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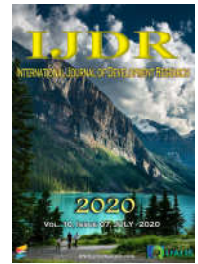
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SAFETY MATURITY MODEL IN THE USE OF AGRICULTURAL DEFENSIVES

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ABSTRACT

The growth in world food production consequently generates a greater demand for agricultural defensives. If, on one hand, the use of them provides an increase in agricultural productivity and a decrease in losses, on the other, their improper use can generate environmental impacts with risks to human health, especially if safety requirements are inadequate. Thus, this article proposes a safety maturity model in the use of agricultural defensives. A review was carried out in the literature with the keywords "Pesticides and Safety", "Pesticides and Foods", "Pesticides and Good habits", "Pesticides and Maturity", "Pesticides and transport", in the Web of Science[®] (WOS) and Scielo[®] databases in the period from 2005 to 2020. Based on the literature, assertions of good practices in the use of agricultural defensives were identified and organized by the following variables: acquisition, transport, storage, application, preparation, cleansing and disposal of containers.

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INTRODUCTION

According to Godecke and Toledo (2015), the twentieth century shows an increase in the production of food products, which occurred due to the increase in technology and cultivation techniques. One of these was the production and use of agricultural defensives, which seeks greater efficiency in terms of quality and quantity. Agricultural defensives are used in plantations to combat pests and diseases. They are classified as physical, chemical or biological agents and are used in pastures, protection of native or planted forests and other ecosystems, as well as urban, water and industrial environments (BRASIL, 2010). Therefore, with the use of new technologies, there was a decrease in the incidence of pests and diseases that affected plantations. The use of agricultural defensives as an agricultural development process has become an important tool as a plant protection agent for growth in food production. According to Tavares *et al.* (2020), agricultural defensives have become relevant in Brazil through bill n^o. 6,299/2002, that aims to amend law n^o 7,802/1989, which talks about the flexibilization of rules for the inspection and

application of agricultural defensives. Due to its strength in agricultural production and continental size, Brazil is the largest consumer in the world and in ten years, the Brazilian agricultural defense market increased by 190%. With the demand for the use of them, the probability of contamination of food, environment, springs, soil, air, rural producers and the population increases. For Barbosa and Machado (2010), in developing countries, the inadequate use of agricultural defensives creates a serious problem for public health. With the increase in these products, it became evident that there is no audit of occupational exposure, effective inspection and control over marketing, the use of Personal Protective Equipment (PPE) and, the diagnosis and treatment of intoxication cases are flawed. Both occupational and environmental exposure can cause several health problems. In their studies in India, Abhilash and Singh (2009) identified national standards for spray equipment, which are followed by the main manufacturers. However, another significant portion does not meet quality standards. They identified a substantial amount of agricultural defensives wasted on spraying machines due to maintenance problems.

Relevant levels of agricultural defensive residues in food crops are also reported. Ibitayo (2006), in his studies in Kenya, identified contamination or accidental poisoning resulting from storage of food and water, application and inappropriate disposal of containers. He also identified irregularities in the storage of agricultural defensives, where more than three quarters of the surveyed farmers pack it close to food and in family rooms, which are usually overcrowded due to lack of space. Thus, it appears that the improper use and storage are two important factors in the occurrence of contamination. It is observed, then, that adequate risk management is fundamental to guarantee good practices in the use of agricultural defensives. The search for alternative treatments for pests and diseases integrated with management practices also play an important role in providing safe and food quality to the public (SUSAETA *et al.*, 2018). For these reasons, this article aims to propose a safety maturity model in the use of agricultural defensives. This goal is based on the evidence of biological and environmental intoxication in the use of agricultural defensives. This model has, as implications, the construction of theoretical subsidies for the application and empirical validation in future studies in different regions and branches of agriculture.

Safety maturity in the use of agricultural defensives in agriculture: According to Buffon, Aguiar and Godarth (2018), the concept of maturity was initiated in the United States with the creation of the Software Engineering Institute (SEI). In the 1980's, this idea supplied the government's need to assess the capacity of contracted organizations in the development of computer systems. In summary, maturity models aim to assist in the assessment of the current state of their processes and in planning the improvement of their practices, seeking organizational adequacy (ANDERSEN; JESSEN, 2003), through guidelines that establish principles or a set of practices for the development of an entity over time (STORBJERG; BRUNOE; NIELSEN, 2016). Maturity levels are identified through practices and routines, according to Paulk *et al.*, (1993) who suggested the basic structure in levels, ranging from level 1 to level 5. Level 1 determines ad hoc processes, in which the good performance is dependent on the individual's initiatives and not on the use of organizational routines. On the other hand, at level 5, incremental improvement occurs through innovative processes. At this stage, the labor power is participative, trained and aligned with organizational values and objectives.

MATERIALS AND METHODS

A growing body of literature has focused on making recommendations on the use of agricultural defensives. To meet the research's objective, a systematic review of scientific articles was carried out, seeking a minimal compilation of evidence-based items. For that, a systematic research was carried out in the Web of Science® (WOS) and Scielo® databases with the following criteria: a) research articles (empirical and theoretical); b) Keywords "Pesticides and Safety", "Pesticides and Foods", "Pesticides and Good habits", "Pesticides and Maturity", "Pesticides and transport". c) published between 2005 and 2020. 6,455 articles were parameterized in the Web of Science® (WOS) and Scielo® databases, in the period from 2005 to 2020;

however, only 236 abstracts were read and 184 of these were discarded because the content did not report safety practices. The remaining 42 articles were used in the proposed table in the following sections. These articles were searched in the national and international databases. Scielo® has more of an agronomic reality in Brazil, as it includes national research, while Web of Science® (WOS) has an international reality. Thus, with this basis, the articles selected in depth were analyzed to identify the best practices in the use of agricultural defensives with safety.

Proposed table of the safety maturity model in the use of agricultural defensives: The assertions of good practices of the safety maturity model, in the use of agricultural defensives proposed in this article, were prepared based on the literature and are presented in the respective variables as shown in Table 1.

