# The pesticides law under the optics of rural producers

## A lei dos agrotóxicos sob a ótica dos produtores rurais

## *La ley de pesticidas bajo la óptica de productores rurales*

## *La loi sur les pesticides sous l'optique des producteurs ruraux*

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**Abstract**: The aim of the current study is to understand the perceptions of rural producers about the procedure for reverse logistics of empty pesticide packages proposed by Brazilian legislation. The research was conducted in Interior of the State of São Paulo for application to 48 small and medium-sized rural producers. As a result, it was found that producers generally do not meet the legal requirements and that one of the possible causes may be the lack of inspection by the Public Authorities.

**Keywords**: reverse logistics; packages; pesticides; rural producers; legislation; environmental management.

**Resumo**: O objetivo do presente estudo consistiu em verificar a percepção dos produtores rurais quanto aos procedimentos da logística reversa das embalagens vazias de agrotóxicos proposta pela legislação brasileira. Foi realizada uma pesquisa de campo no interior do Estado de São Paulo junto a 48 produtores rurais de pequeno e médio porte. Como resultado, verificou-se que existe certa tendência dos produtores, em geral, de não cumprir o que é imposto pela legislação e uma das possíveis causas levantadas pode ser a falta de fiscalização do Poder Público.

**Palavras-chave**: logística reversa; embalagens; agrotóxicos; produtores rurais, legislação, gestão ambiental

**Résumé**: L'objectif de la présente étude est de comprendre les perceptions des producteurs ruraux concernant la procédure de reverse logistique des emballages de pesticides vides proposée par la législation brésilienne. La recherche a été menée à l'intérieur de l'État de São Paulo pour être appliquée à 48 petits et moyens producteurs ruraux. En conséquence, il a été constaté que les producteurs ne respectent généralement pas les exigences légales et que l'une des causes possibles peut être l'absence d'inspection par les autorités publiques.

**Mots-clés**: reverse logistics; emballage produits agrochimiques; producteurs ruraux, legislation, gestion de l'environnement

**Resumen**: El objetivo del presente estudio es comprender las percepciones de los productores rurales sobre el procedimiento para la logística inversa de envases vacíos de plaguicidas propuestos por la legislación brasileña. La investigación se llevó a cabo en el interior del estado de São Paulo para su aplicación a 48 pequeños y medianos productores rurales. Como resultado, se encontró que los productores generalmente no cumplen con los requisitos legales y que una de las posibles causas puede ser la falta de inspección por parte de las autoridades públicas.

**Palabras clave**: logística inversa; envasado; plaguicidas; productores rurales, legislación, gestión ambiental.

## 1 INTRODUCTION

Agriculture expanded greatly with the use of pesticides, which has intensified since the 1960s. However, this impulse with economic and agronomic returns has brought environmental effects and risks to human health and has left, as one of its legacies, pesticide packages that need appropriate disposal (MMEREKI; LI; MENG, 2014).



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Reverse logistics is used for this disposal, with a set of procedures and actions that respond to environmental concerns, as established in the National Policy of Solid Waste (PNRS). This policy had the effects of increasing recycling and reuse of products and waste and reducing costs by inducing the return of materials to the productive cycle and of improving producers' image and communication to the market (MARQUES *et al.*, 2017).

Brazilian law has addressed pesticide packages since 1934, achieving better coverage with Law 7.802/1989, called the Pesticides Law, and the amendments provided for by Law 9.974 (BRASIL, 2000). This law addresses the return of empty pesticide packages by reverse logistics and provides for shared responsibilities, in addition to penalties. The law was initially implemented by Decree 98.816 (BRASIL, 1990) and then ultimately by Decree 4.074 (BRASIL, 2002), imposing requirements that must be fulfilled in the return of packages.

The Alta Paulista region contains a preponderance of agribusiness, with high numbers of rural properties with the main crops of sugar cane, peanuts and corn; it also contains horticulture practiced by small rural producers who use pesticides. As a result, this research raises the following question: How is the reverse logistics of empty pesticide packages perceived by small and medium-sized rural producers in the São Paulo State countryside?

