

Reverse logistics of agrochemical packaging: a contribution to achieving the goals of Sustainable Development Objectives

Logística reversa de embalagens de agrotóxico: uma contribuição para o alcance das metas dos Objetivos de Desenvolvimento Sustentável

Logística inversa de envases de agroquímicos: una contribución al logro de las metas de los Objetivos de Desarrollo Sostenible

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ABSTRACT

This research aims to investigate the presence of the goals of the sustainable development objectives in the reverse logistics system of agrochemical packaging in three grain cooperatives located in the northern region of Santa Catarina. A literature review was carried out addressing the concepts and historical milestones of sustainability and the evolution of the goals of sustainable development. In this way, it was possible to select goals that support the reverse supply chain of agrochemical packaging. After comparing the goals and the reverse logistics process, it was necessary to observe in practice whether the goals of the sustainable development objectives are being followed. After applying the questionnaire and studying each answer obtained, it was observed that the practices of the goals are being followed. For this, it was necessary to analyze the sentences that presented relationships between the goals. Thus, it is concluded that the research is valid to investigate the presence of the sustainable development objectives in the daily lives of workers and farmers in the region studied, as well as presenting learning processes and accessibility to information related to the processes of the reverse supply chain that refer to the goals presented.

Keywords: Reverse Logistics, Sustainable Development, Pesticide Packaging, Sustainable Development Goals.

RESUMO

Esta pesquisa tem como objetivo investigar a presença das metas dos objetivos de desenvolvimento sustentável no sistema de logística reversa de embalagens de agrotóxicos em três cooperativas de grãos situadas na região norte de Santa Catarina. Foi realizada uma revisão de literatura abordando os conceitos e marcos históricos da sustentabilidade e evolução dos objetivos do desenvolvimento sustentável. Desta forma foi possível selecionar metas que suportam a cadeia de suprimentos reversa das embalagens de agrotóxicos. Após o confronto das metas e o processo de logística reversa houve a necessidade de observar na prática se as metas dos objetivos do desenvolvimento sustentável estão sendo seguidas. Após a aplicação do questionário e estudo de cada resposta obtida, foi observado que as práticas das metas estão sendo seguidas. Para isso, foi necessário analisar as sentenças que apresentassem relações entre as metas. Assim, conclui-se que a pesquisa é válida para investigar a presença dos objetivos de desenvolvimento sustentável no cotidiano dos trabalhadores e agricultores da região estudada, bem como apresentam processos de aprendizagem e acessibilidade a informações relacionadas aos processos da cadeia de suprimentos reversa que remetem as metas apresentadas.

Palavras-chave: Logística Reversa, Desenvolvimento Sustentável, Embalagens de Agrotóxico, Objetivos de Desenvolvimento Sustentável.

RESUMEN

Esta investigación tiene como objetivo investigar la presencia de los objetivos de desarrollo sostenible en el sistema de logística reversa de embalajes de agroquímicos en tres cooperativas de granos ubicadas en la región norte de Santa Catarina. Se realizó una revisión de la literatura abordando los conceptos e hitos históricos de la sostenibilidad y la evolución de los objetivos de desarrollo sostenible. De esta manera, fue posible seleccionar objetivos que apoyen la cadena de suministro inversa de envases de plaguicidas. Luego de comparar los objetivos y el proceso de logística inversa, fue necesario observar en la práctica si se estaban cumpliendo las metas de los objetivos de

desarrollo sostenible. Luego de aplicar el cuestionario y estudiar cada respuesta obtenida, se observó que se están cumpliendo las prácticas de las metas. Para ello, fue necesario analizar las oraciones que presentaban relaciones entre los objetivos. Así, se concluye que la investigación es válida para indagar la presencia de los objetivos de desarrollo sostenible en la vida cotidiana de los trabajadores y agricultores de la región estudiada, además de presentar procesos de aprendizaje y accesibilidad a la información relacionada con los procesos de la cadena de suministro inversa que hacen referencia a los objetivos presentados.

Palabras clave: Logística Inversa, Desarrollo Sostenible, Envasado de Plaguicidas, Objetivos de Desarrollo Sostenible.

1 INTRODUCTION

Due to difficulties in solid waste management, sustainability and protection of the environment, conditions in human and animal production are influenced. Economic and social losses in the world due to inadequate disposal of non-recyclable materials can be observed (Santos; Bellingieri; Freitas, 2004). In this sense, reverse logistics is guided as a way to reduce the disposal of products in post-consumption, assisting in the recycling of materials. However, the initiative faces several difficulties in spreading shared responsibility among governments, societies and organizations, despite proposing and emphasizing the numerous environmental and competitive advantages from its implementation (Guimarães; Ribeiro, 2016).

In discussions about the advantages of reverse logistics, it is established that it is not only about established laws, but a common good for all. Some of these benefits include the development of environmental benefits, the reduction of storage and storage costs, as well as the increase in the life cycle of packaging through a series of steps. Among these steps are collection, treatment and environmentally suitable final destination (Lopes; Tonini, 2013; Ferri *et al.*, 2015; Brazil, 2010).

