

**INSTRUCTION LEVEL OF OPERATORS OF AGRICULTURAL SPRAYERS**

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**ABSTRACT**

The Brazilian agribusiness is the sector that highlights the contribution significantly with the gross national product of the country. Over the years, the Brazilian primary production has been demonstrated a high competitive capacity in several sectors, highlighting the production of agriculture commodities. However, the overuse of pesticides for plant protection is at the same time uneconomical and dangerous once it can cause adverse consequences on human health, on environment and on agriculture. Then, for the knowledge level of agriculture engines operators intended to phytosanitary treatment as well as for the operators involved in this process it is of fundamental importance the search of reduction of environmental and individual risks assuring the quality during pulverization activities. In this sense, the aim of this work is to establish the operators' level of knowledge regarding the operational safety, as well as the use and management of pesticides. In order to do this, information acquired through a questionnaire applied to 56 operators of agricultural sprayers from two Brazilian regions, West and Central Frontier of the state of Rio Grande do Sul, was used. Analyzing the obtained results, it can be concluded that the level of the operators' knowledge is considered unsafe, especially with regard to operational safety and the handling of pesticides. The operators' training is necessary when adopting the appropriate methodology for the calibration of the sprayers, thus, technical training activities should be carried out more frequently.

**Keywords:** Level of training. Pesticides. Spraying.

## 1 Introduction

The efficiency of the control under a biological target relies on the proportion of the active ingredients applied on it as well as on the quality of distribution and the uniformity of application in terms of the target area. In this sense, the sprayers are aimed to distribute the phytosanitary products over a given target according to suitable drop measurements. According to Schlosser [1], the quality of an agrochemical application depends on getting date as much as possible about four factors involved in the spraying process: agricultural machine, biological target, local weather implications and pesticides to be used.

According to Gandolfo and Antuniassi [2], the inspection of sprayers and the operators training, with regard to the maintenance and use of agricultural sprayers, can contribute to optimizing the control of weeds, insects and diseases. According to these authors, the embrace of these practices may also contribute to the reduction of costs and the lower use of pesticides in the cultivation areas, resulting in lower risks of contamination.

In this context, Schlosser *et al.* [3] explain that, during the work journey, the agricultural machine operators are susceptible to not ergonomic positions of work, high levels of

noise, dust and pesticide contamination. The theme related to the pesticide contamination is important to be discussed because, according to Konradsen *et al.* [4], it is one of the most serious world health problems, mainly in terms of countries in stage of development.

In this sense, taking into consideration the data presented by the *Instituto Brasileiro de Geografia e Estatística* (IBGE) [5] that said that the number of rural workers represents nearly 15.10 thousands of people developing their activities in nearly 5.07 thousands of rural properties, it worths to point out that the theme about the worker's level of knowledge in relation to the pesticide spraying activities deserves to be widely discussed and spread. According to Dornelles *et al.* [6], many intoxications are related to the inappropriate use of agricultural sprayers. Because of that, it is necessary to be done the suitable maintenance of those machines to keep both the quality of the applications as well as the worker's and the environment security once, according to Martini *et al.* [7], unregulated sprayers or under poor state of conservation may cause high rates of lost and increase the contamination risk. In addition to it, according to Santana *et al.* [8], targeting behavioral and attitude changes allied to suitable preventive practices demands worker's training on pesticide use and storage, as well as on hygienization of sprayers after the spraying practices, besides investments on

fiscalization policies to both commercialization and use of pesticides.

The aim of this research was to establish the operators' level of knowledge regarding the operational safety, as well as the use and management of pesticides.

## 2 Methodology

The data have been got through a questionnaire applied to 56 operators of agricultural sprayers from two regions in the South of Brazil, specifically in the West frontiers and in the Central region of the state of Rio Grande do Sul. The counties that participated of the research were: Itaqui and Maçambará, in the West frontier, and Dona Francisca, Faxinal do Soturno, Ivorá, Restinga Seca, Santa Maria, São João do Polêsine and São Pedro do Sul, in the Central region. It worths to point out that those two regions of the Rio Grande do Sul State were selected because they represent some very distinctive characteristics when compared to the average cultivation areas, targeting, through this, identify differences in relation to the operators' knowledge about the pesticide pulverization practices.