In view of the problem presented and considering that the literature has already presented situations where the reverse logistics of empty pesticide packages does not work properly, the aim was to analyze whether small and medium-sized rural producers from the locality perform reverse logistics of pesticide packages according to the guidelines required by the law. After collecting data by a form on a Likert scale, a Cross-Tab was conducted to determine what items on the scale show significant differences in understanding among the survey respondents.

As a result, it was possible to note that, in practice, the reverse logistics of pesticide packages does not occur in an efficient way as required by law, as there is no inspection and the process depends on the commitment and environmental education of rural producers.

## 2 THEORETICAL FRAMEWORK

The current theoretical review references the reverse logistics guidelines for empty pesticide packages set by the legislation, aspects of the reverse logistics process and the formal structure set up for the practice of the logistics. This process must begin with the rural producer, as the first link in the logistics chain of the return of these packages to the industry, and end with the final destination: recycling and incineration. It also considers research cases in which the reverse logistics process has not worked perfectly.

### 2.1 Pesticides and their packages

As investigated by Marques, Braga Junior e Cataneo (2015), Brazilian legislation has addressed pesticide packages since 1934, culminating with the addition of Law 7.802/1989, called the "Pesticides Law", amended by Law 9.974/2000, and ultimately implemented by Decree 4.074/2002, which provides for shared responsibility among the agents that participate in the logistics chain, in addition to penalties.

In addition to this legislation, Law 12.305 (BRASIL, 2010), which contains the National Policy of Solid Waste, highlights non-generation, reduction, reuse, recycling and solid waste treatment, also including pesticide packages.

According to this legislation, the final disposal of empty pesticide packages is a complex process, demanding effective and distinct participation from all involved in manufacturing, trading, using, licensing, inspection and monitoring pesticides, in addition to the treatment, transportation, warehousing, and processing of such packages.

It is true that the National Policy of Solid Waste, in addition to requiring the responsible disposal of pesticide packages, creates "reverse logistics". This is a legal requirement from Law 12.305/2010, which, in article 33, obliges manufacturers, importers, distributors and sellers to collect, after use by the final consumer, pesticides and their waste and packages, batteries, tires, lubricating oils and their waste and packages, mixed light and mercury and sodium-vapor fluorescent lamps, and electronic products and their components.

Federal Law n. 7.802 of 11/07/89, article 2º I, "a" and "b", defines "pesticides" as the products and agents of physical, chemical or biological processes destined for use in the production, warehousing and processing sectors of agricultural products, in pastures, in native or planted forest protection and industrial, hybrid and urban environments, whose purpose is to alter the composition of flora and fauna, to preserve them from damaging actions by living beings considered harmful and substances and products used as defoliants, desiccants, growth promoters and inhibitors (BRASIL, 1989).

In accordance with NBR 10.004 (ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS [ABNT], 2004), empty pesticide packages are classified as hazardous waste due to their toxicological and contamination potential, as they usually contain waste of the active product. According to Cometti and Alves (2010), if they are disposed of in the environment, they can contaminate the soil and groundwater; if they are reused as domestic utensils they can cause human contamination.

According to Souza and Gebler (2013), what determines the final destination of the empty pesticide packages is the type of materials that compose them and their hazards to the environment, according to the feasibility of the triple-washing process at the moment of preparation of the syrup. As indicated by Standard 10.004 from ABNT (2004), there are two classes of waste: I – hazardous, and II – non-hazardous. The washing procedures are detailed in ABNT Standard 13968/1997.

The rigid empty packages of pesticides, which can be objects of triple washing, are classified as non-hazardous waste (class II) for handling, transportation and warehousing. The packages that contain products in solid form (in granules or powder), used in seed treatment or whose form of application demands an ultra-low volume of water (less than 20 liters per hectare); impeding triple washing, belong to class I.