Reverse logistics is intertwined with sustainability and the Sustainable Development Goals, an action by the UN and member countries that aims to protect society and the environment through 17 established goals. The Sustainable Development Goals (SDGs) encompass three dimensions: economic, social and environmental, an initiative to ensure the purpose of the 2030 Agenda (SDG, 2018).

In the light of the above, this article glimpses the importance of the study and in-depth care related to the return of agro-toxic packaging. It should be noted that due to its

content is, in most cases, classified as dangerous and with high risk of human and animal contamination (Cometti, Alves 2010).

Thus, the general objective of the research is to investigate the presence of the goals of the sustainable development goals in the reverse logistics system of agrochemical packaging. To this end, the following specific objectives were established: a) Identify concepts and historical milestones of the sustainable development and reverse logistics objectives of agrochemicals packaging; b) Select the SDGs targets that support the reverse logistics system of agrochemicals packaging; c) Verify the presence of SDGs in the daily life of Grain Cooperatives.

The Study was conducted by applying a questionnaire based on support between SDGs and reverse logistics through the practical identification of the activities carried out by the companies. The research was applied in a city in Norte Catarinense, Brazil. The city has four agricultural input sales centers, where three were interviewed.

The research was structured with Topic 1 being the Introduction with a brief explanation of the intention of the research. Topic 2: Literature Review with the contextualization of sustainable development goals and reverse logistics. Topic 3: Establishes the methodological dynamics for applying research. Topic 4: Addresses discussions based on collected data. Topic 5: Search results and suggestions for future searches are displayed.

2 LITERATURE REVIEW

Section 2 aims to present and contextualize the main events that have historically marked each topic. Section 2.1 addresses the evolution of Sustainable Development and the emergence of sustainable development objectives. Section 2.2 presents the reverse logistics supply chain and how the Agrotoxic Packaging must be disposed of.

2.1 SUSTAINABLE DEVELOPMENT

Sustainable Development (SD) came to prominence after a long path of criticism between society and the environment. The main objective is to minimize the impacts between civil and industrial growth through the environment, instructing society to

proceed with cleaner production, preserving the ecosystem for the current and future generation (Camargo, 2003).

Aiming at minimizing environmental impacts, leaders started projects with the goal and ideologies of economic development without unbridled degradation of the ecosystem. Thus began the conferences between leaders of several countries, where aims to illustrate and exemplify the exponential growth as well as the consumption of natural resources, pointing out the environmental and social impacts to the planet (Webster, 2015).

The initial idea for the creation of the conferences was in 1968 when the Secretary-General of the United Nations presented a report expounded as: Activities of the United Nations and Programs Relevant to the Environment. This report was established as the basis for the start of the United Nations Environment Program (UNEP) being the world's leading authority (UNEP, 2025).

Regular conferences have therefore been established and established to discuss the objectives for minimizing environmental impacts. Table 1 lists some of the major conferences that have already taken place, according to UN data.

Table 1. Milestones.

Timeline	
1972	From 5 to 16 June 1972, the first United Nations Conference on the Human Environment was held in Stockholm, Sweden. Promulgated the United Nations Environment Program (UNEP);
1992	In Rio de Janeiro, the United Nations Conference on Environment and Development or the Earth Summit was held. Treaties such as Agenda 21 and the opening of two multilateral treaties for signature have been established: the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity;
2000	103 countries sign the Cartagena Protocol on Biosafety. The Millennium Development Goal is set with specific environmental targets, including combating biodiversity loss, forest cover and Global Welfare Goals;
2002	The World Summit on Sustainable Development is taking place in Johannesburg, with a focus on improving people's lives and conserving natural resources in a world that is growing in population. emphasizing improvements in the MDGs;
2012	The United Nations General Assembly establishes universal membership in the UNEP Administrative Council, inaugurated in Rio+20. Carried out assessment of progress and points and gaps regarding the main conferences being; Rio Declaration on Environment and Development; Agenda 21; and the Conventions: Framework on Climate Change, Biodiversity and Combating Desertification.

Source: Unep (2025).

The official initiative of setting specific targets to be followed and the subsequent presentation of results to reduce the environmental impacts caused by man was at the beginning of the 21st century, in September 2000, promoted by the UN in New York during the Millennium Summit, together with its respective member countries. At this conference the states agreed to achieve the eight Millennium Goals by 2015.









Under discussion, eight objectives have been set to follow, called the Millennium Goals, as described below:









I. Eradicate extreme poverty and hunger; II. Achieve elementary education; III. Promoting gender equality and empowerment of women; IV. Reduce child mortality; V. Improve maternal health; VI. Combat HIV/AIDS, malaria and other diseases; VII. Ensure environmental sustainability; VIII. Establish a global partnership for sustainable development (Garcia; Garcia, 2016).

The theme was addressed again in RIO+20, where it was discussed its evolution. The United Nations was committed to creating a set of indicators and targets to significantly measure the progress of Sustainable Development, where it would be presented later in 2015 at the United Nations Summit on Sustainable Development (Silva, 2012).