Table 1. Proposed maturity model in the use of agricultural defensives

Maturity Model Variables	Acquisition	Maturity level
	Transport	1. Never
	Storage	2. Rarely
	Preparation	3. Sometimes
	Application	4. Oftentimes
	Cleaning	5. Always
	Container Disposal	

Source: Elaborated by the authors.

To determine the variables of the proposed model, the flow of observations in which the user of agricultural defensives should use was developed sequentially. To indicate maturity levels, the use of a Likert scale that ranges from "1-Never, 2-Rarely, 3-Sometimes, 4-Oftentimes and 5-Always" is proposed, to show the frequency of practices and routines in favor of a safe use of agricultural defensives. In the subsequent sections, the assertions organized by variable are presented.

Acquisition of Agricultural Defensives: The acquisition of agricultural defensives is when farmers buy chemicals to be applied in agriculture (ABREU; ALONSO, 2014; RISTOW *et al.*, 2020). This article proposes the following assertions defined in Table 2.

Table 2. Criteria to be observed when acquiring agricultural defensives

Code	Assertions	Authors (year)
R01	Select authorized stores that sell agricultural defensives.	Susaeta <i>et al.</i> (2018).
R02	Consult an Agricultural Engineer.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Souza and Azevedo (2017); Rijal <i>et al.</i> (2018); Brasil (2010).
R03	Read the product's information leaflet.	Barbosa and Machado (2010); Abreu and Alonso (2014).
R04	Use an agronomic prescription and save the second copy.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R05	Request and archive the invoice for possible product traceability queries.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R06	Check expiration date of agricultural defensives.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R07	Check the container for damage and/or leakage.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Zhao <i>et al.</i> (2017); Cao <i>et al.</i> (2020); Kang, Kim and Kim (2020); Sieke (2020).
R08	Ensure that labels and information leaflet are legible.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).

Source: Elaborated by the authors.

Initially, when purchasing agricultural defensives, one must "select authorized stores that sell agricultural defensives", since some stores sell the product without authorization. Not having authorization from the Ministry of Agriculture, Livestock and Supply (MAPA) to sell the product can lead to fines. In addition, authorized stores can offer assistance of an Agricultural Engineer when purchasing agricultural defensives (Susaeta *et al.*, 2018). When doing this, farmers must "consult an Agricultural Engineer", since it is mandatory depending on the authorization to purchase the chemical product for its application in agriculture (ABREU; Alonso, 2014; Ristow *et al.*, 2020; Souza, Azevedo, 2017; Rijal *et al.*, 2018; Brazil, 2010). After purchasing, one should "read the product's information leaflet" to know how to handle the agricultural defensives. When an accident occurs with the farmer, they should be referred to a health unit and take along the leaflet to diagnose more quickly what type of product he had contact with and take a more effective medication (Barbosa; Machado, 2010; Abreu; Alonso 2014). To obtain authorization for the use of a chemical product, in case any inspection agency comes to visit the property, one must ask the Agricultural Engineer responsible how to "use an agronomic prescription and save the second copy", to prove that it was purchased in an authorized retailer with an Agricultural Engineer responsible. One should also "request and archive the invoice for possible product traceability queries" and "check the expiration date of agricultural defensives" to make sure that the chemical product is within this date. If it is not, notify the store assistant. It is necessary to "check the container for damage and/or leakage" so that there is no contamination of the farmer and the environment when handling the merchandise. In case of damage to it, immediately notify the store assistant. (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Zhao *et al.*, 2017; CAO *et al.*, 2020; Kang, Kim and Kim, 2020; Sieke, 2020). As for the cautionary instructions in the use of the chemical products, one should "ensure that the label and information leaflet are legible", since it contains the directions for using it, in which period (morning, afternoon or evening), as well as the climatic season (sunny, cloudy, windy). If the product is expired, the container is damaged and the label and information leaflet are not legible, inform the store assistant (Abreu; Alonso, 2014; Ristow *et al.*, 2020).

Transport of Agricultural Defensives: Transportation of agricultural defensives is when the supplier or farmer makes the logistics of the merchandise for the industries, authorized retail stores and rural properties safely through vehicles (Abreu; Alonso, 2014; Ristow *et al.*, 2020). This article proposes the following assertions defined in Table 3.

Initially, one should "check with the merchant (Agricultural Engineer) the procedures for a safe transport of agricultural defensives", since some people transport the chemical products without any due concern and attention. Doing it wrong can lead to the contamination of the merchandise you are transporting. In addition, people with this conduct will prevent contamination of food, medicine, feed, animals and passengers that are taken along (Abreu; Alonso, 2014; Barbosa; Machado, 2010; Brasil, 2010). When transporting agricultural defensives, "verify that the invoice is filled out with the information required in the Dangerous Goods Transport Regulation (DGTR)" in order to present the chemical products being transported to the inspection organ (Abreu; Alonso, 2014; Godecke; Toledo, 2015; Ristow *et al.*,

