the rural population (CALDAS, 2016), positive association between self-reported pesticide poisoning and common mental disorders and depression (CAMPOS et al., 2016).

Additionally, several studies found that despite good knowledge and awareness about harmful effects of pesticides (ABDOLLAHZADEH; SHARIF; DAMALAS, 2015; DAMALAS; GEORGIOU; THEODOROU, 2006; ISIN; YILDIRIM, 2007; RAHMAN, 2003; WENG; BLACK, 2015), most farmers ignore the use of safety behavior measures that can reduce environmental and health problems (DAMALAS; GEORGIOU; THEODOROU, 2006; DAMALAS; HASHEMI, 2010; HASHEMI et al., 2012; HOUBRAKEN et al., 2016). The factors that influence the safety behavior of chemical pesticides in agriculture is especially pertinent in front of evidence that pesticides may pose a significant risk to the farmers and the environment. While previous studies on safe pesticide use provided some support for increased health risks by these chemicals, very few studies have assessed farmers’ safety behavior in pesticide use and its determinants with constructing a composite variable of safety behavior.

1.1 RESEARCH QUESTION

The present study was conducted with an exposed group to answer to the question: What are the factors that influence the safety behaviors of farmers in the pesticide management (Figure 4)?

In the light of the foregoing, the objective of this research was to identify the socioeconomic (SE) factors that influence the different safety behaviors (SB) of farmers in the pesticide managemen**t.** The results might provide insights for the development and adjustment of public policies aiming at reduction of pesticide exposure at farm level and hence less health consequences due to pesticides, whilst still allowing farmers to produce cost effectively, sustainably, and environmentally friendly.

Figure 4 - Which are the socioeconomic factors that influence the different safety behaviors of farmers in the pesticide management?

Source: Elaborated by the Author

2 METHODOLOGY

2.1 DESCRIPTION OF THE STUDY

Data was collected through applications of face-to-face questionnaires to a group of 24 farmers, and through an online questionnaire to rest group of farmers. The initial intention was to conduct the survey through face-to-face questionnaires, however, due to changes the questionnaires had to be answered online in order to complete the survey and the data needed to be collected in two ways to increase the sample size. All the respondents were farmers working with soybean or rice. Both these crops are pesticide-intensive. All the farmers are from Rio Grande do Sul (Figure 5), the Southern state in Brazil. They are from cities of Espumoso, Jaguari, Saldanha Marinho, Panambi, Santo Antônio do Palma, Gentil, Sertão, Não-Me-Toque, Plameira das Missões, Santa Bárbara do Sul, Aroio Grande, Porto Xavier, Salto do Jacuí, Jacuizinho, Palmares do Sul, Fortaleza dos Valos, Barra do Quaraí, Júlio de Castilhos, Carazinho, Selbach, Colorado and many from Uruguaiana. The state plays an important role to the national food supply, and soybean and rice are among the main agricultural crops produced in Rio Grande do Sul. These crops are important in exported products from Brazil and have a significant contribution to the Brazilian Gross Domestic Product (GDP) (FEIX; LEUSIN JUNIOR; AGRANONIK, 2017). The study area is a typical agricultural land with heavy pesticide use and relevant studies concerning farmers' behavior in the crop production do not exist in the area.

Figure 5 - State of Rio Grande do Sul in Brazil.

Source: (Rio Grande do Sul, 2014)

2.2 QUESTIONNAIRE AND SAMPLE SIZE

Data was collected in a questionnaire, with structured items which were designed based on previous literature and it had 72 respondents. Although, a great variety of items could have been included in the questionnaire, the items were selected based on simplicity, to facilitate understanding by farmers, and on originality in terms of frequency of use in previous publications. Therefore, we tried to select original items to increase the novelty of our study and we kept the suggested answers simple, so that farmers could easily understand, regardless their education level. We collected data about, socioeconomic characteristics such as farmers' age, education, farm size, income and years of applying pesticides. These were continuous variables. We also collected data about socioeconomic characteristics using binary variables: rural studies, land owner, act directly into the farm activities, applying pesticide mixture, basic training in pesticide use, access to advice and information provided with pesticide purchase. Farmers' safety behavior was measured by a set of binary variables: reading pesticide labels, use of complete personal protective equipment (PPE), knowledge about the properties of the sprayed pesticide, follow preharvest intervals (PHI) after spraying, the inspection of the correct crop stage before spraying, the identification of major pests in crops, taking special care of correct disposal of pesticides containers, reading and following the agronomic recipe (AR) of used pesticide products , regulation of pressure when spraying, knowledge of different types of nozzles and their properties and checking the wind when spraying. Table 2 shows the questions that were asked to the farmers, disposed in form of binary and continuous variables and the scales used to the questionnaire's answer.

It is important to mention that the research was supported by the Secretary of Agriculture, Livestock and Rural Development of the State of Rio Grande do Sul (SEAPDR) to conduct the interview with field professionals authorized by the state government. These professionals work with rural inspection, part of which is to visit rural properties and ask farmers questions about crop activities. They conducted the work at first, with permission from SEAPDR to carry out the work and subsequently, due to unpredictable activities, the rest of the forms were sent by Google Forms and answered online.