For the reverse logistics of pesticide packages to work, everyone to whom the law assigns responsibilities must participate. According to Faria and Pereira (2012), Cometti and Alves (2010), and Grutzmacher *et al*. (2006), these responsibilities should be assigned to the rural producer:

To the pesticide users – agriculturists (consumers):

- Prepare the empty packages to return them (for washable rigid packages: perform triple or pressure washing; disable, drilling, to avoid reutilization);
- For non-washable rigid packages: Keep them intact: properly closed and with no leakage. For flexible contaminated packages: Pack them in standard plastic bags;
- Temporarily store the empty packages in an appropriate place on the property;
- Transport and return the empty packages, with their lids, to the establishment where the product was purchased or to the receiving unit on the invoice one year from its date of purchase;

• Maintain in your possession the packages' proof of delivery and the invoice for the purchase of the product for one year.

## 2.2 The reverse logistics

Reverse logistics is applied in the return of empty pesticide packages, contributing to environmental protection, especially for recycling when possible and incineration. According to Marques *et al*. (2017), pesticides are partially packed in plastic containers of different sizes, presenting risks of soil contamination if discarded without the necessary care.

Sehnem, Simioni e Chiesa (2009) state that "the process by which the recycling stream of empty pesticide packages is triggered is 1- Product purchase; 2- Application to crops; 3- Package washing; 4- Destruction of package; 5- Return to the receiving unit; 6- Package pressing; 7- Transportation to the final destination; 8- Recycling stage; 9- Artifact production."

According to Boldrin *et al*. (2007, p. 36), the following stages must be followed so that the collection of empty pesticide packages in the field succeeds: "producer → incentives for discarding → triple washing → transportation from the rural area to the collector center → receiving in the collector center → warehousing in this center until certain stock level → recollection on behalf of the industry to be taken to the final destination".

Therefore, it is clear that the reverse logistics applied to empty pesticide packages is a way of contributing to environmental protection and that there is a well-defined structure, through the legislation, for the implementation of this procedure.

Reverse logistics provides the instrument to promote the return to the right destination (DIAS; BRAGA JUNIOR, 2016) of empty pesticide packages, contributing to the reduction of environmental impacts. It is sufficient that those involved in the reverse logistics chain are conscious of the importance of this practice.

## 2.3 The formal structure of reverse logistics of pesticide packages

To enable the fulfillment of the legal requirements and to facilitate the operationalization of reverse logistics, the National Institute for Empty Packaging (INPEV) was created in December 2001, a result of the cooperation of the industry in the area in fulfilling the requirements of 9.974/2000. It began operations in March 2002.

This organization represents industrial producers of pesticides and is structured to manage the processing of pesticide packages, which, after collection, must be directed to recycling or incineration. The main function of INPEV is to connect the collector station with the destination headquarters.

Veiga (2013) states that the "Reverse Logistics Program of the Empty Pesticide Packages" is composed of eight stages: (1) transportation to the suppliers for temporary storage; (2) warehousing and stocking in the suppliers' warehouse facilities; (3) transportation to warehouse facilities; (4) stocking in warehouse facilities; (5) transportation to the central warehouse; (6) stocking in the central warehouse; (7) transportation to an installation designated for final destination; and (8) incineration and recycling. Each of these activities, adapted to the guidelines in Decree 4.074/2002, from 01/04/2002.

In the case of pesticide package collection, there must be cooperation by rural producers, who make up the first link in the agricultural chain, as highlighted by INPEV (2015).

According to Carbone, Sato and Moori (2005), this process begins with the agriculturist, who has the legal obligation to perform, with the packages, a triple or pressure washing and return them within one year after purchase or six months after the expiration of the product. Pressure washing is used for rigid and metal packaging, whereas flexible packaging materials (e.g., paper bags, aluminized and low-density polyethylene) are ultimately incinerated.