2020). After checking the documentation, one should "identify the classes (class I - extremely toxic, class II - highly toxic, class III - moderately toxic and class IV - slightly toxic) of the agricultural defensives in order to know the several logistical precautions" and with this, separate them to prevent mixture in case of leakage. Furthermore, the people involved should be informed of the risks they are exposed to when transporting the merchandise (Mendes *et al.*, 2017; Carneiro *et al.*, 2015); Ristow *et al.*, 2020; Rijal *et al.*, 2018; Susaeta *et al.*, 2018; Embrapa, 2015; Tavares *et al.*, 2020). In the transportation of chemical products, the driver and passenger should "know the procedures for salvaging agricultural defensives in case of accidents" to be able to isolate them in case of a leak, so as not to contaminate other places (water, soil, animals) and thereby reduce the environmental impact (Abreu; Alonso, 2014; Mendes *et al.*, 2017; Ristow *et al.*, 2020; Kang; Kim; Kim, 2020). Check when to "transport agricultural defensives separately from other items, such as food, medicine and animal and human feed" so that there is no contamination and therefore, prevents any risk of human and animal intoxication when consuming the goods (Carneiro *et al.*, 2015; Morello *et al.*, 2019; Arioli *et al.*, 2019; Abhilash; Singh, 2009; Sieke, 2020; Turnipseed *et al.*, 2019; Karthikeyan *et al.*, 2019). The driver who transports merchandise "can't smoke when handling agricultural defensives" due to the contamination of the people involved in the activity and the flammable substances that have a low flash point, which can cause sparks and trigger a fire (Mendes *et al.*, 2017; Zhao *et al.*, 2017). When transporting chemical products in vehicles, "never transport inside the cabin and damaged and/or leaking containers" to avoid contamination of the driver and passenger who are exposed to them and the risk of fire, which is propitious seeing as the product is flammable and close to the engine of the vehicle. The driver must "use a cargo box to store agricultural defensives in case of transport with another type of product", in order to isolate them from food, animals, feed and others, and therefore avoid contamination of the same. When transporting chemical products with vehicles containing a truck body, one should "cover the containers with a waterproof tarp attached to the truck body" so that it is not contaminated with rain, sun or other weather conditions, preventing a possible hazard of the product leaking due to the merchandise being isolated. Also, one should "store in a way that the containers do not exceed the height of the truck body", so as not to have the risk of the merchandise falling. By placing it at the height of the truck body, the merchandise is safer to transport to its final destination (Abreu; Alonso, 2014; Ristow *et al.*, 2020).

Storage of Agricultural Defensives: Storage is the location where one leaves the agricultural defensives in the farm's ware house (Abreu; ALONSO, 2014; Ristow *et al.*, 2020). This article proposes the following assertions set out in Table 4. Initially, one should "build a warehouse at least 30 metres away from water sources, residences and animal facilities", seeing as some farmers build theirs near them to ease the locomotion of services. If built too close, it can lead to the contamination of drinking water, animals, people and the environment. Furthermore, by building in an adequate location, the farmer will benefit from not contaminating and impacting the environment with chemical products (ABREU; Alonso, 2014; Ristow *et al.*, 2020; Turnipseed *et al.*, 2019; Karthikeyan *et al.*, 2019; ZHAO *et al.*, 2017;

Table 3 - Criteria to be observed in the transport of agricultural defensives

CODE	ASSERTIONS	AUTHORS (YEAR)
R09	Check with the merchant (Agricultural Engineer) the procedures for a safe transport of agricultural defensives.	Abreu and Alonso (2014); Barbosa and Machado (2010);Brasil (2010).
R10	Verify that the invoice is filled out with the information required in the Dangerous Goods Transport Regulation (DGTR).	Abreu and Alonso (2014); Godecke and Toledo (2015);Ristow et al. (2020).
R11	Identify the classes (class I - extremely toxic, class II - highly toxic, class III - moderately toxic and class IV - slightly toxic) of the agricultural defensives in order to know the several logistical precautions.	Mendes et al. (2017);Carneiro et al. (2015); Ristow et al. (2020); Rijal et al. (2018); Susaeta et al. (2018); Embrapa (2015); Tavares et al.(2020).
R12	Know the procedures for salvaging agricultural defensives in case of accidents.	Abreu and Alonso (2014); Mendes et al. (2017);Ristow et al. (2020); Kang, Kim and Kim (2020).
R13	Transport agricultural defensives separately from other items, such as food, medicine and animal and human feed.	Carneiro et al.(2015); Morello et al. (2019); Arioli et al. (2019); Abhilash and Singh (2009);Sieke (2020); Turnipseed et al. (2019); Karthikeyan et al.(2019).
R14	No smoking when handling agricultural defensives.	Mendes et al.(2017);Zhao et al. (2017).
R15	Never transport inside the cabin and damaged and/or leaking containers.	Abreu and Alonso (2014); Ristow et al. (2020); Cao et al. (2020);Abhilash and Singh (2009); Kang, Kim and Kim (2020).
R16	Use a cargo box to store agricultural defensives in case of transport with another type of product.	Abreu and Alonso (2014); Ristow et al. (2020).
R17	Cover the containers with a waterproof tarp attached to the truck body.	Abreu and Alonso (2014); Ristow et al. (2020).
R18	Store in a way that the containers do not exceed the height of the truck body.	Abreu and Alonso (2014); Ristow et al. (2020).

Source: Elaborated by the authors.