Table 2 – Interview guide used on the study

Variable	Abbreviation	Unit
Continuous variable		
Age	AGE	Years
Education	EDU	Years of education
Farm size	FAS	Hectares
Income	INC	Percent of agriculture income
Years of applying pesticide	YAP	Years
Binary variable		
Rural studies	1	0 = NO 1 = YES
Land owner	2	0 = NO 1 = YES
Act directly into the farm activities	3	0 = NO 1 = YES
Applying pesticide mixture	4	0 = NO 1 = YES
Basic training in pesticide use	5	0 = NO 1 = YES
Access to advice	6	0 = NO 1 = YES
Information provided with pesticide purchase	7	0 = NO 1 = YES
Reading pesticide labels	8	0 = NO 1 = YES
Use the complete PPE	9	0 = NO 1 = YES
Knowledge about the properties of the sprayed pesticide	10	0 = NO 1 = YES
Follow PHI after spraying	11	0 = NO 1 = YES
Inspection of the correct crop stage before spraying	12	0 = NO 1 = YES

The identification of the major pests in the crops	13	0 = NO 1 = YES
Take special care of correct disposal of pesticides containers	14	0 = NO 1 = YES
Reading and following the AR of pesticide products used	15	0 = NO 1 = YES
Regulation of pressure when spraying	16	0 = NO 1 = YES
Knowledge of different types of nozzle and their properties	17	0 = NO 1 = YES
Checking the wind when spraying	18	0 = NO 1 = YES

2.3 IDENTIFYING THE DEGREE OF TOXICITY EXPOSURE

Data on the degree of toxicity of the pesticides used by the farmers were obtained by analyzing all the agricultural products obtained to each of the farmers. This analysis was possible thanks to the collaboration of Secretary of Agriculture, Livestock and Rural Development (SEAPDR), as they have a system where it is possible to access all the "agronomic recipes" issued to each farmer and this data was provided for the research. In Brazil, the acquisition of any agrochemical can only be done by presenting the "agronomic recipe" to the retailer. The agronomic recipe is issued by a professional in the agronomic area and its main objective is the correct use of the product. The agronomic recipe (AR) contains guidelines related to the quantity, application time, indicated crop, grace period, worker and environmental protection, and final disposal of empty agrochemical containers. In other words, pesticides can only be commercialized directly to the user through the presentation of the agronomic recipe. After analyzing all the agronomic recipe, all the products utilized by each farmer were classified in the degree of toxicity.

For pesticide registration and classification in Brazil, the company should provide a lot of information about the product for the National Health Surveillance Agency (ANVISA) to determine the potential danger, aimed to reduce the risk to final consumers (MARIA et al., 2015). The toxicity data are obtained through animal experiments and laboratory analysis. Then, the toxicological classification of pesticides is established according to dermal exposure, oral or inhalation studies, thus determining the parameters lethal concentration (LC 50) and lethal dose (LD 50), and the acute effects (ANVISA, 2018). The classification is reported on the labels and instructions for use of pesticides, as shown in Table 3.

Table 3 - Classification of pesticides according to the degree of toxicity

Class	Toxicity ☠	Color
I	Extremely toxic	Red
II	Highly toxic	Yellow
III	Moderately toxic	Blue
IV	Slightly toxic	Green

Source: (ANVISA, 2018)

2.4 DATA ANALYSIS

Statistical analyzes were performed in two stages. Firstly, we used descriptive statistics to characterize the sample and describe the main characteristics of the farmers through the continuous variables. For the second stage, the respondents answered the socioeconomic questions and the safety behavior through a binary variable (1 = yes; 2 = no) for the answers. The Mean test performed by Chi-square test was to explore the differences between respondents who answered yes to SE and SB questions and to those who answered no to the same questions of SE and SB. Each of the socioeconomic questions were confronted with the questions of safety behavior, in order to verify if there is a relation between the variables, that is, if the factors described for the socioeconomics questions influence in having attitudes of safety behavior. We used $p \leq 0.05$ as a criterion for statistical significance in all data analysis. The variables used in our analysis are presented in Table 4.

Table 4 - Binary socioeconomic and safety behavior variables used for Chi-square test

SE variables	SB variables
Rural studies	Use the complete PPE
Land owner	Knowledge about the properties of the sprayed pesticide
Act directly into the farm activities	Follow PHI after spraying
Applying pesticide mixture	Inspection of the correct crop stage before spraying
Basic training in pesticide use	The identification of the major pests in the crops
Access to advice	Take special care of correct disposal of pesticides containers
Information provided with pesticide purchase	Reading and following the AR of pesticide products used
Reading pesticide labels	Regulation of pressure when spraying
	Knowledge of different types of nozzle and their properties
	Checking the wind when spraying

3 RESULTS

3.1 DESCRIPTIVE STATISTICS

Most of the farmers in the sample were male (97.84 percent) and the average age was 43.61 years (SD of 15.804 years). Although most farmers were male, there were females that also responded the questionnaire on behalf of someone in charge and some of the females are also involved in the activities. The farmers in the sample had an average experience of 27.4 years of applying pesticides (SD of 16.464 years). The average farm size, measured as the number of hectares, was 846.25 (SD of 1267,205 ha). The levels of education in the sample were as follows: 14.1 percent had incomplete elementary school, 1.4 percent had complete elementary school, 7.0 percent had incomplete high school, 8.5 percent had complete high school, 7.0 percent had an incomplete bachelor degree, 45.1 percent had a complete bachelor degree, and 15.5 percent had "Agricultural Technician" studies, that consists of three years of rural studies after the end of the high school. Due to a high percentage of respondents having the complete bachelor's degree and the average farm size is considered for the region high as well, it can be said that respondents are the "select group" and highlight it. All the results are described below, in the Table 5.