According to Sehnem, Simioni and Chiesa (2009), INPEV, in addition to managing the Collector Centers and Stations, there is still an itinerant collector or Mobile collecting, an organized system by distribution channels, cooperatives, regional partners and government agencies. Where there are these services the itinerant collector operations occur in locals close to the rural properties, on a temporary basis, in days and places normally communicated in advance so that the agriculturists can prepare their packages for return.

The searched literature shows cases in which the reverse logistics of empty pesticide package procedures did not have complete coverage and has shown deficiencies such as those portrayed by Nogueira and Dantas (2013) and Lima *et al*. (2009).

## 3 METHODOLOGICAL PROCEDURES

### 3.1 The object of study

The current study involved consultations with 48 small and medium-sized rural producers to the city of Tupã, SP, selected in a non-probabilistic way and according to their willingness to participate in the survey. For a non-probabilistic sample, Stevenson (1981) recommends n > 30. The aim was to learn about the rural producers' perceptions of the reverse logistics of empty pesticide packages proposed by the Brazilian legislation to determine whether the reverse logistics works perfectly in the region, making the study relevant.

### 3.2 Data collection procedures

To achieve the objective of this study, we developed exploratory research, of the quantitative type, involving a bibliographical and documentary survey, to determine the effectiveness of the legislation in terms of the return of empty pesticide packages. Before doing so, we needed to examine the legislation and compare it to the execution of its guidelines.

In the bibliographical survey, we sought data from secondary sources (official documents from public archives, including laws, decrees, and resolutions, and bibliographical research about the subject of study in books, theses, essays, monographs, magazines, newspapers and other sources). For the survey (field research), we sought to analyze the understanding of and actions performed by the rural producers regarding the reverse logistics of pesticide packages. For this purpose, we developed, validated, and applied a form with the involvement of rural producers. This form had 17 closed questions with responses on a five-point Likert scale to observe rural producers' responsibilities and the procedures to which they are subject, referring to 6º, 7º, 12ª, 14, 15 and 19 of the Pesticides Law (Law 7.802/1989) and articles 52, 53, 55 and Annex IX to the Decree, as presented in chart 1.

To construct the questions, procedures recommended by DeVellis (2012) were used for the formulation process, phase and subject validation. Finally, the questions were distributed in terms of the responsibility assigned to the rural producer by the legislation as follows: A – Return

empty packages in accordance with the instructions received to the commercial establishment where the pesticide was purchased or a collector station; B – Triple wash the empty packages and prepare and store them beforehand on the rural property; C – Keep available for inspection agencies the return receipts of the empty packages (chart 1).

Chart 1 – Distribution and grouping of the questions on the form applied to the rural producers

| Construct | Nº | Questions | Legal Basis |
|---|---|---|---|
| A – Return empty packages in accordance with the instructions received at the commercial establishment where the pesticide was purchased or the collector stations. | P-01 | I am always informed there is a requirement to return the empty packages of agricultural pesticides. | Art. 7º, II, "d" of Law 7.802/1989 and Art. 53 of Decr. 4.074/2002 |
| | P-02 | I read the instructions on the leaflets and labels of agricultural pesticides before using them. | Art. 6º § 2º; Art. 7º, IV of Law 7.802/1989 and Art. 52 of Decr. 4.074/2002 |
| | P-03 | I read the instructions on the leaflets and labels of agricultural pesticides for the return of the packages. | Art. 6º § 2º of Law 7.802/1989 and Art. 52 of Decr. 4.074/2002 |
| | P-08 | I always return the packages to the address indicated on the purchase invoice. | Art. 53 § 2º of Decr. 4.074/2002 |
| | P-09 | When I have out-of-date agricultural pesticides, I return them. | Art. 6º § 2º of Law Lei 7.802/1989 and Art. 53 § 4º of Decr. 4.074/2002 |
| | P-10 | I always pay the costs to transport the packages to the collector station. | Art. 6º § 2º of Law 7.802/1989 and Art. 53 of Decr. 4.074/2002 |
| | P-12 | I always return the empty packages of agricultural pesticides to the retailers where I purchased them. | Art. 6º § 2º of Law 7.802/1989 and Art. 53 of Decr. 4.074/2002 |
| B – Perform the triple washing of the empty packages, necessary preparation and storage on the rural property before returning the packages. | P-04 | I have been informed about the need to prepare the packages for correct disposal. | Art. 6º § 4º of Law 7.802/1989 and Art. 53 § 5º of Decr. 4.074/2002 |
| | P-05 | I have been informed that I need to store them temporarily in appropriate locations on my property. | Art. 6º of Law 7.802/1989 and Art. 53 of Decr. 4.074/2002 |
| | P-06 | During purchase, the retailer gives instructions on washing, packaging, storage, transportation and return of the packages. | Art. 7º, II, "d" of Law 7.802/1989 and Annex IX in the Decr. 4.074/2002 |
| | P-07 | I disable the package right after triple washing it. | Art. 7º, II, "d" of Law 7.802/1989 and Annex IX in the Decr. 4.074/2002 |
| | P-17 | I triple wash the packages when told to do so in the leaflet instructions. | Art. 6º § 3º of Law 7.802/1989 and Art. 53 § 6º of Decr. 4.074/2002 |