To procedure on this research, when arriving at the properties, firstly it was done both the team and the project

presentation to the property's owner or to the responsible by it, ressaltating that personal information would be kept confidential.

After agreement, the project was presented to the machine's operator that was responsible by the spraying activities, and so after it was applied the questionnaire (Annex A). The operator's indication was done both by the owner itself or by the responsible by the property, in which place the operators received technical orientations about operational security and use, as well as suitable maneuver of pesticide products, after previously requirement of the information on this research.

After evaluations were conducted, the data collected were submitted to exploratory analysis by descriptive statistics with the use of percentage frequency.

## 3 Results and Discussion

After a previous data survey on basic knowledge about pesticides application, sprayer maintenance programs and calibration, it was possible to observe that the operators under this research presented few knowledge about those things, what means a problem mainly in terms of the need to maximize the quality of the applications and to reduce both environmental and personal contamination. Also points out the absence of knowledge in terms of those things by agricultures and operators

as one of the main reasons for the high levels of errors in terms of agricultural spraying parameters [9].

Although the average cultivation area of the properties visited in the West frontier was nearly 783 ha, and the average properties area in the Central State Region was 85 ha, it was realized that the problems related to the operator's knowledge on operational security as well as on the use and maneuver of pesticide products do not presented differences between the regions. In this way, it is possible to infer that the problem is not in the producers' purchasing power or in the cultivated area, but also in people's lack of consciousness about the theme, once there is little or not knowledge about operational security and pesticide use. Those data are in confirm to those ones published by Santana *et al.* [8] which, when submitted the rural workers' profiles on avaliation, it means, their practices and attitudes in terms of pesticide use, concluded that the most of the interviewers used pesticide products inadequately and, still having knowledge on the risks of being exposed to spraying procedures, they continue up not using individual protection equipment.

When measuring the operators' level of education, it was possible to realize that most of the operators have finished elementary school (37.50%) or high school (26.79%). However,

just 5.63% of the interviewees have finished higher school and 1.79% of them have finished technical education. Among the operators who were interviewed, the highest levels of education were registered among people who had finished high school (38.00%) and those ones who had not finished elementary school (26.05%) [10]. According to these authors, the operators' schooling levels do not allow correlating to their levels of knowledge about machine maintenance or suitable maneuver of pesticides, justifying so the necessity of applying specific questionnaires on the theme, as well as giving them the technical orientation.

In terms of basic knowledge about pesticides application and sprayer maintenance, most of the interviewees (80.36%) said making sprayer inspections just once a year, 8.93% said they had never made any kind of sprayer inspection and only 1.79% of them said making some kind of inspection after each application. According to Dedordi *et al.* [11], sprayers must be over proper maintenance due to their high acquisition costs, what goes in agreement with Casali *et al.* [10], which justify those machine maintenance as fundamental to guarantee efficient sprayings that are also safe environmentally.

When giving instructions to landowners, agents and operators about the importance of making inspections and

preventive maintenances (during the interval between harvests) in order to avoid unnecessary breaks and even minor repairs that might lead to the loss of the work period (harvest window), it was realized that operators (82.14%) are used to make those maintenances by themselves. However, in some properties (10.71%) there is a person responsible for making maintenances of agricultural machines and implements (mechanic) and in just 7.14% of the cases the sprayers are taken to authorized agencies. Machine maintenance to be efficient means not just making fast repairs, but also it needs to keep function able to operation in order to avoid failures and reduce risks of unplanned stops [12].

As it can be seen in Figure 1, the most operators' worries in terms of sprayers are in relation to the spray nozzles (98.21%) and the filtering system (83.93%) what end up justifying why those parts are submitted more to maintenances. It is important to emphasize that although in a lower scale, the other parts of the sprayers are also submitted to maintenances at least once a year as, for example, pump, hoses, spray bars, fittings, manometers and tanks. According to Martini *et al.* [13], the non performing of filter cleanliness or the use of distinct filter meshes can cause premature wear and tear of nozzle, flowing reduction or solution distribution problems, once it may trouble the sprayer filtering system efficiency.