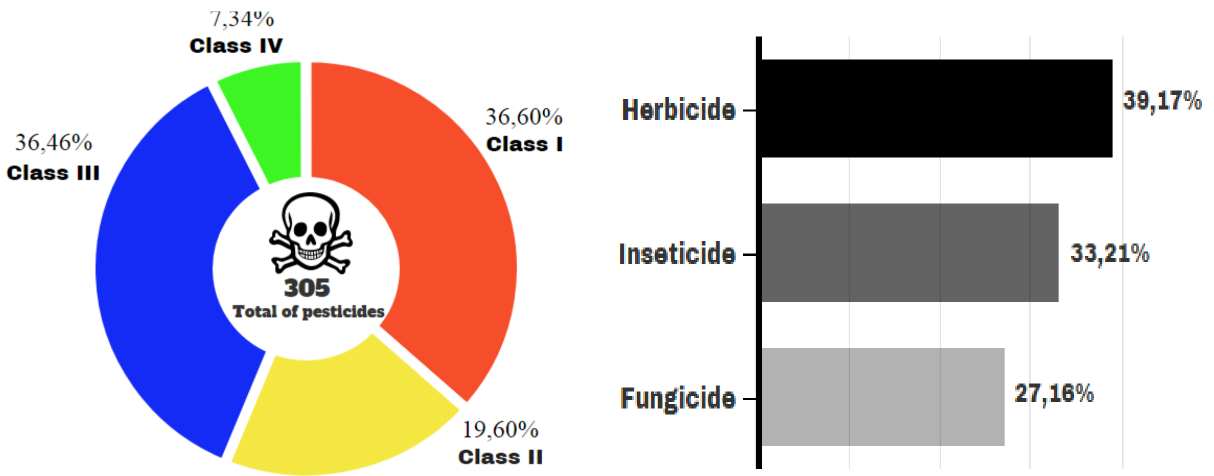
Table 5 - Characterization of the sample through continuous variables answered by farmers (*n=72)*

Variable	Minimum	Maximum	Mean	Std. Deviation
Age (Years)	21	84	43,61	15,804
Education (Years)	3	17	15	-
Farm size (ha)	10	7000	846,25	1267,205
Income (%)	30	100	-	-
Application of pesticide (Years)	1	75	27,44	16,464

3.2 CLASSIFICATION AND TOXICITY DEGREE OF PESTICIDE USED BY FARMERS

A total of 305 different commercial brands of pesticide, all registered for culture, were found to be in use during the survey period and can be found in the Appendix B. Herbicides (39.17%) were the most commonly used pesticides, followed by insecticides (33.21%) and fungicide (27.61%) (Table 2). About 36.60% of the pesticides used belong to the ANVISA toxicity class I (extremely toxic), with a close number (36.46%) to the toxicity class III (moderately toxic). The rest of the pesticides were less expressive, compared with the other two: 19,60% was classified as highly toxic and just 7.34% slightly toxic. The types and classification hazardous of pesticides is possible to see in Figure 6.

Figure 6 - Analysis of the agrochemicals utilized by farmers



3.3 RESULTS OF THE CHI-SQUARE

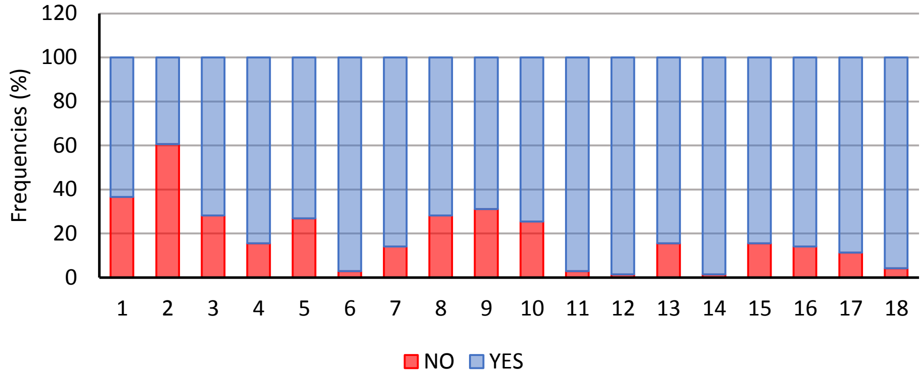
The Table 6 presented the frequency of the farmers’ answers to each of SE (1 to 8) and SB (9 to 18) questions. Through the farmers' answers for each response, the Chi-square test was applied to it and Table 6 and Figure 7 could be constructed. It was noticed that for most of the answers, the farmers answered yes. A few questions were observed, which were: access to advice, follow the preharvest interval after spraying, the Inspection of the correct crop stage before spraying, taking special care of correct disposal of pesticides containers and checking the wind when spraying, which had a frequency of more than 95% for the yes response.

Table 6 - Frequencies of the answers about farmers socioeconomic and safety behavior

Variables	Frequency	Percentage (%)
1 Rural study		
No	26	36,6
Yes	45	63,4
2 Land owner		
No	43	60,6
Yes	28	39,4
3 Act directly into the farm activities		
No	20	28,2
Yes	51	71,8
4 Applying pesticide mixture		
No	11	15,5
Yes	60	84,5
5 Basic training in pesticide use		
No	19	26,8
Yes	52	73,2
6 Access to advice		
No	2	2,8
Yes	69	97,2
7 Information provided with pesticide purchase		
No	10	14,1
Yes	61	85,9
8 Reading pesticide labels		
No	20	28,2
Yes	51	71,8
9 Use the complete PPE		

No	22	31
Yes	49	69
10 Knowledge about the properties of the sprayed pesticide		
No	18	25,4
Yes	53	74,6
11 Follow PHI after spraying		
No	2	2,8
Yes	69	97,2
12 Inspection of the correct crop stage before spraying		
No	1	1,4
Yes	69	98,6
Variables	Frequency	Percentage (%)
13 The identification of major pests in crops		
No	11	15,5
Yes	60	84,5
14 Take special care of correct disposal of pesticides containers		
No	1	1,4
Yes	70	98,6
15 Reading and following the AR of pesticide products used		
No	11	15,5
Yes	60	84,5
16 Regulation of pressure when spraying		
No	10	14,1
Yes	61	85,9
17 Knowledge of different types of nozzle and their properties		
No	8	11,3
Yes	63	88,7
18 Checking the wind when spraying		
No	3	4,2
Yes	68	95,8

Figure 7 - Frequencies of the answers about farmers socioeconomic and safety behavior



The Chi-square test of independence allows determining whether variables are independent of each other or whether there is a pattern of dependence between them. If there is a dependence, it's possible to claim that the two variables have a statistical relationship with each other. For the presentation of Chi-Square test results (Table 7), the variables were crossed out in a 2x2 tabulation format, meaning that each question about SB was crossed between all the SE answers, to see if farmers who apply each of the safety behavior would differ of farmers who do not apply, in terms of its socioeconomic characteristics.