Table 4. Criteria to be observed in the storage of agricultural defensives

CODE	ASSERTIONS	AUTHORS (YEAR)
R19	Build a warehouse at least 30 meters away from water sources, residences and animal facilities.	Abreu and Alonso (2014); Ristow et al. (2020); Turnipseed et al. (2019); Karthikeyan et al. (2019); Zhao et al. (2017); Potter and Coffin (2017); Gonzalez et al. (2016);Tabacco, Comino and Borreani (2018).
R20	Build a masonry warehouse, with a cemented floor, resistant roof and no leaks (leak containment ducts, directed to the filter).	Abreu and Alonso (2014); Ristow et al. (2020); Susaeta et al. (2018); Potter and Coffin (2017); Gonzalez et al. (2016).
R21	Store in a covered, ventilated and rain-proof location with a protected electrical installation of quality	Abreu and Alonso (2014); Susaeta et al. (2018); Potter and Coffin (2017); Gonzalez et al. (2016).
R22	Build the warehouse with good ventilation and natural lighting.	Abreu and Alonso (2014); Ristow et al. (2020); Susaeta et al. (2018).
R23	Designate an exclusive warehouse from other constructions.	Abreu and Alonso (2014); Barbosa and Machado (2010); Brasil (2010); Susaeta et al. (2018).
R24	Designate a warehouse to be free of floods and moisture	Abreu and Alonso (2014); Ristow et al. (2020); Barbosa and Machado (2010); Brasil (2010); Susaeta et al. (2018); Potter and Coffin (2017);Gonzalez et al. (2016).
R25	Preserve in original and unopened container.	Abreu and Alonso (2014); Ristow et al. (2020); Castro and Confalonieri, 2005; Sieke (2020).
R26	Store the containers on metal shelves or on pallets, without contact with the floor, walls and ceiling.	Abreu and Alonso (2014); Castro and Confalonieri, 2005; Ristow et al. (2020).
R27	Organize the warehouse to be stored by class.	Susaeta et al. (2018); Ntow et al.(2006); Abreu and Alonso (2014); Ristow et al. (2020); Sieke (2020).
R28	Identify the label to remain visible and legible.	Abreu and Alonso (2014); Ristow et al. (2020).
R29	Define a warehouse away from residence and lodging.	Castro and Confalonieri, 2005; Morello et al.(2019).
R30	Store agricultural defensives away from other items, such as food, medicine, feed and animals.	Abreu and Alonso (2014); Ristow et al. (2020); Castro and Confalonieri, 2005; Morello et al. (2019); Carneiro et al. (2015); Abhilash and Singh (2009);Sieke (2020); Arioli et al. (2019); Turnipseed et al. (2019); Karthikeyan et al.(2019).
R31	Store and close the remaining agricultural defensives in their own container.	Carneiro et al. (2015); Rijal et al.(2018);Ibitayo (2006); Sieke (2020).
R32	In the event of a container rupturing, use an overload of transparent plastic.	Abreu and Alonso (2014); Ristow et al. (2020).
R33	Leave the doors locked and signaled to prevent the entry of children and unauthorized individuals.	Abreu and Alonso (2014); Ristow et al. (2020); Castro and Confalonieri, 2005;Abhilash and Singh (2009).

Source: Elaborated by the authors.

Tabacco; Comino; Borreani, 2018; Potter; Coffin, 2017; Gonzalez et al., 2016). When storing agricultural defensives, farmers should "build a masonry warehouse, with a cemented floor, resistant roof and no leaks (leak containment ducts, directed to the filter)" on their property so that there is no water infiltration in the establishment. With this conduct, they will avoid contaminating the environment with the chemical product (Abreu; Alonso, 2014; Ristow et al., 2020; Susaeta et al., 2018; Potter; Coffin, 2017; Gonzalez et al., 2016). After construction, the products should be "stored in a covered, ventilated and rain-proof location with a protected electrical installation of quality" to keep them preserved from the weather conditions (rain, sun, wind and others) and in good condition when needed

(Abreu; Alonso, 2014; Castro; Confalonieri, 2005; Susaeta et al., 2018; Gonzalez et al., 2016). When storing, they should "build the warehouse with good ventilation and natural lighting", so that the environment is suitable for the ideal temperature and therefore, maintain the preservation of the merchandise (Abreu; Alonso, 2014; Ristow et al., 2020; Susaeta et al., 2018). Farmers should "designate an exclusive warehouse from other constructions" so that they do not come in contact with another product in there and Thus, maintain an Isolation in the Event of a leak (Abreu; Alonso, 2014; Barbosa; Machado, 2010; Brasil, 2010; Susaeta et al., 2018). In order to ensure a secure storage environment, farmers must "designate a warehouse free of floods and moisture" so that the environment is not contaminated and

the agricultural defensives are preserved (Abreu; Alonso, 2014; RISTOW *et al.*, 2020; Barbosa; Machado, 2010; Brasil, 2010; Susaeta *et al.*, 2018; Potter; Coffin, 2017; Gonzalez *et al.*, 2016). The merchandise must be "preserved in its original and unopened container" in order to maintain the conservation conditions listed on the factory container and not lose product quality (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Castro; Confalonieri, 2005; Sieke; 2020). When storing agricultural defensives in the warehouse, farmers must "store the containers on metal shelves or on pallets, without contact with the floor, walls and ceiling" to avoid having contact with the construction in a possible humid environment and consequently, prevent the loss of product and quality (Abreu; Alonso, 2014; Castro; Confalonieri, 2005; Ristow *et al.*, 2020). When placing agricultural defensives in stock, one should "organize the warehouse to be stored by class" to facilitate handling and avoid any leakage of chemical products that may contaminate other classes (Susaeta *et al.*, 2018; Ntow *et al.*, 2006; Abreu; Alonso, 2014; Ristow *et al.*, 2020). When the merchandise is finished being placed in the warehouse, one should "identify the label to remain visible and legible" so that when it is needed, one can follow the guidelines on how to use the agricultural defensives that are shown on the container and comply with the legislation (Abreu; Alonso, 2014; Ristow *et al.*, 2020).

Check the site to "define a warehouse away from residence and lodging" so that in a potential leakage of the chemical product, its environment isn't contaminated and the safety of the property is maintained (Castro; Confalonieri, 2005; Morello *et al.*, 2019). Organize the warehouse to "store the agricultural defensives away from other items, such as food, medicine, feed and animals" so as not to be contaminated with the chemical products. Doing this prevents contact with other food products in case of leakage (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Castro; Confalonieri, 2005; Morello *et al.*, 2019; Carneiro *et al.*, 2015; Abhilash; Singh, 2009; Sieke, 2020; Arioli *et al.*, 2019; Turnipseed *et al.*, 2019; Karthikeyan *et al.*, 2019). Verify when "storing and closing the remaining agricultural defensives in their own container" so as not to lose quality of the chemical product. Keeping the same container and it well sealed eliminates contamination from other containers and the risk of someone knocking it over and spilling the liquid (Benetti, 2016; Rijal *et al.*, 2018; Ibitayo, 2006; Sieke, 2020). Check the warehouse daily for "in the event of a container rupturing, use an overload of transparent plastic" to be able to see how much product is in the container and comply with the legislation (Abreu; Alonso, 2014; Ristow *et al.*, 2020). And finally, upon leaving the warehouse, "leave the doors locked and signalized to prevent the entry of children and unauthorized individuals" and avoid future damages to the containers, as well as contamination of people and animals (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Castro; Confalonieri, 2005; Abhilash; Singh, 2009).