Noting that the targets set have yielded significant results, especially for developing countries, a new initiative has been developed for work, the Sustainable Development Goals for implementation and development for the next fifteen years (UNDP, 2015). The results of this new project are expected to be presented in the 2030 Agenda "Transforming Our World: The 2030 Agenda for Sustainable Development" (UN, 2015). The initiative was signed by 193 UN member states, which encompasses 17 objectives as well as 169 specific targets, including monitoring and evaluation mechanisms (Onubr, [s.d]a, 2016).

Table 2. The 17 Sustainable Development Goals.

GOAL / DESCRIPTION / NUMBER OF GOALS FOR EACH GOAL	
 <p>1 ERRADICAÇÃO DA POBREZA</p>	Eliminate poverty in all its forms and places (<i>7 goals</i>).
 <p>2 FOME ZERO E AGRICULTURA SUSTENTÁVEL</p>	Ensure quality food and eradicate hunger (<i>8 goals</i>).
 <p>3 SAÚDE E BEM-ESTAR</p>	Promote the well-being of all and give health conditions to all ages (<i>13 goals</i>).
 <p>4 EDUCAÇÃO DE QUALIDADE</p>	Improve access to quality education throughout people's lives (<i>10 goals</i>).
 <p>5 IGUALDADE DE GÊNERO</p>	Reduce gender inequality and prejudice against women (<i>9 goals</i>).
 <p>10 REDUÇÃO DAS DESIGUALDADES</p>	Reduce inequality within and across countries (<i>10 goals</i>).
 <p>11 CIDADES E COMUNIDADES SUSTENTÁVEIS</p>	Making cities safe, inclusive and sustainable (<i>10 goals</i>).
 <p>12 CONSUMO E PRODUÇÃO RESPONSÁVEIS</p>	Ensure sustainable consumption and production patterns (<i>11 targets</i>).
 <p>13 AÇÃO CONTRA A MUDANÇA GLOBAL DO CLIMA</p>	Take measures to combat climate change and its consequences (<i>5 targets</i>).
 <p>14 VIDA NA ÁGUA</p>	Preserve the maritime ecosystem in a sustainable manner (<i>10 targets</i>).

GOAL / DESCRIPTION / NUMBER OF GOALS FOR EACH GOAL			
 <p>6 <small>ÁGUA POTÁVEL E SANEAMENTO</small></p>	Ensure management of drinking water and sewage for all (8 goals).	 <p>15 <small>VIDA TERRESTRE</small></p>	Adequate forest management and combating desertification (12 targets).
 <p>7 <small>ENERGIA LIMPA E ACESSÍVEL</small></p>	Modernize energy sources to be more sustainable (5 targets).	 <p>16 <small>PAZ, JUSTIÇA E INSTITUIÇÕES EFICAZES</small></p>	Promote peaceful and inclusive societies at all socio-economic levels (12 goals).
 <p>8 <small>TRABALHO DECENTE E CRESCIMENTO ECONÓMICO</small></p>	Fostering decent and inclusive working conditions for all (12 targets).	 <p>17 <small>PARCERIAS E MEIOS DE IMPLEMENTAÇÃO</small></p>	Fostering the global partnership for sustainable development (19 targets).
 <p>9 <small>INDÚSTRIA, INOVAÇÃO E INFRAESTRUTURA</small></p>	Improve infrastructure and foster innovation in industry and society (8 targets).		UNITED NATIONS BRAZIL

Source: UN (2025).

The 2030 Agenda is an action plan for prosperity, rebuilding biodiversity and the ecosystem, as well as ensuring better living conditions, seeking peace between all segments of both the environmental, economic and social (SDG, 2018; Onubr, 2016).

Each indicator, objective and principle is expressly important to shape a new sustainable path for the planet. It is in this sense that new projects are emerging for the improvement mainly of industrial environments, since they are the main precursors of such degradation and pollution, investing in minimizing the use of non-renewable materials and discarding products, seeking ways for reuse, through remanufacturing, recycling, or else programming the correct disposal of the material.

2.2 REVERSE LOGISTICS

Reverse logistics aims at the correct return of products after their use, most packaging can be reused in some way, which can be through recycling, repair or remanufacturing adding some economic and ecological value. If re-use is not possible, the post-consumer product must be discarded correctly after all decontamination protocols have been completed (Brazil, 2010; Agrawal *et al.*, 2015).

Figure 1 highlights the reverse logistics cycle, which is presented from the raw material extracted for the production of the material to the recycling industry. Reverse logistics are consolidated once the waste is collected and stored appropriately. The second step is the recycling of the material from the Cooperative integrated into the system, responsible for segregating the products and defining the destination, the waste is

separated according to the classification of reuse and sent to the recycling or incineration industry, thus returning again the chain as usable product (Milk, 2003).

Figure 1. The Cycle of Reverse Logistics.



Source: Guarnieri (2011).