Table 7 - Chi-Square test results between answers of socioeconomic and safety behavior

Rural Study	*p*	Difference between groups
Use the complete PPE	0,976	
Knowledge about the properties of the sprayed pesticide	0,013	*
Follow PHI after spraying	0,602	
Inspection of the correct crop stage before spraying	0,629	
The identification of the major pests in the crops	0,048	*
Take special care of correct disposal of pesticides containers	0,634	
Reading and following the AR of pesticide products used	0,194	
Regulation of pressure when spraying	0,098	
Knowledge of different types of nozzle and their properties	0,024	*

Checking the wind when spraying	0,045	*
Land owner	*P*	Difference between groups
Use the complete PPE	0,865	
Knowledge about the properties of the sprayed pesticide	0,956	
Follow PHI after spraying	0,152	
Inspection of the correct crop stage before spraying	0,600	
The identification of the major pests in the crops	0,106	
Take special care of correct disposal of pesticides containers	0,394	
Reading and following the AR of pesticide products used	0,023	*
Regulation of pressure when spraying	0,157	
Knowledge of different types of nozzle and their properties	0,098	
Checking the wind when spraying	0,658	
Act directly into the farm activities	*P*	Difference between groups
Use the complete PPE	0,910	
Knowledge about the properties of the sprayed pesticide	0,076	*
Follow PHI after spraying	0,487	
Inspection of the correct crop stage before spraying	0,286	
The identification of the major pests in the crops	0,372	
Take special care of correct disposal of pesticides containers	0,718	
Reading and following the AR of pesticide products used	0,628	
Regulation of pressure when spraying	0,579	
Knowledge of different types of nozzle and their properties	0,599	
Checking the wind when spraying	0,636	
Applying pesticide mixture	*P*	Difference between groups
Use the complete PPE	0,461	
Knowledge about the properties of the sprayed pesticide	0,568	
Follow PHI after spraying	0,288	
Inspection of the correct crop stage before spraying	0,157	
The identification of the major pests in the crops	0,458	
Take special care of correct disposal of pesticides containers	0,845	
Reading and following the AR of pesticide products used	0,542	
Regulation of pressure when spraying	0,485	
Knowledge of different types of nozzle and their properties	0,360	
Checking the wind when spraying	0,401	
Basic training in pesticide use	*P*	Difference between groups
Use the complete PPE	0,071	
Knowledge about the properties of the sprayed pesticide	0,014	*
Follow PHI after spraying	0,069	
Inspection of the correct crop stage before spraying	0,743	
The identification of the major pests in the crops	0,034	*

Take special care of correct disposal of pesticides containers	0,732	
Reading and following the AR of pesticide products used	0,613	
Regulation of pressure when spraying	0,084	
Knowledge of different types of nozzle and their properties	0,363	
Checking the wind when spraying	0,017	*
Access to advice	*P*	Difference between groups
Use the complete PPE	0,527	
Knowledge about the properties of the sprayed pesticide	0,555	
Follow PHI after spraying	0,944	
Inspection of the correct crop stage before spraying	0,971	
The identification of the major pests in the crops	0,712	
Take special care of correct disposal of pesticides containers	0,972	
Reading and following the AR of pesticide products used	0,712	
Regulation of pressure when spraying	0,736	
Knowledge of different types of nozzle and their properties	0,786	
Checking the wind when spraying	0,917	
Information with product purchase	*P*	Difference between groups
Use the complete PPE	0,008	*
Knowledge about the properties of the sprayed pesticide	0,219	
Follow PHI after spraying	0,736	
Inspection of the correct crop stage before spraying	0,871	
The identification of the major pests in the crops	0,485	
Take special care of correct disposal of pesticides containers	0,859	
Reading and following the AR of pesticide products used	0,515	
Regulation of pressure when spraying	0,429	
Knowledge of different types of nozzle and their properties	0,277	
Checking the wind when spraying	0,630	
Reading pesticide labels	*P*	Difference between groups
Use the complete PPE	0,210	
Knowledge about the properties of the sprayed pesticide	0,003	*
Follow PHI after spraying	0,513	
Inspection of the correct crop stage before spraying	0,714	
The identification of the major pests in the crops	0,153	
Take special care of correct disposal of pesticides containers	0,718	
Reading and following the AR of pesticide products used	0,009	*
Regulation of pressure when spraying	0,004	*
Knowledge of different types of nozzle and their properties	0,035	*
Checking the wind when spraying	0,189	

* Significant differences between SB for $p < 0{,}005$

4 DISCUSSION

This study provided insight into the socioeconomic factors that influence farmers in taking safety attitudes in pesticide use. All farmers were using chemical pesticides for the management of pests with a significant part of the used pesticides belonging to the extremely toxic or moderately toxic. Data reveals that **rural study** influences the farmers into the knowledge about the properties of the sprayed pesticide, the identification of major pests in crops, knowledge of different types of nozzle and their properties and checking the wind when spraying. Education plays a very important role as it widens the vision of the farmers and exposes them to various aspects and opportunities related to agriculture and related fields (SHETTY et al., 2010). Higher levels of education contribute positively to farmers' knowledge on pesticide use (DAMALAS; KHAN, 2017; JALLOW et al., 2017), being increasingly recognized the importance of education to safe pesticide use (MATTHEWS; MEMBER, 2012). As the majority of the sample had their education related to agribusiness, it is possible to understand how to achieve some awareness and management about crop production.