Preparation of Agricultural Defensives: Preparation of agricultural defensives is when farmers prepare the chemical product to be applied (Abreu; Alonso, 2014; Ristow *et al.*, 2020). Initially, one should "read the labels and information leaflet about handling, precautions, first aid, destination of empty containers, protective equipment, among others", since some people do not read the information on the container.

Not doing this may lead to the contamination of the farmer and the environment due to the amount of product used and the way it is applied to the plant. Furthermore, the farmer who reads the labels and information leaflet is preventing possible damage to their health and the environment in the period of time that they are exposed to the chemical products, while also maintaining a more effective way of combatting pests and weeds on plantations (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Rijal *et al.*, 2018; Zhao *et al.*, 2017). When preparing agricultural defensives, one should "prepare it outdoors and away from children, animals and unprotected individuals" to avoid contamination and intoxication of the chemical product by contact and the respiratory system (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Susaeta *et al.*, 2018; Cao *et al.*, 2020; Abhilash; Singh, 2009; Arioli *et al.*, 2019; Turnipseed *et al.*, 2019; Karthikeyan *et al.*, 2019). When preparing agricultural defensives, farmers should "use clean water to avoid clogging the nozzles of the sprayer" and having contact with the chemical product they are using, consequentially preventing contamination, reducing waste in the application and lowering the impact on the environment (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Zhao *et al.*, 2017; Cao *et al.*, 2020; Abhilash; Singh, 2009). To do this, one should also "use scales, graduated cups, buckets and specific funnels to prepare the mixture" so that there's an exact measurement of the product and therefore it is not wasted (Abreu; Alonso, 2014; Ristow *et al.*, 2020). The person handling the product should not forget to "use PPEs when performing the activities involving dissolution, dilution and application of agricultural defensives" to prevent contact with the chemical product and future health damage. The personal protective equipments (PPEs) include: pants, coat, boots, lab coat, respirator (mask), protective visor, gloves, hat with neck flap, and safety glasses (CAO *et al.* (2020); Fang *et al.* (2018); Zhao *et al.* (2017); He, *et al.* (2020); Li *et al.* (2018); Guedes *et al.*, 2012). Farmers should always "prepare the recommended dosage, according to the information leaflet" in order to have an effective application to combat pests and weeds and not waste the chemical product, causing damage to people's health due to an overdosage (Susaeta *et al.*, 2018; Guedes *et al.*, 2012; Rijal *et al.*, 2018; Cao *et al.*, 2020; Zhao *et al.*, 2017; Zhao; Liu, 2020; De Rop *et al.*, 2019; Riccò *et al.*, 2020; Adeux *et al.*, 2017; Olajumoke *et al.* 2016). And lastly, farmers must "wash the utensils after finishing the preparation and leave them to dry in the sun" so that the measurement containers that have been used do not have remaining residues and pose a risk of contamination to the environment and the people involved (Abreu; Alonso, 2014; Ristow *et al.*, 2020).

Application of agricultural defensives: Application of agricultural defensives is when farmers will apply the chemical product to combat pests and weeds in the plantation (Abreu; Alonso, 2014; Ristow *et al.*, 2020). One should initially "purchase PPEs for application", since some farmers do not buy them because they are not aware of the use and how it can prevent health damage. By acquiring the necessary safety gadgets, workers will use them when applying agricultural defensives and avoid possible illnesses. When buying the equipments, farmers should "ask an agronomist how to use the PPEs" (pants, lab coat, boots, apron, respirator (mask), protective visor, gloves, hat with neck flap and safety glasses), so that they aren't intoxicated when handling the chemical products and avoid triggering

Table 5. Criteria to be observed in the preparation of agricultural defensives

CODE	ASSERTIONS	AUTHORS (YEAR)
R34	Read the labels and information leaflet about handling, precautions, first aid, destination of empty containers, protective equipment, among others.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Rijal <i>et al.</i> (2018); Zhao <i>et al.</i> (2017).
R35	Prepare it outdoors and away from children, animals and unprotected individuals.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Susaeta <i>et al.</i> (2018) Cao <i>et al.</i> (2020); Abhilash and Singh (2009); Arioli <i>et al.</i> (2019); Turnipseed <i>et al.</i> (2019); Karthikeyan <i>et al.</i> (2019).
R36	Use clean water to avoid clogging the nozzles of the sprayer.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Zhao <i>et al.</i> (2017); Cao <i>et al.</i> (2020); Abhilash and Singh (2009).
R37	Use scales, graduated cups, buckets and specific funnels to prepare the mixture.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R38	Use PPEs when performing activities involving dissolution, dilution and application of agricultural defensives.	Guedes <i>et al.</i> (2012); Cao <i>et al.</i> (2020); Fang <i>et al.</i> (2018); Zhao <i>et al.</i> (2017); He <i>et al.</i> (2020); Li <i>et al.</i> (2018).
R39	Prepare the recommended dosage, according to the information leaflet.	Susaeta <i>et al.</i> (2018); Guedes <i>et al.</i> (2012); Cao <i>et al.</i> (2020); Fang <i>et al.</i> (2018); Zhao <i>et al.</i> (2017); Cheng <i>et al.</i> (2017); Yuan <i>et al.</i> (2016); Kang, Kim and Kim (2020); Zhao and Liu (2020); Nobile <i>et al.</i> (2020); De Rop <i>et al.</i> (2019); Adeux <i>et al.</i> (2017).
R40	Apply in accordance with the frequency of application prescribed in the information leaflet.	Susaeta <i>et al.</i> (2018); Guedes <i>et al.</i> (2012); Rijal <i>et al.</i> (2018) Cao <i>et al.</i> (2020); Zhao <i>et al.</i> (2017); Zhao and Liu (2020); De Rop <i>et al.</i> (2019); Riccò <i>et al.</i> (2020); Adeux <i>et al.</i> (2017); Olajumoke <i>et al.</i> (2016).
R41	Wash the utensils after finishing the preparation and leave them to dry in the sun.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).

Source: Elaborated by the authors.