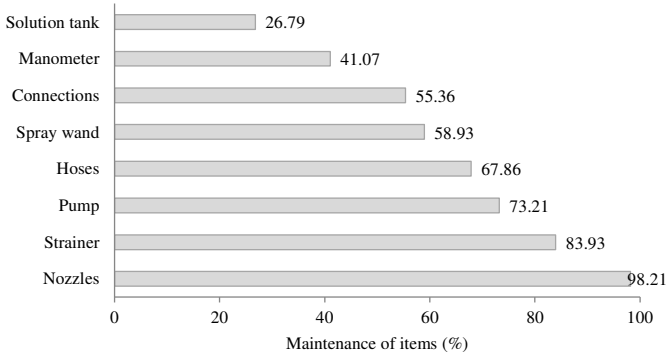


Figure 1 - Sprayer maintenance levels.

In relation to the frequency of adjustments and calibration of sprayers, interviewees have not answered to it equally once that some interviewees affirmed making periodic maintenances over the year (as, for example, for nozzles and filters) while others affirmed making it just once a year. However, the worst situation related in relation to it was that in which the maintenances processes were carried out without any determined frequency or established standard, being performed only when there was the necessity for more severe interventions in the sprayers. According to Martini *et al.* [7], maintenance is one of the factors that may allow to keep good sprayers' condition of use what will lead to more accurate sprayings.

When asked about calibration and adjustments frequencies, 58.93% of the interviewees answered that they perform calibration just once a year without any further verification until



the end of the culture cycle. Besides that, 96.43% of the interviewees answered just using the calibration cup when calibrating, what may end up interfering in the accuracy of the volume to be applied once that the calibration cups available in the Brazilian market are not submitted to evaluation by the *Instituto Nacional de Metrologia, Qualidade e Tecnologia* (INMETRO) and so may be considered inappropriate for that purpose [10]. Similarly, Martini *et al.* [14], describe that the use of the calibration cup may induce to calibration errors due to not presenting any scale graduation standard.

However, it is important to emphasize that 25.00% of the interviewees answered performing calibration after every time the sprayer is used what might improve this activity (if performed suitably) in terms of quality allowing the active ingredient to perform better in terms of biological effectiveness. Considering the results related to the sprayers calibration frequency, it is important to point out that according to Martini *et al.* [14], the main calibration error is related directly to the operator's lack of knowledge in terms of power take off (PTO), system pressure, suitable methodology for sprayer calibration and the use of the calibration cup for sprayer calibration.

Considering still the operators who both perform calibration and accuracy on the volume of application (Figure 2), it is said

that the most worrying fact observed is the not use of manometers by these professionals, either because they believe it is not necessary once that they are used to use the calibration container (23.08%) or just because the manometers available are not working properly (15.38%). In this sense, was reported that 77% of the interviewees did not use manometers for calibrating the sprayers simply by being unaware of the importance of those spraying parts [15]. It is important to ressalt that according to Martini *et al.* [14], most part of the sprayers calibration errors are related to the use of imprecises manometers or to the lack of them to determine the hydraulic circuit inner pressure.

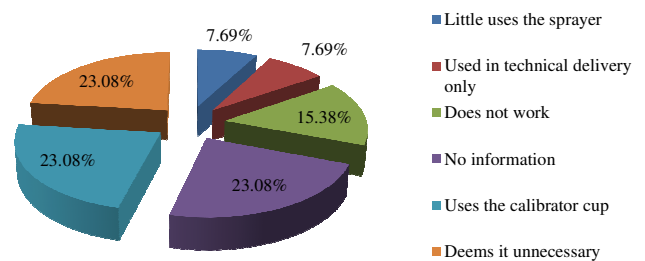


Figure 2 - Manometers in relation to spraying calibration.

Although manometers are responsible for informing an operator about the internal pressure in the hydraulic systems in every stage of the process, it is said that they get much more importance during calibration when it is taken into consideration the kind of nozzle used in the sprayer. On the whole, flat spray nozzles may be used when pressure is around 133 to 400 kPa (20

to 60 lb in<sup>-2</sup>) and conical spray nozzles may be used when pressure is around 533 to 1000 kPa (80 a 150 lb in<sup>-2</sup>). Thus, if the pressure was higher than this, the spray nozzles can be wear out prematurely what can cause flow rates above to the admissible by the regulatory standard ISO 16122 [16].