Being the land owner is related to reading and following the AR of used pesticide products, as well as acting directly to the farm activities is related with knowledge about the properties of the sprayed pesticide. Rahman (2003) also found a positive relation in being a land owner and pesticide use. **Acting into the farm activities** is tied to experience in years of applying pesticide and contributing to farmers' knowledge of pesticide use. This means that pesticide use is not just a mental capacity, but also carries elements of practical and physical skills. Farmers tend to generate knowledge from practical experiences and not from formal experiments and research. For example, an episode of pesticide intoxication in the past showed a significant positive effect on personal protective equipment (PPE) use (FEOLA; BINDER, 2010). This effect indicates that farmers who experienced adverse health effects from pesticide use in the past were more likely to use PPE (DAMALAS; ABDOLLAHZADEH, 2016), suggesting that farmers learn from previous personal experiences.

In our study, **basic training in pesticide** use gives farmers knowledge about the properties of the sprayed pesticide, the possibility of identifying major pests in crops and checking the wind when spraying. Factors such as the lack of training on safe pesticides use are considered the main barriers to the practice of good safety behavior (CABRERA;

LECKIE, 2009; DAMALAS; KHAN, 2017; KHAN; DAMALAS, 2015) and training has been reported as a determinant of environmentally safe behavior in pest control by Khan and Damalas, (2015). Linked to good practices of pesticide application, action as checking the wind when spraying and knowledge of different types of nozzle and their properties are important to avoid drift products, which can cause damage to susceptible off-target sites, lower rate than intended, which can reduce the effectiveness of the pesticide and waste pesticide and money, and environmental contamination, such as water pollution and illegal pesticide residues (KLEIN; SCHULZE; OGG, 2007). It is believed that courses and programs focused in how to apply and conduct pesticides provide farmers with improvements in the agricultural practices.

Information with purchase of products influences the use of complete PPE. Even with a satisfactory number of respondents claiming to use complete protective equipment (almost 70%), it can be said that this number was due to a socially desired response, that is, farmers answered what they wanted to hear. They use some parts of the equipment, but not the full EPI. The recommended would be a measurement with periodic visits to the property, to see and know how much of the EPI is used. One of the main barriers to implementation of pesticide safety measures among farmers in the sample and reported in other studies was related to the inadequate design of protective equipment. For example, farmers mentioned that the use of PPE was highly inconvenient to them because it reduced their physical flexibility and interfered with their ability to work with pesticides. The equipment makes them feel hot, being uncomfortable to wear in the humid climate and it was difficult to breathe properly through a mask (DAMALAS; GEORGIOU; THEODOROU, 2006; DAMALAS; KOUTROUBAS; ABDOLLAHZADEH, 2019; REZAEI; DAMALAS; ABDOLLAHZADEH, 2018; SHARIF et al., 2019). However, Damalas; Koutroubas; Abdollahzadeh, (2019) concluded that self-confidence in spraying, following colleagues' behaviors, risk perception, knowledge of pesticide toxicity, and farm size were significant predictors of safe behavior in terms of PPE use during pesticide spraying.

The last perception in the study was that **reading pesticide labels** improve the knowledge about properties of the sprayed pesticide, read and follow the AR of pesticide products use, regulation of pressure when spraying and knowledge of different types of nozzle and their properties. Farmers can improve their abilities and insights with information contained in pesticide label. According to the Brazilian Federal Decree 4074 (04/01/2002), certain requirements must be met in order to provide safety and alert the user of the inherent risks of handling chemicals, pesticide labels and leaflets must contain, among other information: product origin, degree of toxicity, method of use, recommendations for the label to be read before pesticide application, hazard symbols and standardized warning phrases according to their toxicological class and instructions for accidents. The pictograms on the labels should be internationally accepted and have the purpose of facilitating communication with the applicator of the products, as well as informing the non-literate public. However, even though pictograms and pesticide labels should be for an easy understanding, some authors have found that there is a low understanding of the pictograms and information contained in the labels (EMERY et al., 2015; OLUWOLE; CHEKE, 2009; TIJANI, 2006), as well as in Brazil (VIVIANA; EVE; CELSO, 2007).

The socioeconomic factors access to advice and applying pesticide mixture were not related to any safety behavior. The results highlighting rural studies, a basic training and reading pesticide labels, which brings more types of safe attitudes to the farmers in relation to the agricultural activities of the pest control management. It is important to remember that the survey portrayed whether the variables are independent of one another or whether there is a dependency pattern between them. In other words, it was verified statistically if there is a relation between the socioeconomic factors and of safety behavior. For example, "access to advice" and "applying pesticide mixture" did not show statistical relationship to any safety behavior, however, it does not mean that people have not responded positively to these two socioeconomic factors or that they do not take any safety behavior. The results only show that there is no statistical relation between the factors, even answering yes to the socioeconomic factors and taking the behavior of safety behavior, that is, one does not influence the decision making of the other.