Table 6. Criteria to be observed in the application of agricultural defensives

CODE	ASSERTIONS	AUTHORS (YEAR)
R42	Purchase PPEs for application.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Zhao <i>et al.</i> (2017).
R43	Ask an agronomist how to use the PPEs.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Zhao <i>et al.</i> (2017).
R44	Make sure that the merchant has provided information on where to return empty containers.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R45	Should be handled by adults (between 18 and 60 years old).	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Cao <i>et al.</i> (2020); Bouktif Zarrouk <i>et al.</i> (2020); Riccò <i>et al.</i> (2020).
R46	Get training on how to use the application equipment.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Rijal <i>et al.</i> (2018); Susaeta <i>et al.</i> (2018); Zhao <i>et al.</i> (2017).
R47	Read the instruction manual of the application equipment	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020) Chen <i>et al.</i> (2019); Adeux <i>et al.</i> , 2017); Cao <i>et al.</i> (2020); Zhao <i>et al.</i> (2017).
R48	Never use application equipment with defects or leaks.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020) Cao <i>et al.</i> (2020); Zhao <i>et al.</i> (2017).
R49	Use PPEs when applying agricultural defensives	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R50	It is forbidden to drink and eat when applying agricultural defensives.	Mendes <i>et al.</i> (2017); Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Zhao <i>et al.</i> (2017).
R51	Unclog nozzles only with hands and while wearing gloves	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R52	Keep beard and nails done when applying agricultural defensives.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R53	Use the necessary PPEs for application (when using a tractor or doing the work manually), such as pants, lab coat, boots, apron, respirator (mask), protective visor, gloves, hat with neck flap, safety glasses.	Abreu and Alonso (2014); Barbosa and Machado (2010); Nassinhack (2017); Souza and Azevedo (2017); Rijal <i>et al.</i> (2018); Ntow <i>et al.</i> (2006); Carneiro <i>et al.</i> (2015); Silva <i>et al.</i> (2013); Ristow <i>et al.</i> (2020).
R54	Apply agricultural defensives without wind and rain.	Castro and Confalonieri (2005); Guedes <i>et al.</i> (2012) Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Fang <i>et al.</i> (2018); Zhao <i>et al.</i> (2017); Potter and Coffin (2017).
R55	Apply agricultural defensives without hot sunny weather	Castro and Confalonieri (2005); Guedes <i>et al.</i> (2012) Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Fang <i>et al.</i> (2018); Zhao <i>et al.</i> (2017); Riccò <i>et al.</i> (2020).
R56	Direct the spray jet on to the plant, according to the information leaflet of the agricultural defensives	Bayer (2020); Cao <i>et al.</i> (2020).
R57	Preferably apply at the time specified in the information leaflet.	Bayer (2020); Cao <i>et al.</i> (2020).
R58	Respect the re-entry period.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Rijal <i>et al.</i> (2018); Susaeta <i>et al.</i> (2018).

Source: Elaborated by the authors.

future diseases (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Zhao *et al.*, 2017). Upon leaving the authorized retail store, "make sure that the merchant has provided information on where to return empty containers" after using the chemical product (Abreu; Alonso, 2014; Ristow *et al.*, 2020). When applying agricultural defensives, these "should be handled by adults (between 18 and 60 years old)", as it is common in farming for children, pregnant women and the elderly to apply chemical products on the plantation. This can lead to a deteriorating health in children because they are in a growing phase, the elderly due to them being at the end of their life cycle, and in the baby's development in pregnant women. On the other hand, it is assumed that people between 18 and 60 years of age have a greater physical resistance and more responsibility in the application of agricultural defensives (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Cao *et al.*, 2020; Bouktif Zarrouk *et al.*, 2020; Riccò *et al.*, 2020). Before the application, one should "get training on how to use the application equipment" to avoid potential risks with chemical products (Abreu; ALONSO, 2014; Ristow *et al.*, 2020; Rijal *et al.*, 2018; Susaeta *et al.*, 2018; Zhao *et al.*, 2017). The workers should "read the instruction manual of the application equipment" to avoid contamination with the chemical product and to the environment and prevent environmental impact and damage to the health of the worker (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Chen *et al.*, 2019; CAO *et al.*, 2020; Zhao *et al.*, 2017; Adegbe *et al.*, 2017). When handling equipments, farmers should "never use application equipment with defects or leaks" to avoid intoxication of the chemical product they are using and an impact on the environment of the property. With this conduct, they will be avoiding damages to their health and the society (ABREU; ALONSO, 2014; RISTOW *et al.*, 2020; CAO *et al.*, 2020; ZHAO *et al.*, 2017).

One should always "use PPEs when applying agricultural defensives" in order not to contaminate themselves with the chemical product and avoid damage to the workers' health, such as cancer, suicide and other chronic diseases (ABREU; ALONSO, 2014; RISTOW *et al.*, 2020). "It is forbidden to drink and eat when applying agricultural defensives", because it will lead to the worker being intoxicated more quickly due to the lack of protection of the human mouth (MENDES *et al.*, 2017; ABREU; ALONSO, 2014; RISTOW *et al.*, 2020; ZHAO *et al.*, 2017). When applying agricultural defensives, one should "unclog nozzles only with hands and while wearing gloves", never using their mouths or other body parts to perform this activity, to avoid contamination with the chemical products that they are exposed to. Farmers should always maintain personal hygiene when handling chemical products and "keep beard and nails done when applying agricultural defensives" so as not to contaminate the worker, seeing as the mask does not cover well with a beard and thus may intoxicate the farmer (ABREU; ALONSO, 2014; RISTOW *et al.*, 2020). When applying agricultural defensives, farmers should "use the necessary PPEs for application (when using a tractor or doing the work manually), such as pants, lab coat, boots, apron, respirator (mask), protective visor, gloves, hat with neck flap, safety glasses" to prevent intoxication during this period and avoid chronic diseases (Abreu; Alonso, 2014; Barbosa; Machado, 2010; Nassinhack, 2017; Souza; Azevedo, 2017; Rijal *et al.*, 2018; Ntow *et al.*, 2006; Carneiro *et al.*, 2015; Silva *et al.*, 2013; Ristow *et al.*, 2020). Farmers should also check the climatic season when applying, seeing as they should "apply