According to Kumar and Tan (2003), the use of the reverse supply chain is increasingly discussed in the industrial segment, becoming management strategy, promoting increased profits, product life cycle, new distribution channels, as well as significant changes in the supply chain through market forces. The reuse of products as returnable packaging has been adding profits and growth in the economy of companies, stimulating the initiatives of reverse logistics. In addition, customers value companies that adopt sustainable policies mainly related to return and return of packaging, facilitating logistics (Lacerda, 2002).

In the economic sphere it provides the recycling and marketing of new products, and also proposes shared responsibility with society, shaping a new culture, with care to the environment, driving new paths for sustainable development (Cometti; Alves, 2010).

Based on the above strongly guided as one of the actions that assist Sustainable Development, contributing to the correct return of the post-consumption product, optimizing the reuse and savings in the consumption of new raw materials, due to the degradation and unrestrained use of virgin raw materials, lowering the rates of contamination and degradation of the environment (Cometti; Alves, 2010).

The National Policy on Solid Waste (PNRS) shows that what cannot be recycled or remanufactured is what requires the greatest attention throughout the cycle. One of the products that requires too much attention throughout the chain of sale, consumption and

return are the packaging of agro-toxic products, which in the vast majority present a risk to human beings when used improperly (Milk, 2003).

From the concept presented, reverse logistics is denoted as a major ally to reduce as much as possible the inadequate disposal of packaging in general and of agrochemicals, establishing rules and return chains that must be strictly followed by all the sectors that make up this process. Starting with the manufacturer obliged to offer all the necessary information for resales, facilitating access to information to the farmer who must follow with all the measures imposed, until the packaging returns to the manufacturer and it is possible to carry out the correct destination of the waste (Milk, 2003).

According to NBR 10.004, pesticide packaging is categorized as hazardous waste due to the high risk of toxicity and contamination. This is due to the fact that, after the consumption of the product, there may still be active residues (Abnt, 2004). For Cempre (2000), if the packaging does not follow the correct destination process, and remains in the environment, it can cause contamination of surface water and groundwater, consequently putting both human and animal life at risk.

With the unbridled consumption of pesticides, it became necessary to develop measures to reduce pollution of the environment. Thus, in 2002, Law No. 9974/2000 came into force, regulated by Decree No. 4074/2000, where responsibilities were established with the intention that the packaging of agro-toxic products return to the manufacturer for the correct destination (Inpev, 2013).

In order for the return chain to be efficient, it was necessary to create a mechanism of shared responsibility between farmers, responsible for triple washing where the packaging must be rinsed at least three times before proceeding with the return process; shops are required to own compartments for storing the packaging and indicate on the invoices where the material must be returned, and the next step is the responsibility of the manufacturer to collect and give the correct destination to the packaging, in addition to the systematic government oversight on the return of the packaging (Inpev, 2013).

To help control the return of packaging, INPEV (National Institute for Empty Packaging Processing) was founded, so monitoring became effective by promoting constant development and improvements. The INPEV aims to represent and supervise all stages of the process, from the purchase of the material by the farmer in the cooperatives, to the final return at the manufacturer of the agrototoxic products (Inpev, 2013).

Thus, in order to be possible and effective the implementation of projects for the proper disposal of pesticide packaging waste, it is plausible to associate reverse logistics with other relevant issues, largely guided since 1972 with the start of the Sustainable Development conferences involving new concepts and approaches, as well as the creation of specific objectives to be followed and to seek to achieve the imposed goals, which are currently called Sustainable Development Goals (SDGs).

3 METHODOLOGY

The research presents an exploratory and descriptive nature overlapping development, with the objective of understanding and clarifying concepts and ideas with the contextualization of the problem with greater precision, covering documentary and bibliographic content (Hair *et al.*, 2005).

The study seeks to deepen in particular the relevance of the Sustainability approach, presenting inquiries and issues related to the Sustainable Development Goals. To this end, we analyzed the fundamentals of reverse logistics, as well as Sustainable Development and the Sustainable Development Goals. In this way, the research was carried out in three stages. Step 1: Literature Review with the aim of highlighting the historical milestones of the sustainable development and reverse logistics objectives of agrotoxics packaging; Step 2: Application of a questionnaire with open questions in order to obtain data on the SDGs targets in relation to the reverse logistics system of agrotoxics packaging; and Step 3: Analysis of the results identified in the grain cooperatives located in the region of the Northern Plateau of Santa Catarina, on the presence of the Sustainable Development Goals within the reverse logistics practice.

3.1 STEP 1: LITERATURE REVIEW

Key words were defined for the development of the study, in order to understand, in the first moment, how the concepts were established, as well as, what was the historical trajectory of each subject addressed so far. Each keyword selected aims to verify mutual synergy, seeking to relate each subject. As Table 1 presents the keywords used, as well as the first results found, it is necessary to use filters to better classify the search quality.

Table 1. Search results in databases.

Subject	Keywords used	Number of publications	After applying filters
Sustainability	Sustainable Development	794	124
	Sustainable Development Goals	165	13
Mechanisms for Waste Management	Reverse Logistics	3,965	44
	Circular Economy	142	47
Problematic	Packs of Agrotoxic Products	10	10
	TOTAL	5,076	238

Source: Prepared by the authors.