| Construct | Nº | Questions | Legal Basis |
|---|---|---|---|
| C – Keep available for the inspection agencies the return receipts of empty packages. | P-11 | The Collector Station always gives me a receipt for packages returned. | Art. 53 § 3º and Art. 55 of Decr. 4.074/2002 |
| | P-13 | I keep archived for inspection purposes the purchase invoices and return receipt for the empty packages. | Art. 53 § 3º of Decr. 4.074/2002 |
| | P-14 | When I make a new purchase of agricultural pesticide, I am charged by the retailer for the empty packages from the last purchase. | Art. 19 sole paragraph of Law 7.802/1989 |
| | P-15 | I am regularly inspected regarding the storage, transportation and return of empty packages of agricultural pesticides. | Art. 12A of Law 7.802/1989 |
| | P-16 | I am aware of the penalties applied for inadequate disposal of the empty packages. | Arts. 14 and 15 of Law 7.802/1989 |

Source: The authors, based on the legislation.

The application of the form with the 17 closed questions took place in person at a meeting of an association of rural producers. The producers were invited to participate in the research voluntarily and upon accepting, the purpose of the research and form of completion were explained. Thus, during filling, it was observed that the producer felt more comfortable in answering the form.

### 3.3 Data analysis procedures

A descriptive statistical analysis was performed with the data obtained from the form distributed to the rural producers. The software SPSS 22.0 was used to test the frequency of and classify the cases.

The data were also analyzed using the cross-tab, with the scale questions cross- checked with the variables time of return, area segment, time segment and cultivation segment.

According to Hair Jr. *et al*. (2005, p. 292-3):

> The cross-tab is a distribution of frequency of replies from two or more sets of variables. This means we tabulate the replies for each group and we compare them. The chi-square analysis allows us to test if there are statistical differences among groups.
> [...]
> The chi-square statistics are used to test the statistical significance among the distribution of frequency from two or more groups. [...] The null hypothesis is that there is no difference.

In this respect, the responses where the p-value was less than 0.05 (5%) were evaluated; therefore, this reference shows there were differences to be evaluated (HAIR JR. *et al*., 2005).

The link in the chain considered critical, the producers, was analyzed to determine whether their understanding of the law and actions are aligned with the Law's purpose or whether there are distortions.

## 4 RESULTS

The producers were classified by the following variable categories: type of culture, area size and the time they produce in the area. These variable categories followed the classifications

presented by the Brazilian Institute of Geography and Statistics (IBGE) and allowed categorizing producers by size (small, medium or large), predominant agricultural crops and experience.