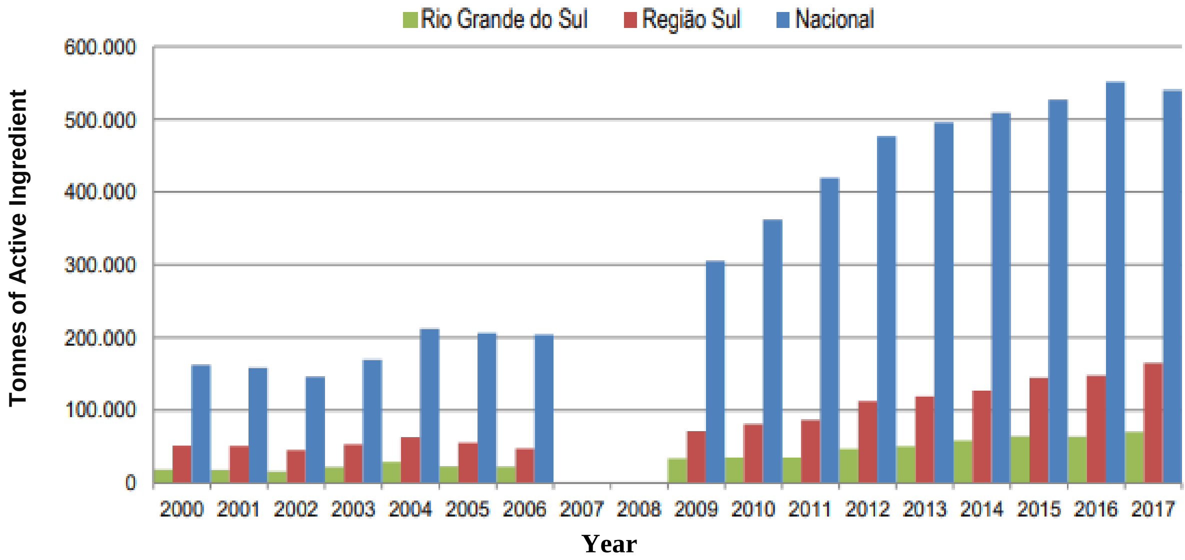
It is also important to mention as a limitation of the research, that the questionnaires were conducted under inspection by State Agricultural and Livestock Officer of Secretary of Agriculture, Livestock and Rural Development (SEAPDR). The answers given by the farmers, however true they may have been, could still have been a socially desired response, that is, farmers answered what they wanted to hear, or even responded positively because they felt safe.

The misuse of agrochemicals in agricultural production is a common problem in developing countries (FAN et al., 2015; JIN; BLUEMLING; MOL, 2015), including Brazil. Brazil is one of the countries with high capacity to increase agricultural production, having a generally favorable climate and vast areas that are suitable for agriculture. Indeed, Brazil ranks among the world’s ten largest economies and is the second largest global supplier of food and agricultural product and it is expected that it will contribute 40% to the global food demand by 2050 (OECD/FAO, 2015). Agribusiness in Brazil is considered as one of the main activities of the Brazilian economy, responsible for 21.46% of the gross domestic product (GDP) in 2015, according to statistics data of the Ministry of Agriculture Livestock and Supply (MAPA, 2016). It also impacts on the trade balance, accounting for 49.55% of national exports from January to July 2016.

Much of the success of the Brazilian agribusiness is related to technological advances in agriculture (FERMAM, 2009). The estimates of the losses in the country caused by insect attacks on 35 major crops is 7.7%, generating an annual loss of approximately US$ 14.7 billion to the Brazilian economy, despite the adoption of control measures. Therefore, in terms of volume, Brazil suffers a reduction of approximately 25.0 million tons of food, fiber and biofuels (OLIVEIRA et al., 2014). Although successful control strategies of pests are used in Brazil that enables the control of key pests with reduced environmental impacts, based, for example, on biological control agents (BOTELHO, 1992), and the use of genetically modified plants (BERNARDI et al., 2013; DE SOUZA RAMALHO et al., 2011; OKUMURA et al., 2013), the application of synthetic insecticides has been the main measure used to control insect pests, resulting in increased productivity and enabling competitiveness in the international market (FERMAM, 2009).

Since the turn of the century, Brazil's pesticide imports have grown faster (760%) than anywhere else in the world, making it the world's second largest market by 2008 (COMTRADE, 2014). In 2013, domestic pesticide sales amounted to some US$ 11.5 billion (SINDIVEG, 2014), second only to the USA, with estimated sales of US$ 14 billion (USDA, 2014). Decree No. 4,074 of 2002, in article 41, requires that companies that have records of pesticides in Brazil submit marketing reports to the public authority every six months. These reports allow the monitoring of the volumes of agrochemicals commercialized in our country, as well as the quantities imported and exported. In 2017 the Bulletin informs that there was a sale of 539,944.95 tons of Active Ingredients of agrochemicals in Brazil, where 165,282.77 tons were traded in the South region, of which 70,143.64 tons were in the state of Rio Grande do Sul, as shown in Figure 8.

Figure 8 – Pesticide and similar products' sales (2000 – 2017).



Source: (IBAMA, 2017) Consolidation of data provided by companies registering for technical products, agrochemicals and the like, according to art. 41 of Decree No. 4,074 / 2002. Note: Data reported by companies for the years 2007 and 2008 were not systematized by IBAMA.

Today's pesticide Federal Law 7802 of 11 July 1989 (BRASIL, 1989), now in force for over 30 years in 2019, by Decree 4074 of 04 January 2002 (BRASIL, 2002), was drafted in a context of intense pressure from interest groups with conflicting rationales: one pushing the intensive use of agricultural inputs to boost agribusiness yields, versus the preservation of human health and the environment by means of controlling that production model. The law set stricter rules to control pesticides, including a broader range of inputs and positive steps to protect human health and preserve the environment, for example, the agronomic recipe, used for controlling the sale of pesticides and for the correct use of it (FRANCO; PELAEZ, 2016).