After choosing each keyword, it was necessary to extract tables in Excel format from each survey carried out, resulting in a total number of 5,076 articles. Articles were selected preferably from 2014, and initial reading of each article's title left 238 articles for further study. Of these 238 articles, 105 were available for reading, after brief reading of summary and conclusion 40 articles were separated for full reading.

The research went through the portals Scopus and Capes, in addition, searches were made on sites related to the topics covered, such as UN, ODS, UNDP, INPEV, WEBSTER, UNEP, which offer relevant and reliable information, bringing significant contributions, since they present specific and clear content, which in some cases could not be found in articles.

During the course of the bibliographic research it was possible to observe the relevance of the link between all the subjects covered, one composing the other in a significant way. However, the research took direction as a search for in-depth study especially the relevance of the Sustainability approach, presenting inquiries and issues related to the Sustainable Development Goals.

3.2 STEP 2: SEARCH APPLICATION

This study is framed methodologically as an applied research, as there was experimental procedure for obtaining data; it is exploratory, as it aims to observe the results between SDG and reverse logistics. According to the approach of the problem, it qualifies as qualitative, using a questionnaire (Bonat, 2009). This questionnaire sought to investigate whether the presence of the Sustainable Development Goals targets in the reverse logistics system of pesticide packaging.

The survey was applied in a city of approximately 20,000 inhabitants - according to the last IBGE census - located in Norte Catarinense, Brazil (Ibge, 2010). The city has

four Grain Cooperatives, whose business branch is the sale of agricultural inputs for production and large scale grain plantations. Data were collected from three of these companies as a result of the questionnaire.

Methodology and data collection was done by applying a qualitative exploratory questionnaire, as described in Appendix A. The questionnaire was carried out by means of six open questions with the purpose of meeting the specific objectives of the article. The questionnaire applied was the starting point for understanding the research in which it first seeks the contextualization of what is the reality and development of reverse logistics and sustainability. The complete answers of each respondent are provided in Appendix B.

3.3 STEP 3: DATA PROCESSING

The analysis of the questionnaire applied with the companies interviewed was proposed through an initial study of each response, extraction of each information and data link, and, finally, data processing, aiming at visibility and identification of what is in fact being fulfilled between reverse logistics, Sustainable Development Goals and the practical reality of a city of the Northern Plateau of Santa Catarina.

In the course of the bibliographic research it was possible to observe the relevance of the link between reverse logistics and the Sustainable Development Goals, one composing the other in a significant way. However, the research took direction as a search for in-depth study especially in the relevance of the Sustainability approach, presenting inquiries and issues related to the Sustainable Development Goals.

From this perspective, Table 3 has been elaborated, depicting the main objective and its subsequent goal. A number of reasons have been listed, justifying and presenting the need for study in the light of the goals that must be developed and put into practice for the 2030 Agenda.

Table 3. Selected Sustainable Development Goals and implementation justifications.

Purpose	Targets	Reason	References
Objective 2: Zero hunger and sustainable agriculture	2.5 Promoting sustainable food production systems, increased productivity, ecosystem support, progressive improvement of land and soil quality.	It makes it possible to reduce the consumption of agrototoxic products.	ODS (2018); Onubr (2025); Almeida (1997); Guimarães;
	2a Preserve the genetic diversity of seeds and animals.	Stabilizing the ecosystem.	Fontoura (2012);
	2.b Invest in rural infrastructure and technology, agricultural services, aiming at the growth of productive capacity.	Inventions and greater mobility and less contact with chemicals.	Onubr (2016)
Objective 6: Drinking water and sanitation	6.3 Minimizing the use of hazardous chemicals and materials, reducing water contamination and overall pollution. Motivate increased recycling and safe reuse.	Improvement in quality of life mainly for the farmer who is in direct contact with the product, as well as preservation of the environment around him.	Guimarães; Fontoura (2012); Onubr (2016)
Objective 9: Industry, innovation and infrastructure	9.4 Reforming industries by making them sustainable, increasing efficiency and resource use. Using cleaner, more environmentally sound production.	Now it's the main precursor of pollution, it should create a spontaneous thought of preservation, take as motto.	Guarnieri <i>et al.</i> (2006); Leite (2003); Guimarães; Fontoura (2012)
Objective 12: Responsible consumption and production	12.4 Optimizing the correct and healthy consumption of chemicals and waste throughout its lifetime. Reduce incorrect disposition for minimization contamination of soil, air and water. Reserve human health.	It will be a facilitator for the correct destination of the product or packaging.	Guimarães; Ribeiro (2016); Guimarães; Fontoura (2012); Ipea (2012)
	12.5 Significantly reduce waste generation through prevention, reduction, recycling and reuse.	Reduction of products or packaging discarded in the environment without proper treatment.	

Source: Prepared by the authors, based on ODS (2018).