The kind of questionnaire applied to the operators was that of multiple choice one that enquired them about subjects as the operators' personal opinions about pesticide, dosage, volume of application and spray nozzles selection. The results got from it were the following: in relation to pesticides, dosage and volume of application, all the operators have pointed out following the agronomist engineering's recommendations for performing them. On the other hand, in terms of spray nozzles selection, drop size and durability only some operators did it as we can realize through this: 46.43% of the operators answered following the technical recommendation for spray nozzles selection; 41.07% of the operators answered following the technical recommendation for drop size measuring and 17.86% of the operators answered following the technical recommendation for spray nozzles durability. According to Dornelles *et al.* [17], the use of unsuitable and / or extremelly worn out spraying nozzle are some factors that contribute both to the environmental contamination and to the inefficiency of applications.

In terms of time of applying and biological target control, the questionnaire showed that 89.29% of the interviewees are not used to monitoring weather conditions through thermo-hygrometers during the application. However, 82.14% of them declared being aware of the ideal weather conditions for the application, which are temperature inferior to 30 degrees Celsius, relative humidity (RH) higher than 55.00%, and wind speed until 10 km/h [18]. Some interviewees pointed out just monitoring the efficiency of the product through the extinction of the pests and plant disease vectors (94.64%), while others affirmed also doing it during the pesticide application through water-sensitive papers.

In terms of the meaning of colors in labelling, it was verified that 78.57% of the operators were aware of that the colors represent different levels of toxicity depending on the active ingredient (a.i), but 7.14% of them were not aware. Those data testify what was approached by Casali *et al.* [10], showing as until better capacited operators do not know how to answer all questions about basic knowledge on use and maneuver of pesticides

When the operators were asked about both the means of intoxication by pesticides and the effects of it on the body, just one operator said being unaware about the means of intoxication. In 19.64% of the cases, the operators reported feeling some

malaise after spraying of pesticides as for example burning face (27.27%) and headache (27.27%) (Figure 3). The symptoms that happened the most are in agreement with those ones observed by Santana *et al.* [8] who pointed out that the most cited intoxication symptoms were headache (33.40%), nausea (25.00%), dizziness (16.60%), skin irritation (12.60%) and loss of appetite (4.20%).

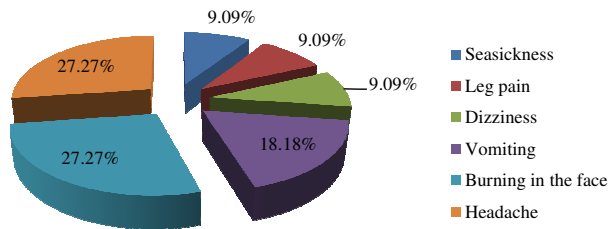


Figure 3 - Kind of malaises after spraying of pesticides.

When the operators were asked about if they believed that pesticides could cause damages to the environment, 85.71% of them answered affirmatively just in case of lack of planning and monitoring by operators or landowners. According to them, those damages would have worst effects on water (79.17%), soil (62.50%) and animals (43.75%), so showing as governmental policies on those people's training are relevant once that according to approached by Milkiewicz and Lima [19], the pesticides register can be considered as a way of control to the use of them in order to protect human health and the environment during the pesticide half-life.

#### 4 Conclusions

Analyzing the obtained results, it can be concluded that the level of knowledge of the operators is considered unsafe, especially with regard to operational safety and the handling of pesticides as they emphasize that the application of this compounds without monitoring can cause damage to the environment, however, 89.29% of respondents do not monitor climatic conditions during application.

The operators training is necessary when adopting the appropriate methodology for the calibration of the sprayers, highlighting the importance of using graduated cylinders and the calibration formula.

Technical training activities should be carried out more frequently to agricultural sprayers operators in order to make them aware of the importance of the preventive and periodic equipment review, as well as to maintain a routine for checking the volume of application during the activity performance.