In this respect, the majority practices temporary culture (37.5%) of corn, peanuts, manioc, beans, tomato, and watermelon, although this proportion is not far from the 33.3% who practice horticulture; a smaller percentage (29.2%) conducts permanent cultivation.

In terms of production area segmentation, most producers occupy an area of less than one hectare (27.1%), followed by those who occupy between two and less than five hectares (20.8%), one to less than two hectares (16.7%) and 20 to less than 50 hectares (12.5%). The rest have a high average area distribution of approximately six hectares.

In terms of the respondents' experience with the practice of agriculture, the majority has been in the business between one and five years (31.3%) and between five and ten years (29.2%), followed by 10 to 15 years (12.5%) and 15 to 20 years (14.6%). The minority has been in the business under one year (8.3%) or over 20 years (4.2%).

Chart 2a- Situations of Cross-tab with Chi-Square < 0.05

| Evaluated Question | Crossover | Chi-Square | Analysis |
|---|---|---|---|
| P-1 – I am always informed there is a requirement to return the empty packages of agricultural pesticides. | How often I return packages. | 0.006 | There is consistency in the responses because for the 16 who fully agreed about having known about the requirement to return empty packages, at least 11 said that they return them and of the 13 who disagreed, six responded that they do not return them and seven vary in their return timing, showing uncertainty in return. |
| P-4 – I have been informed about the need to prepare the packages for correct disposal. | How often I return packages. | 0.003 | There is also some consistency here because for the 35 who agreed and/or fully agreed about having information about the need to prepare the packages for correct disposal, 22 said they return them even if their timing in doing so varies. Of those who disagreed or were indifferent, the majority said they do not return the packages. |
| P-6 – During purchase, the retailer gives instructions for washing procedures, packaging, storage, transportation and return of the packages. | How often I return packages. | 0.018 | There is consistency in the responses as 11 of those who agreed or fully agreed about receiving instructions for washing procedures, packaging, storage, transportation and return of the packages, nine said they return them, and of the 30 who disagreed or fully disagreed, 18 said they do not return them, and seven said their return timing varies. |
| P-8 – I always return packages to the address indicated on the purchase invoice. | How often I return packages. | 0.006 | The nine who agreed or fully agreed when asked always return packages to the address indicated on the purchase invoice, all said they return packages even if their timing varies, and of the 26 who disagreed or fully disagreed, 20 strongly stated they do not return them. |

Source: Research data.

With the sample profile defined, the cross-tab of the responses was performed with the purpose of observing whether there was a difference among the variable categories for the researched twelve situations in which a chi-square below 0.05 was observed, i.e., whether there

was statistical significance requiring analysis of the situation. For a clearer depiction, the analysis presented in chart 2 has been divided into 2a, 2b and 2c.

Chart 2b- Situations of Cross-tab with Chi-Square < 0.05

| Evaluated Question | Crossover | Chi-Square | Analysis |
|---|---|---|---|
| P-10 – I always pay the costs to transport packages to the collector station. | How often I return packages. | 0.000 | There is accentuated consistency in the responses, as of the seven who agreed or fully agreed about paying the costs to transport packages to the Collector Station, all said they return them; and of the 34 who disagreed or fully disagreed, 16 said they do not return packages, and 11 said their return timing varies. |
| P-10 – I always pay the costs to transport packages to the collector station. | Cultivation group. | 0.018 | There is a balance in the producer's distribution among types of cultivation, with 18, 16 and 14, respectively, in temporary culture, horticulture and permanent culture. Additionally, of the 30 who fully disagreed about paying the costs to transport packages to the Collector Station, 8, 12 and 10, respectively, are in temporary culture, horticulture and permanent culture. |
| P-10 – I always pay the costs to transport packages to the collector station. | Segmentation of the area by IBGE. | 0.032 | There is a certain proportionality among the responses regarding paying the costs to transport packages to the Collector Station and the size of the harvested area, as of the 30 who fully disagreed, 23 cultivate areas smaller than five hectares, which suggests that, for them, the cost of empty package transportation is high, so they tend, when they return packages, to use favors from other large-sized producers, as noted in the responses when the data collection was performed. |
| P-12 – I always return the empty packages of agricultural pesticides to the retailers where I purchased them. | How often I return packages. | 0.021 | There is consistency in the responses, as 27 of those who responded that they disagreed or fully disagreed about returning packages to the retailers, 17 responded they do not return them and the other eight that their timing of return varies. Of the four who responded that they completely agreed about returning packages, all said that they return packages between one and two years from the date of purchase. |
| P-13 – I keep archived for inspection purposes the purchase invoices and the return receipts for empty packages. | How often I return packages. | 0.016 | Of 25 who disagreed or fully disagreed about keeping, for purposes of inspection, the purchase invoices and the package return receipts, 15 said they do not return packages and eight said that their timing of return varies. However, of 17 who agreed or fully agreed about keeping the invoices and return receipts, 11 said they return them even if their timing in doing so varies. |