4 RESULTS AND DISCUSSIONS

4.1 LITERATURE REVIEW RESULTS

By searching the database for understanding and correlation of the subjects intended for study, it was necessary to seek synergy and create a sequence of keywords as mentioned in Table 1. Theoretical research began with the study of the concepts of Sustainability focusing on the trajectory and gradual evolution through conferences and agreements between countries. Regarding the topic of Sustainability, Sustainable Development and the Sustainable Development Goals, they were treated as a focus of research because of the need to raise awareness of the reduction of environmental

damage. These are the main points addressed through the list of articles studied, in this way it was possible to delimit a precise path in the sequence of the research.

During the Literature Review and data processing based on the study and macro understanding of the 40 articles read in full that were extracted from the databases mentioned in the research methodology (APPENDIX C). These are exemplified through the selected keywords, it was possible to observe greater attention with the disposal of recyclable and non-recyclable materials, precisely due to the mechanisms of reuse and environmentally correct disposal that were previously not used. In line with the theme studied and elaborated concepts, it was possible to apply methods for the management of Solid Waste, then to follow the approaches of how the Reverse Logistics process occurs.

Based on the above and observing the treatments that were taken through the reverse logistics process, the study of the return of pesticide packaging was selected as the direction of the research, treating this as problematic, aiming the study of the process as well as the correlation and investigation of the presence of the Sustainable Development Goals in the return processes and how the practices and targets discussed in Table 3 are followed.

4.2 PREPARATION OF THE QUESTIONNAIRE

Based on the Literature Review, it was possible to obtain a correlation between reverse logistics of agrochemicals packaging and the Sustainable Development Goals, as presented in Table 3. The framework contains the macro-targets of the objectives as well as the subsequent targets. Based on the review and presentation of the reasons for how these fit into the proposed theme, it was possible to draw up a questionnaire with open questions, as presented in Appendix A.

The intention of the application of the questionnaire was to investigate the presence of the Sustainable Development Goals in the Northern region of Santa Catarina. Each question sought to identify sentences or keywords that refer to each goal of the SDGs, in which the respondent presents what the reverse logistics cycle is like in practice, as well as exemplifying how the SDGs are present in the reverse supply chain.

4.3 ANALYSIS OF THE DATA OBTAINED

From the application of the questionnaire, three replies were obtained from employees of each Grain Cooperative from a total of four Cooperatives, as presented in full in Appendix B.

Based on the above, with the application of the questionnaire it was observed that, with the experience of each respondent, some time ago - without the exact specification of which time space - the treatment regarding the agro-toxic packaging was different, without the environmentally most indicated destination. According to reports, the packaging was discarded in landfills or even burned.

However, with the follow-up of each question, it was possible to observe that the reverse logistics had significant evolution, besides noting the presence of the Sustainable Development Goals through an analysis of each response to what fits into each target, as presented in Table 4.

Table 4. Data Analysis.

Purpose	Judgments
Objective 2: Zero hunger and sustainable agriculture	A1: Transgenics as process of "improvement"; Advance in the genetics of more productive hybrid cultivars;
	R2: Improvement and investment in seed technology; transgenic technologies and agricultural machinery; Investment in receiving units;
	A3: Evolution and technology in transgenics.
Objective 6: Drinking water and sewerage	A1: Reduction of pesticides; awareness of the harmful effects on the environment of packaging not discarded correctly, through lectures and courses;
	A2: Drones for better water use; Investment in soil correction; decrease in pesticide/insecticide use; obligation to give the final correct disposal to the packaging and not to make reuse;
	A3: Composting; no-till; obligation to give the correct final disposal to the packaging and not to make reuse of it.
Objective 9: Industry, innovation and infrastructure	A1: Disposal and separation of recyclable material through electronic materials and chemical packaging;
	R2: Investment in receiving and storage units;
	A3: Direct planting and soil cover; use of bio-inputs.

Source: Prepared by the authors.

As for Objective 12, all the judgments observed in Table 4 fall into place, so it is possible to state that reverse logistics and the Sustainable Development Goals are being applied in the day-to-day life of both the rural producers as well as the Grain Cooperatives that make the receipt and present the alternatives of improvement and aid to the farmer.

Based on the analysis of the Sustainable Development Goals, together with the answers collected in the questionnaire, it can be observed that the keywords and sentences

presented in Table 4, combine with the proposed practices presented in Table 3, indicating that the practices have been applied.

According to the answers, there are criticisms and points to be developed, some negative points and comments are presented as to the processes, and even with the genetic diversity and the possibility of reducing the use of pesticides and insecticides, there is the opening for the proliferation of new pests that were previously considered secondary and have become primary in this way can consequently increase the consumption of pesticides.

Despite the instructions given to farmers, there are still cases in which in the long term they can make indiscriminate use of pesticides, thus contributing to greater pest resistance, greater pollution of the environment and damage to the health of the collaborator who applies or manipulates this type of chemical.

However, it is necessary to highlight that these should increase knowledge, since, in the course of the answers to the questionnaire and exploration of the concepts of each target, there are still improvements to be made, such as better dissemination and explanation to employees and farmers about what are the positive and negative impacts, as well as the importance of handling, cleaning, and reverse logistics in the recycling chain of agro-toxic packaging.