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### NÍVEL DE INSTRUÇÃO DOS OPERADORES DE PULVERIZADORES AGRÍCOLAS

**RESUMO:** O agronegócio brasileiro é o setor que se destaca por contribuir de forma significativa no produto interno bruto (PIB) do País. Ao longo dos anos, a produção primária brasileira tem demonstrado elevada capacidade competitiva em diversos setores, destacando-se a produção das *commodities* agrícolas. No entanto, o uso excessivo de agrotóxicos para proteção de plantas, não somente é antieconômico, como também pode provocar consequências adversas à saúde humana, ao ambiente e a agricultura. Assim, o nível de conhecimento dos operadores de máquinas agrícolas destinadas à realização do tratamento fitossanitário das culturas, bem como, dos trabalhadores envolvidos de forma direta ou indireta neste processo é, de fundamental importância na busca pela redução dos riscos ambientais e pessoais, garantindo desta forma, qualidade nas atividades de pulverização. Neste sentido, o objetivo deste trabalho foi estabelecer o nível de conhecimento dos operadores no que se refere à segurança operacional, bem como, ao uso e

manejo de agrotóxicos. Para tanto, utilizaram-se informações adquiridas por meio de um questionário aplicado a 56 operadores de pulverizadores agrícolas em duas regiões, Fronteira Oeste e Central do Estado do Rio Grande do Sul. Ao analisar os resultados obtidos, pode-se concluir que o nível de conhecimento dos operadores é considerado inseguro, principalmente no que diz respeito à segurança operacional e ao manejo dos agrotóxicos. A capacitação dos operadores se faz necessária quanto a adoção da metodologia adequada para a calibração dos pulverizadores, portanto, estas atividades técnicas de treinamento devem ser realizadas com maior frequência.

**Palavras-chave:** Nível de capacitação. Agrotóxicos. Pulverização.

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**Annex A - Questionnaire applied to agricultural sprayers operators****What is the operator's education?**

- Incomplete elementary school  
 Complete primary education  
 Incomplete high school  
 Complete high school  
 Incomplete technical education  
 Complete technical education  
 Incomplete higher education  
 Complete higher education

**How often is the sprayer checked?**

- Every harvest  
 Once a year  
 Every 2 years  
 Over 2 years  
 Never been made

**Who does the maintenance the sprayer?**

- Operator  
 Authorized agency  
 Mechanical  
 Never been made

**Which parts are reviewed?**

- Nozzles  
 Pump  
 Solution tank  
 Spray wand  
 Manometer  
 Strainer  
 Hoses  
 Connections

**How often the sprayer is adjusted?**

- Every application  
 1 time per harvest  
 Once a year  
 1 time per month  
 Never

**Is the manometer used to adjust the sprayer?**

- No information  
 Used in technical delivery only

- Does not work  
 No, little uses the sprayer  
 Deems it unnecessary  
 Uses the calibrator cup

**Which is the procedure used to adjust the sprayer?**

- Graduated cylinder and the calibration formula  
 Calibrator cup  
 Mass / min  
 Empirical measure

**How do you check if the application was effective or not?**

- Checking the target's elimination  
 By the number of drops per area  
 Does not check

**What is the criteria used for selecting the spray volume?**

- Better operating performance  
 Product to be applied  
 Number of drops per area  
 Empirical knowledge  
 Indicated by the engineer agronomy

**Who recommends pesticides and the dose?**

- Engineer Agronomy  
 Agricultural Technician  
 Own indication  
 Friend  
 Salesperson (Profession) \_\_\_\_\_  
 \_\_\_\_\_

**Which criteria is used to choose the spray nozzle?**

- Drop size formed  
 Type of pesticide  
 Low price  
 Durability  
 Technical recommendation  
 \_\_\_\_\_

**Are climatic conditions monitored with thermohygroanometer?**

- Yes  
 No

**What are the ideal temperature, relative humidity and wind speed conditions for pesticide application?**

- > 30 °; < 55%; > 10 km/h.  
 < 30 °; > 55%; between 3 to 10 km/h.

- > 30 °; < 55%; between 10 to 15 km/h.  
 < 30 °; < 55%; < 10 km/h.

**Why pesticide labels use different colors?**

- Difference in price  
 Different degree of danger to targets  
 Different targets  
 Different degree of danger to warm-blooded animals  
 Different manufacturing companies  
 Different degree of toxicity

**After applying pesticides, do you feel some kind of discomfort?**

- No  
 Yes, which one? \_\_\_\_\_

**What are the means of intoxication?**

- Mouth  
 Eyes  
 Nose  
 Skin

**Do the registered pesticides cause damage to the environment?**

- No  Yes, which? \_\_\_\_\_  
 Ground  
 Animals  
 Water  
 None of them