Source: Research data.

Regarding the timing of return and where the water from the washing of the packages is poured, the responses were surprising. Almost all the respondent producers said they return the water from washing to the tank or pump to make maximum use of the product, except for two

of the respondents, who said they throw the water directly on the soil. It should be noted that although they perform the washing because doing so is appropriate from an economic point of view, they do not tend to give due care to the preparation and storage before further return, which are addressed in the question of Construct B.

Chart 2c- Situations of Cross-tab with Chi-Square < 0.05

| Evaluated Question | Crossover | Chi-Square | Analysis |
|---|---|---|---|
| P-14 – When I make a new purchase of agricultural pesticide, I am charged by the retailer for the empty packages from the last purchase. | How often I return packages. | 0.043 | Of 42 who fully disagreed about being charged by the retailer for empty packages from the last purchase, 21 said that they do not return packages and 12 that their timing of return varies. Of five who agreed or fully agreed about being charged by the retailer, four said that they return packages. |
| P-16 – I am aware of the penalties applied for inadequate disposal of empty packages. | How often I return packages. | 0.012 | Of 30 respondents who agreed or fully agreed about knowing the penalties for the inadequate disposal of empty packages, 11 do not return them, and 12 said that their timing of return varies. In contrast, of 14 who disagreed or fully disagreed about knowing the penalties, seven do not return packages. |
| P-16 – I am aware of the penalties applied for inadequate disposal of the empty packages. | Segmentation of the area by IBGE. | 0.043 | There is a certain balance between the responses regarding knowing the penalties for inadequate disposal of empty packages and the size of the harvested area, as of the 30 who agreed or fully agreed, 19 cultivate areas smaller than five hectares. Of the 14 who disagreed or fully disagreed, 10 also cultivate areas smaller than five hectares. This leads us to consider that for them (the small producers), the responsibility is more keenly felt. |

Source: Research data.

In terms of the timing of return of empty packages, we note that 45.8% responded that they tend not to return packages, and 25% could not specify exactly how often they make returns. Those who said that they return packages within two years were 14 producers (29.2%), and among these, 12 (25%) reported returning them within the appropriate period of one year and the remaining 4.2% do so within the regular period defined in the legislation, as shown in table 1.

Table 1 – Frequency of returning empty pesticide packages

How often do I return packages?

| | Frequency | Percentage | Valid Percentage | Accumulative Percentage |
|---|---|---|---|---|
| **More than once per year** | 12 | 25 | 25 | 25 |
| **Once every 1-2 years** | 2 | 4.2 | 4.2 | 29.2 |
| **Varies** | 12 | 25 | 25 | 54.2 |
| **Do not return** | 22 | 45.8 | 45.8 | 100 |
| **Total** | 48 | 100 | 100 | |

Source: Research data.