agricultural defensives without wind and rain" so that there is no waste of the chemical product, impact on the environment and intoxication of the worker when handling it (Castro; Confalonieri, 2005; Guedes *et al.*, 2012; Abreu; Alonso, 2014; Ristow *et al.*, 2020; Fang *et al.*, 2018; Zhao *et al.*, 2017; Potter; Coffin; 2017). The owner should also "apply agricultural defensives without hot sunny weather", so as not to be exhausted during the application, avoid discomfort in the use of personal protective equipment (PPE) and intoxication of the chemical product due to excessive heat (Castro; Confalonieri, 2005; Guedes *et al.*, 2012; Abreu; Alonso, 2014; Ristow *et al.*, 2020; FANG *et al.*, 2018; Zhao *et al.*, 2017; Riccò *et al.*, 2020). Farmers must "direct the spray jet on to the plant, according to the information leaflet of the agricultural defensives" in order to have an effective result in the use of the chemical product, seeing as each type has its own recommendation on how to apply it. When applying agricultural defensives, farmers should "preferably apply at the time specified in the information leaflet" to control pests and weeds on the plantation and maintain a more effective application of the chemical product (Bayer, 2020; Cao *et al.*, 2020). And finally, "respect the re-entry period" on the plantation by checking the time that is written on the instructions, so as not to contaminate oneself with the chemical product that was applied (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Rijal *et al.*, 2018; Susaeta *et al.*, 2018).

Cleansing of Agricultural Defensives: It is the cleaning of personal protective equipments (PPEs), equipments, accessories and clothes that the farmer used when applying and handling agricultural defensives (Abreu; Alonso, 2014; Ristow *et al.*, 2020). Initially, one should "wash the gloves while still wearing them and follow a logical sequence to remove the PPEs (hat with neck flap, protective visor, apron, lab coat, boots, pants, gloves, respirator (mask) and safety glasses)" as instructed by the manufacturers, since some workers have difficulties and lack of information in removing the PPEs (ABREU; ALONSO, 2014; RISTOW *et al.*, 2020; SUSAETA *et al.*, 2018). This can lead the farmer to become intoxicated with the chemical product he using in the application. In addition, the worker maintaining this sequence will prevent damage to their health due to agricultural defensives (ABREU; ALONSO, 2014; RISTOW *et al.*, 2020; SUSAETA *et al.*, 2018). After removing the contaminated PPEs, farmers should use other properly cleaned equipments to "wash the clothes used in the preparation and application separately from other family clothes and in an exclusive washing tank", which will prevent the contamination of other family clothes (Abreu; Alonso, 2014; Barbosa; Machado, 2010; Souza; Azevedo, 2017; Susaeta *et al.*, 2018).

After that, one should "take a shower as soon as they finish applying and put on clean clothes" so as not to get contaminated with the chemical product. The longer the product is in contact with the body, the higher the probability of intoxication. Farmers should "use neutral soap, not leave clothes soaking and dry them in the shade" so as not to damage them when washing and therefore get them clean and reuseable. Also, when cleansing clothes and personal protective equipments (PPEs) of agricultural defensives, farmers should "rinse them with plenty of running water to dilute and remove agricultural defensive residues" so that there are none left on the items that have been used in the application (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Kang;

Table 7. Criteria to be observed in the cleaning of agricultural defensives

CODE	ASSERTIONS	AUTHORS (YEAR)
R59	Wash the gloves while still wearing them and follow a logical sequence to remove the PPEs (hat with neck flap, protective visor, apron, lab coat, boots, pants, gloves, respirator (mask) and safety glasses).	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Susaeta <i>et al.</i> (2018).
R60	Wash the clothes used in the preparation and application separately from other family clothes and in an exclusive washing tank.	Abreu and Alonso (2014); Barbosa and Machado (2010); Souza and Azevedo (2017); Susaeta <i>et al.</i> (2018).
R61	Take a shower as soon as you finish applying and put on clean clothes.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R62	Use neutral soap, do not leave clothes soaking and dry them in the shade.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R63	Rinse with plenty of running water to dilute and remove agricultural defensive residues.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Kang, Kim and Kim (2020); Turnipseed <i>et al.</i> (2019).
R64	Use bleach without scrubbing the clothes.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R65	Apply a fabric sealant on the clothes	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R66	Put away the clothes/PPE used in the preparation and application separately from other family clothes after washing and drying.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Susaeta <i>et al.</i> (2018).
R67	Put the PPEs to dry out of the sun.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020).
R68	Place the contaminated water in an appropriate place so as not to pollute other sources	Mascarenha (2014); Cao <i>et al.</i> (2020); Zhao <i>et al.</i> (2017); Turnipseed <i>et al.</i> (2019); Rice; Horgan; Hamlin, 2017).
R69	Sewer with washing water should be made directly into the septic tank for a chemical residue treatment.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020) Fang <i>et al.</i> (2018) Zhao <i>et al.</i> (2017); Turnipseed <i>et al.</i> (2019).

Source: Elaborated by the authors.