Although in modern agriculture, pesticides, have been important tools for producing food with the quality and quantity needed for the growing world population (FERMAM, 2009), their use may generate environmental costs and costs related to acute and chronic hazards to human health (COSTA et al., 2007; DASGUPTA; MAMINGI; MEISNER, 2001; PIMENTEL et al., 1992; PIMENTEL; BURGESS, 2014). For this purpose, there is no point in all existing policies and agencies acting as a result of monitoring compliance with the Law, if there is only the idea that agrochemicals are only an indispensable product for agriculture. It is true that they are rather an indispensable tool in agricultural production and guarantee high productivity in crop production, but are also dangerous products that must have their use carried out with acts of safety behavior and consciousness, on the part of the farmers, the main user of pesticides in the grain production chain. The incorrect use of agrochemicals can contaminate food and the environment, causing irreversible damage to human health and damages to the maintenance of the ecologically balanced environment, with loss of a great ally in the challenge of increasing food production for all.

5 CONCLUSIONS

Pesticides are considered to be of extreme importance and decisive tools for agricultural production. The unsafe behavior by farmers in the use of these products is a major threat to the environment, as well as to farmers, and its misuse ultimately to the public consumers' health, especially in developing countries where widespread use of pesticides has emerged as a dominant trend in agriculture. This study identifies which are the socioeconomic factors that influence the different safety behaviors of farmers in the pesticide management. The sample was dependent on chemical pesticides for the management of insect pest and diseases and most of them were using extremely or moderately toxic pesticides. The Chi-square revealed that a) rural studies influence the farmers in the knowledge about the properties of the sprayed pesticide, in the identification of major pests in crops, in the knowledge of different types of nozzle and their properties and in checking the wind when spraying; b) Being a land owner is related to reading and following the AR of used pesticide products; c) working directly in the farm activities is related with the knowledge about the properties of the sprayed pesticide; d) Basic training in pesticide use gives the farmers knowledge about the properties of the sprayed pesticide, the possibility of identifying major pests in crops and about checking the wind when spraying; e) information with purchase of products influences the use of complete personal protective equipment (PPE); f) reading pesticide labels improves the knowledge about properties of the sprayed pesticide, about reading and following the AR of used pesticide products, the calibration of pressure when spraying and the knowledge of different types of nozzle and their properties. The socioeconomic factors access to advice and applying pesticide mixture were not related to any safety behavior. The results showed the socioeconomic differences of the farmers and what influences them, highlighting rural studies, basic training and reading pesticide labels, which brings more types of safe attitudes to the farmers in relation to the agricultural activities of the pest control management. The conclusion is, in spite of the strict state regulations and enforcement in pesticide use, there are fine individual behavioral traces that are modulated by a socioeconomic environment which goes beyond legislation. These determinants must be taken into consideration if we want to expect personal and environmental safety in the pesticide management practices. As a recommendation is cited that, given to the significant role played by extension in pesticide use, the agricultural extension system should be restructured to further strengthen the capacity of personnel and retailers and to provide more effective services and inspire confidence and trust to farmers' activities. Finally, government interventions with a strong policy on the correct and safe use of pesticides are also needed to strengthen enforcement mechanisms with respect to current pesticide laws and regulations , and especially to make the producer, a key player in the agricultural production chain, being aware of the correct use of these products.

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APENDIX A – QUESTIONNAIRE APPLIED TO FARMERS

RESEARCH ON THE USE OF AGROCHEMICALS

This research aims to make a survey of the correlation between knowledge about the use of pesticides and socioeconomic factors.

1- Complete name and city: ____________________________

2 - Age: _________________

3 - Education
( ) Incomplete Primary School
( ) Complete Primary School
( ) Incomplete High School
( ) Complete High School
( ) Incomplete College Degree
( ) Complete College Degree
( ) Farming Technician

4 – Did you have rural studies?
( ) No
( ) Yes

5 – Are you the land 0owner?
( ) No
( ) Yes

6 – What is the farm size? (Should be counted the area that is planted by you, but not is yours)________________________

7 – What is, approximately, the percentage of your agriculture income? _______________

8 – How long have you been in farming activities? _______________

9 – Do you act directly into the farm activities?
( ) No
( ) Yes

10 – Do you apply pesticides mixtures?
( ) No
( ) Yes

11 – Did you have basic training in pesticide use?
( ) No
( ) Yes

12 – Do you have access to pesticide advice?
( ) No
( ) Yes

13 – Do you receive information with product purchase?
( ) No
( ) Yes

14 – Do you read the pesticides' labels?
( ) No
( ) Yes

15 – In descending order, the class of the most used pesticide, to the less used:
( ) Fungicide
( ) Herbicide
( ) Inseticide

16 - Do you use the complete EPI?
( ) No
( ) Yes

17 - Do you know about the properties of the pesticide you spray?
( ) No
( ) Yes

18 - Do you follow preharvest intervals (PHI) after spraying?
( ) No
( ) Yes

19 - Do you inspect the correct crop stage before spraying?
( ) No
( ) Yes

20 - Can you identify the major pests in your crops?
( ) No
( ) Yes

21 - Do you take special care of correct disposal of pesticide containers?
( ) No
( ) Yes

22 - Do you read and follow the RA of the pesticide products you use?
( ) No
( ) Yes

23 - Can you regulate pressure when spraying?
( ) No
( ) Yes

24 - Do you know different types of nozzles and their properties?
( ) No
( ) Yes

25 - Do you check the wind when spraying?
( ) No
( ) Yes

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APENDIX B – COMPLETE LIST WITH THE COMMERCIAL NAME OF PESTICIDE PRODUCTS USED BY FARMERS