Referring to the negative impacts, it can be said that, if the reverse supply chain process is not followed correctly by farmers, the objectives 2, 6 and 12 are no longer met, since, respectively, in objective 2 there would be no proper disposal of the packaging, which would interrupt the flow of return as well as no longer meet the investments implanted in the reverse logistics system.

With regard to Objective 6, there is an increase in the possibility of contamination of water and the environment in general, uncoupling the measure and intention of recycling materials. As for objective 12, if the flow or return of packaging were to be halted, it would jeopardize the whole system of constructing the concepts of the sustainable development objectives, given that the latter aims at the correct sequencing of the whole chain.

However, objective 9, as presented in the questionnaire and data survey, is being applied with investments in drones, composting processes, receiving units, storage and studies aimed at grain genetics, which makes it possible to meet the previous objectives that must be carried out by farmers and monitored by the Cooperatives. In this way,

analyzing the data with the positive approach, it can be said that the reasons for the application of the sustainable development objectives presented in Table 3, if correctly followed, are met, giving concrete expression to the theoretical concepts addressed.

Based on the information collected through the questionnaire, it is understood that the companies as a whole are following the rules established by INPEV as well as the Sustainable Development Goals, emphasizing the importance of the reverse supply chain as a whole, from the conscious use of the product, washing of the packaging, storage and return to the Cooperative where the product was purchased, so that it follows the logistic process for recycling, can be destined raw material for manufacturing other packaging or final disposal, such as incineration.

5 CONCLUSIONS

The present research, which had the general objective of investigating the presence of the goals of the sustainable development objectives in the reverse logistics system of agro-chemicals packaging, had satisfactory results, since the objective was reached. Based on the collected data, it can be stated that there is the presence of the SDG goals in the reverse supply chain, as well as the process is followed correctly.

As to the objectives of this research, it can be said that the first objective, to identify concepts and historical landmarks of the objectives of sustainable development and reverse logistics of agro-chemicals packaging, has been achieved. The research presented how the initial evolution of the concepts of Sustainability progressed towards the Sustainable Development Goals addressing the main historical milestones that were fundamental for progress and the achievement of improvements and actions for the reduction of negative impacts on the environment and society, taking as an initiative the advancement to the 2030 Agenda.

The second objective, to select goals for the SDGs that support the reverse logistics system for the packaging of agrochemicals, was achieved. Through in-depth theoretical study based on true information, it was possible to relate the reality of reverse logistics with the concept of the Sustainable Development Goals.

The third objective, being to verify the presence of the SDGs in the daily life of the Grain Cooperatives, was achieved. By means of the questionnaire, it was possible to concretely realize the concepts addressed and discussed in the second objective, noting

that the goals of the Sustainable Development Goals are present in the daily lives of farmers and employees who are assisting for better development and dissemination of sustainable practices.

During the research, some questions arose, which can be treated as suggestions for future research: from this research, it can be explored what were the improvements made in seed genetics and how is the development so that such pests or diseases can be contained, in addition to the development of biological pesticides; apply this methodology in other regions with the objective of observing whether there is linearity in the application of the Sustainable Development Goals. It is pertinent to investigate if there is the relationship of other goals of the SDGs that fit into the proposed theme and to expand the field of research.

Some difficulties and points of attention that should be discussed is the applicability and knowledge of farmers as to the relevance to follow the cycle of reverse logistics, and despite being promoted talks, there are still negative discussions as to the handling of pesticides that can be misused aggravating the local situation, both with pollution with the development of new pests and the creation of resistance.

Finally, it was concluded that the methodology is satisfactory, displaying the results clearly, showing that there are several points that need to be improved through study, however, these are already being developed, and even though there is still a long way to go, the elaborated concepts are having positive effects on the three dimensions, social, environmental and economic.

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APPENDIX A - QUESTIONNAIRE

1. Based on your experience, what is your opinion regarding improvements in seed genetic diversity. With regard to the use of pesticides, has there been an increase or decrease in use?
2. Have there been any advances in technology? What are the most relevant investments in rural infrastructure and technology in the region?
3. Has the company implemented any action plan to increase resource efficiency in a way that is favorable to the sustainability project? Cleaner production (reduction in waste generation) and environmentally sound.
4. Is there a reason for increasing the recycling and safe reuse of pesticide packaging?
5. In your opinion, have there been any developments regarding sustainability issues in the region along with the increase in grain productivity?
6. Explain how the return chain of pesticide packaging works at the cooperative.
7. In the past, where were the agro-chemical packaging discarded?

APPENDIX B - QUESTIONNAIRE WITH REPLIES

1. *Based on your experience, what is your opinion on the improvements in seed genetic diversity? With regard to the use of pesticides, has there been an increase or decrease in use?*

Answer 1: Focusing on transgenics, as a process of genetic "improvement", I can say that for certain pests (for which transgenics was developed) there was a reduction in pesticides. However, the longevity of the transgenic gene depends a lot on handling in the field, citing for example areas of refuge. Generally speaking, when dealing with monocultures, we ended up selecting new pests, which previously were regarded as secondary and become primary, which could increase their use.