Table 8. Criteria to be observed in the disposal of agricultural defensive containers

CODE	ASSERTIONS	AUTHORS (YEAR)
R70	Return empty agricultural defensive containers in a drop off facility authorized by the Ministry of Agriculture, Livestock and Supply (MAPA).	Abreu and Alonso (2014); Barbosa and Machado (2010); Susaeta <i>et al.</i> (2018); Carneiro <i>et al.</i> (2015); Morello <i>et al.</i> (2019); Ristow <i>et al.</i> (2020).
R71	Rigid containers containing miscible or despicable formulations in water must be submitted by the user to the triple rinse method.	Souza and Azevedo (2017); Brasil (2010); Ntow <i>et al.</i> (2006).
R72	Dispose of the remaining agricultural defensive solutions in a place designated for treatment.	Carneiro <i>et al.</i> (2015); Mascarenha (2014) Zhao <i>et al.</i> (2017); Turnipseed <i>et al.</i> (2019).
R73	Use the empty containers only to store the same product.	Carneiro <i>et al.</i> (2015); Ding <i>et al.</i> (2010).
R74	Place empty containers in the warehouse for collection.	Abreu and Alonso (2014); Wang and Burke (2017); Ristow <i>et al.</i> (2020); Morello <i>et al.</i> (2019); Carneiro <i>et al.</i> (2015).
R75	Make the containers useless (perforate the bottom) for storage, pre-return and return.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Ferreira, Jabbour and De Sousa Jabbour (2017).
R76	Present purchase invoice for each product when returning agricultural defensive containers.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Ferreira, Jabbour and De Sousa Jabbour (2017).
R77	Return the containers within one and a half years after purchasing.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Ferreira, Jabbour and De Sousa Jabbour (2017).
R78	Observe the logistical precautions of storage and transport of empty containers.	Abreu and Alonso (2014); Ristow <i>et al.</i> (2020); Ferreira, Jabbour and De Sousa Jabbour (2017).

Source: Elaborated by the authors.

Kim; Kim, 2020; Turnipseed *et al.*, 2019). After, "use bleach without scrubbing the clothes" to avoid damaging the pieces that were used in the application and therefore maintain their lifespan. One should also "apply a fabric sealant on the clothes" to prolong their lifespan (Abreu; Alonso, 2014; Ristow *et al.*, 2020). When cleansing of agricultural defensives, farmers should "put away the clothes/PPE used in the preparation and application separately from other family clothes after washing and drying", so as not to mix them and therefore use the same ones that were worn in the application on the plantation (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Susaeta *et al.*, 2018). Farmers should also "put the PPEs to dry out of the sun" so as not to compromise its quality and maintain the effectiveness of the equipment used (Abreu; Alonso, 2014; Ristow *et al.*, 2020). Then, they should "place the contaminated water in an appropriate place so as not to pollute other sources", such as rivers, streams and springs. It should be disposed of in a containment basin to treat the effluent and be able to reuse the water (Mascarenha, 2014; Zhao *et al.*, 2017; Turnipseed *et al.*, 2019; Rice; Horgan; Hamlin, 2017). And finally, "sewer with

washing water should be made directly into the septic tank for a chemical residue treatment" in order not to contaminate the environment and maintain the control of the chemical products (Abreu; Alonso, 2014; Ristow *et al.*, 2020).

Disposal of agricultural defensive containers: Disposal of agricultural defensive containers is when a farmer returns the containers he has used to an authorised retail store (ABREU; Alonso, 2014; Ferreira; Jabbour; De Sousa Jabbour, 2017). Initially, one should "return the empty agricultural defensive containers in a drop off facility authorized by the Ministry of Agriculture, Livestock and Supply (MAPA)", since some farmers do not return them for authorized resale. This will lead to the contamination of the environment, such as water springs, streams and rivers, as well as the homes of the rural property. Some farmers use these containers as a trough for treating animals, which generates a commodity chain that contaminates human beings. In addition, with the owner returning the agricultural defensive containers, he will be preventing contamination of his property and damage to people's health, as well as an impact on the environment (Abreu; Alonso, 2014; Barbosa; Machado, 2010;

Susaeta *et al.*, 2018; Carneiro *et al.*, 2015; Morello *et al.*, 2019; Ristow *et al.*, 2020). But first, the "rigid containers containing miscible or despicable formulations in water must be submitted by the user to the triple rinse method" to leave the container thoroughly clean. This process should be done to ensure that no residues are left in the container (Souza; Azevedo, 2017; Brasil, 2010; Ntow *et al.*, 2006). Farmers should "dispose of the remaining agricultural defensive solutions in a place designated for treatment" in order not to contaminate the environment and to prevent damage to their health during their work life (Carneiro *et al.*, 2015; Mascarenha, 2014; Zhao *et al.*, 2017; Turnipseed *et al.*, 2019). When there are agricultural defensives left in the containers, farmers should "use the empty containers only to store the same product" to avoid contaminating these containers with a different chemical. If the chemical product is placed in a contaminated container, the final result may be affected (Carneiro *et al.*, 2015; Ding *et al.*, 2010). When "placing empty containers in the warehouse for collection", do not mix with other containers and identify on site so that when they are taken to an authorized retail store, you will know where the returning merchandise is (Abreu; Alonso, 2014; Wang and Burke, 2017; Ristow *et al.* 2020; Morello *et al.*, 2019; Carneiro *et al.*, 2015). When disposing of agricultural defensive containers, farmers should "make the containers useless (perforate the bottom) for storage, pre-return and return" in order to keep them dry and not leave residues inside or use them for any other purpose. Farmers must "present a purchase invoice for each product when returning agricultural defensive containers" to an authorized retailer to show proof of purchase. They must also "return the containers within a year and a half after purchasing" so that they don't remain on the farm for too long and therefore save space in the warehouse where the chemical products are stored. And finally, "observe the logistical precautions of storage and transport of empty containers" in order not to get intoxicated with the product and have any accidents during transport, as well as to avoid damage to the workers' health and impact on the environment (Abreu; Alonso, 2014; Ristow *et al.*, 2020; Ferreira; Jabbour; DE Sousa Jabbour, 2017).

Conclusion

This article proposed a safety maturity model for the use of agricultural defensives. Understanding safety maturity as standard routines practiced by farmers in the use of agricultural defensives, one can determine and guide the evolution process of an agricultural production unit, seeking the best practices and minimizing, or even eliminating, the harmful effects on human health and the environment. In order to identify the main variables to be observed, a literature review was performed, among them the Web of Science® (WOS) and Scielo® databases. The proposed identified variables with their respective assertions defined as acquisition, transport, storage, preparation, application, cleaning and container disposal, determine the cycle of use of agricultural defensives. Future recommended studies are directed towards an empirical validation in distinct agricultural regions and branches.

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