From all the analyses performed, we note that the classification of the researched producers regarding type of cultivation–whether temporary culture, horticulture or permanent culture–and regarding the segmentation of productive area in both hectares and time of production have no direct relation to the responses to the questions about compliance with the legislation. The only exception to this finding is a greater tendency among those who cultivate areas smaller than five hectares to not be concerned about the costs of transporting the empty packages and to have better perspective on their responsibility in terms of the possible penalties for noncompliance. The majority of the responses remain the same independent of the variables of harvested area, exploitation time and type of culture.

## 5 DISCUSSION

From the analyses performed, we note that the majority of responses remain the same independent of the variables of harvested area, exploitation time and type of culture.

We note that the Cross-tab applied in the current survey indicated 12 cases in which there was consistency in the responses of the rural producers, which represents 25% of the 48 consulted producers, from which we deduce that 75% of them tend not to comply with the legislation and have not begun the reverse logistics process.

Therefore, we determine that while there is a strong structure built with the support of INPEV, there are system failures, cases in which packages are not returned and thus are not disposed of correctly.

Table 2 – The results of the statistical analysis

| Comparative cases | May or may not return packages (%) | Tendency to not return packages (%) | Performed analysis | Percentage tendency to not comply with the legislation (%) |
|---|---|---|---|---|
| **Nogueira and Dantas (2013)** | 37.5 | 62.5 | The study reports that 37% return, 53.1% burn and 9,4% keep or throw away packages. | 62.5 |
| **Lima *et al.* (2009)** | 20 | 80 | The study shows that 80% keep packages and may or may not return them. | 80 |
| **Vezzali (2006)** | 33.4 | 66.6 | It is established that of nine properties visited, six received a fine for not returning packages. | 66.6 |
| **IBGE (2005)** | 38.1 | 61.9 | The statistics show that 600 municipalities had places to receive the packages and 978 disposed of them in open-air dumps. | 61.9 |
| **Our research** | 25 | 75 | The Cross-tab determined that only 25% of the respondents had a tendency to comply with the legislation, with their responses consistent. | 75 |

Source: Research data interpreted by the authors.

However, the research performed in other locations and noted here suggests a predisposition not to comply with the legislation in the order of 61.9% to 80%, with the results of the current research (75%) inserted in the margin, as presented in table 2. It has been demonstrated, therefore, that the reverse logistics of empty pesticide packages has its failures in different locations and regions.

## 6 CONCLUSIONS

From the entire exposition shown, it is possible to observe that the reverse logistics of empty pesticide packages does not occur in the expected way and in accordance with the law, with the principles of reverse logistics or the pesticide legislation not fully observed, specifically with respect to the return of empty packages. This observation is reinforced by both the survey findings from this research and the results from other studies, which show some weaknesses.

We must attempt to ensure that the reverse logistics of empty pesticide packages works well with the collect performed by the Stations or Centers integrated into the Campo Limpo System, managed by INPEV.

Rural producers, considered individually, and mainly the small ones, tend not to comply with the legislation in relation to their part in the responsibility for package return and/or delivery of the related items to the locations indicated by the retailers.

Thus, the main bottlenecks in package return (reverse logistics) may be in rural producers, who, in the case of small or medium enterprises, generally do not have the structure and financial support to pay the expenses of the process. Note that the functioning of reverse logistics depends on the willingness and consciousness of rural producers, who, although they often want to perform this initial operation, may feel unable to do so due to a lack of structure or resources.

It is observed that, in practice, the performance of the process as required is rare due to the lack of inspection and of effective environmental education, since rural producers must be concerned about this issue to be willing to do its part in the process.

The Brazilian legislation contains information, strong concern, and directions, so that the application of reverse logistics as a propelling instrument for environmental preservation and reduction of environmental impacts has real and consistent mechanisms. Furthermore, INPEV, through its structure, is an operator and manager of this logistics. However, the lack of inspection coupled with the lack of favorable conditions of collector points close to small and medium rural producers have the effect that return does not occur.

The findings related here encourage future research in the same or identical situations, motivating the public authorities to implement better public policies on the control and effectiveness of reverse logistics.

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