Answer 2: Improvement and investment in seed technology has improved year by year, with which we have decreased uses of such insecticides/pesticides, however, even with the use of these technologies, insects have also created resistance, where we need to be evolving in research in seed genetics.

Answer 3: The evolution of technology, especially when it comes to transgenics, ends up reducing defensive use in the short term. In the long term, the indiscriminate use

of some active ingredients ends up generating resistance in pests, which results in an increase in the use of pesticides

2. *Have you had any breakthroughs in local technology? What are the most relevant investments in rural infrastructure and technology in the region?*

Answer 1: Yes. Over the years we have had advances in genetics, with selection of more productive cultivars and hybrids (both for grain and hortifruti crops and for livestock). In terms of infrastructure, we can cite easier access to the Internet for remote locations, paving of important roads, which can cite paving of road between and (city*), and more recent the widening of the track and new paving of access (city*). Within the issue of generating demand and jobs we can cite the (activity*) plant installed in (city*). It needs to evolve a lot, through public policy, but if you look back 10 years, there have been significant improvements.

Note: information deleted from the text (city* and activity*) to ensure that the interviewee and his/her company are not identified.

Answer 2: Yes, producers have invested in transgenic technologies and agricultural machinery, companies in the region have also invested in receiving and storage units, although not at the same pace that the producer has invested and for reasons of high raw material values.

Answer 3: There are several technologies. We can cite no-till and variable rate as the main ones.

3. *Has the company implemented any action plan to increase resource efficiency in a way that is favorable to the sustainability project? Cleaner production (reduction in waste generation) and environmentally sound.*

Answer 1: The company follows all the laws in force. In the question of disposal, we separate everything from recyclable material, passing through electronic materials, to chemical packaging.

Answer 2: Yes, we have in the region agreements and partnership with final destination company of pesticide packaging, investment in training and lectures with updated technology of the best use of equipment, application quality of sprayer and drones thus making the best use of the waters, investment in soil correction producing more with the same area size.

Answer 3: Yes, the waste is destined for proper purposes... recycling, composting.

4. *Is there a reason for increasing the recycling and safe reuse of pesticide packaging?*

Answer 1: There has been greater awareness of the harmful effects on the environment of packaging not disposed of correctly. Awareness raised through lectures, online courses offered by multiple platforms. Currently companies are better prepared to receive the packaging and better guide the correct way of disposal (from syrup, washing and sorting).

Answer 2: There would be no motivation but an obligation on the part of the conscious producer to give the final correct destination of the packaging and not to make reuse.

Answer 3: The law, and the ease of destination of the high volume of generated packaging.

5. *In your opinion, have there been any developments regarding sustainability issues in the region along with the increase in grain productivity?*

Answer 1: Honestly, no. There has been an increase in production due to the opening up of new areas (previously woodland areas). We must focus on increasing productivity (production per area) so that we have greater production without the need to open up areas of native undergrowth.

Answer 2: Yes, because in the region we can say that small producers predominate where the increase in productivity took place with the best use of the area and technology, increasing productivity.

Answer 3: No-till and soil cover. Use of bioinputs.

6. *In the past, where were the agro-chemical packaging discarded?*

Answer 1: There was a lot of burning of packaging, even disposal in common garbage (landfills).

Answer 2: It is known that they were burned or even re-used in the past, now with direct collection from producers and signatures in prescriptions where the producer undertakes to the destination of the packaging and campaigns of correct destinations, has greatly improved this issue.

Answer 3: In the time I worked with agro, 10 years, reverse logistics already existed. Prior to that I would not know how to inform.

APPENDIX C - LISTING OF 40 SELECTED ARTICLES

- 1 Silva, C. H. R. T. Rio+20: Avaliação Preliminar De Resultados E Perspectivas Da Conferência Das Nações Unidas Sobre Desenvolvimento Sustentável. Senado Federal, p. 1-6, 2012.
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- 10 Santana, Y. R. S.; Lima, A. M. F. Resíduos Eletroeletrônicos: Sinergia Entre A Economia Circular, Logística Reversa E As Perspectivas Dos Objetivos Do Desenvolvimento Sustentável (ODS) No Brasil. X Congresso Brasileiro de Gestão Ambiental, v. 11, n. 1, p. 1233-1242, 2021.
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- 13 Aragos, K. P. C.; Filho, L. R. A. G.; Junior, S. S. B. Logística reversa de embalagens vazias de agrotóxicos e as dificuldades para efetiva implantação. *Research, Society and Development*, v. 10, n. 2, p. 1- 12, 2021.
- 14 Barreto, R. C.; Xavier, L. H. Mineração Urbana Para A Gestão De Equipamentos Eletroeletrônicos: Avaliações Preliminares para a aplicação dos ODS. VIII Jornada do Programa de Capacitação Institucional – PCI/CETEM, p. 106-112, 2019.
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