2,4 D Amina 840 SL	Cabrio Top	Dimilin 80 WG	Gli Up 720 WG
2,4 D Nortox	Callisto	Diox	Glifosato Atanor
Abacus HC	Campeon	Diuron Nortox 500 SC	Glifosato Atar 48
Abamectin Nortox	Carbendazin Nortox	DMA 805 BR	Glifosato Nortox 480 SL
Abamex	Cefanol	Drible	Glifoxin
Accent	Cercobin 700 WP	Dual Gold	Glister
Acefato Nortox	Certero	Echo	Glizmax Prime
Actara 250 WG	Certeza	Ecotrich WP	Glyphotal TR
Actellic 500 EC	Cinelli 250 FS	Elatus	Gramocil
Actellic Lambda	Cipermetrina Nortox 250 EC	Eminent 125	Gramoking
Agritone	Classic	Engeo Pleno/S	Gramoxone 200
Ally	Cletodim Nortox	Envoy	Graolin
Alterne	Clincher	Evidence 700 WG	Heat
Aminol 806	Clipper Sinon	Exalt	Helmoxone
Amistar WG	Clorim	Facet	Helmstar Plus
Ampligo	Clorimuron Nortox	Famoso	Herbadox 400 EC
Approach Prima	Clorimuron 250 WG	Fascinate BR	Hero
Apron RFC	Cloripirifós Fersol 480 EC	Fason	Horos
Argenfrut RV	Confidor Supra	Fastac 100	Hussar
Assist	Connect	Fastac Duo	Iharol
Atabron 50 EC	Cropstar	Fertox	Imazetapir plus
Ativum	Crucial	Fezan Gold	Imidacloprid Nortox
Atrazina Atanor 50 SC	Cruiser 350 FS	Field	Imidagold 700 WG
Atrazina Nortox 500 SC	Cruiser Opti	Finale	Imperador BR
Avatar	Cuprodil WG	Fipronil Alta	Incrível
Azimut	Cypress 400 EC	Fipronil Nortox	Infinito
Basagran 480	Cyptrin 250 EC	Flak 200 SL	Intrepid 240 SC
Basagran 600	Decis 25 EC	Flex	Juno
Battle	Decorum	Fortenza 600 FS	K-obiol 2p
Baytan FS	Delan	Fox	Kaiso 250 CS
Bazuka 216 SL	Dermacor	Fox Xpro	Karate Zeon 50 CS
Belt	Derosal Plus	Fusão	Kifix
Belure	Detia Gas_Ex-T	Fusilade 250 EW	Klorpan 480 EC
Bendazol	Dez	Galil SC	Kromo 250 WG
Bim 750 BR	Difere	Game	Labrador
Bravonil 500	Diflubenzuron 240 SC	Gamit 360 CS	Lannate
Brilhante BR	Difluchem 240	Gastoxin B57	Larvin 800 WG
Brio	Diflumax	Gladium	Locker
Larvin 800 WG	Dimax 480 SC	Gli Over	Login

Lorsban 4Lorsban 480 BR	Platinum	Siptran	U 46 BR
Maestro	Poast	Sirius 250 SC	U 46 Prime
Manfil 800 W	Poquer	Soberan	Unizeb Glory
Match EC	Potenza Sinon	Soldier	Unizeb Gold
Maxim XL	Preciso	Solist 430 SC	Upmyl
Metsuram 600 WG	Premio	Sombrero	Urge 750 SP
Micromite 240 SC	Prend-D 806	Spectro	Veredict MAX
Mimic 240 SC	Previnil	Sperto	Veredict R
Mirant	Primatop SC	Sphere Max	Versatilis
Mirza 480 SC	Primóleo	Spider 840 WG	Vessarya
Monaris	Priori	Spot SC	Vitavax-thiram 200 SC
Much 600 FS	Priori Top	Sprayquat	Wasp 480 SC
Mustang 350 EC	Priori Xtra	Stam 800	Xeque Mate
Nativo	Proclaim 50	Standak Top	Zafera
Nexide	Propiconazole Nortox	Starice	Zaphir
Nico	Prostore 25 EC	Starion	Zapp QI 620
Nominee 400 SC	Protreat Quatdown	Start	Zartan
Nomolt 150	Racio	Status	Zethamaxx
Nufos 480 EC	Rancona T	Stinger WG	
Nufosate WG	Rapel	Stoy 40 SC	
Nufuron	Recop	Streak 500 SC	
Oberon	Reglone	Sumigran 500	
Odin 430 SC	Rephon 800 WG	Sumiguard 500 WP	
Only	Ricer	Sumisoya	
Opera	Ridomil Gold MZ	Talisman	
Orix	Rimon 100 EC	Talstar 100	
Orkestra SC	Rival 200 EC	Tebuco 430	
Orthene 750 BR	Rodazim 500 SC	Tebufort	
Pacto	Roundup Original	Tebuzin 250 SC	
Palace	Roundup Original DI	Terra Forte	
Panther 120	Roundup Transorb r	Tilt	
Panzer 250 WDG	Roundup Ultra	Tino	
Paradox	Roundup WG	Tívaro	
Paraquate Alta 200 SL	Rovral	Tocha	
Peencozeb WG	Rubric	Toco	
Perito 970 SG	Saddler 350 CS	Togar TB	
Permitrina Fersol 384 EC	Safety	Topik 240 EC	
Phostek	Score	Trinca Caps	
Picloram Nortox	Select 240 EC	Trop	
Ping BR	Select One Pack	Trulymax	
Piramide	Shadow	Tucson	
Pirate	Shelter	Turbo	
Planador	Singular BR	Twister	