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Impact of plastic pesticide containers on agricultural soils: a cultural problem of Ecuadorian agriculture

Impacto del plástico de envases de pesticidas en suelos agrícolas: una problemática cultural del agro ecuatoriano

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Abstract:
Microplastics are generated by the degradation of larger fragments in the environment, thanks to ultraviolet light that can fragilize the materials, allowing them to be a source of severe toxins that affect the microbiota existing in the soil. The impact produced by plastics from pesticide containers in agriculture carried out by small and medium farmers on the soil is one of the cultural problems studied in this work. Through the implementation of surveys to forty farm owners and associates in legally established organizations in the rural area of the Puebloviejo and Quinsaloma canton, with open and closed questions, managed in a descriptive and informative way and analyzed quantitatively, data were obtained such as schooling, productivity, training and management of agricultural waste such as those common plastics used in their daily agricultural routine among them pesticide containers, PVC irrigation pipes, drip irrigation tapes and drip irrigation tapes, among others, drip irrigation tapes or covers for transplanting in their different labors allow increasing the sources of plastic materials, obtaining unflattering data on the handling and management of pesticide containers, and other common plastics, understanding the impact of contamination by pesticide plastics used by farmers, reflected in 93%, concluding that farmers do not return the containers and/or do not comply with their legal obligations, mainly due to lack of public support for control, motivation, lack of knowledge and awareness.

Key words: Plastics, microplastic, contamination, culture, management, waste

Resumen
Los microplásticos se generan por la degradación de fragmentos más grandes en el medio ambiente, gracias a la luz ultravioleta que puede fragilizar los materiales, permitiendo ser fuente de toxinas severas que afectan a la microbiota existente en el suelo. El impacto producido por los plásticos de los envases de pesticidas en la agricultura realizada por pequeños y medianos agricultores a los suelos es una de las problemáticas culturales que se estudiaron en este trabajo. Mediante la implementación de encuestas a cuarenta dueños de fincas y asociados en organizaciones legalmente establecidas de la zona rural del cantón Quinsaloma, y el cantón Puebloviejo, con preguntas abiertas y cerradas, gestionadas de modo descriptivo e informativo y analizadas cuantitativamente, se obtuvieron datos como escolaridad, productividad, capacitación y gestión de residuos agrícolas como aquellos plásticos comunes a utilizar en su rutina agrícola cotidiana entre ellos los envases de pesticidas, tuberías de riego de PVC, cintas de riego por goteo o fundas para el trasplante en sus distintas labores permiten aumentar las fuentes de materiales plásticos, obteniendo datos poco halagadores sobre el manejo y gestión de envases de pesticidas, y otros plásticos comunes, entendiendo al impacto de contaminación por plásticos de pesticidas utilizado por los agricultores, reflejado en un 93%, concluyendo que los agricultores no devuelven los contenedores y/o no cumplen con sus obligaciones legales, principalmente por falta de apoyo público para el control, la motivación, desconocimiento y la concientización.

Palabras clave: Plásticos, microplástico, contaminación, cultura, gestión, residuos.

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1. Introduction

Plastic has revolutionized our lives in many ways, but its excessive consumption and inadequate waste management

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have led to a significant amount of solid waste in all countries, regardless of their economic situation [1].

Soil is the loose top layer of the earth in which plants can grow. It plays an irreplaceable role in ensuring environmental and energy security and protecting biodiversity. However, soil is also an important reservoir of microplastics in the terrestrial environment. According to reports, almost 90% of plastic debris on land enters the soil environment directly or indirectly affecting soil organisms. [2].

Since microplastics can also serve as carriers of various toxic contaminants, if these contaminants enter the soil environment, they will also damage its ecosystem and negatively affect the health and functioning of the soil ecosystem. [3].

Today, countless combinations of polymers are used in various industries, and some of the qualities sought in the production of plastics or PM are strength, durability, and low production costs. This complicates standardized protocols for identifying particles in soil [4].

As a surplus, resulting in its presence in the water of seas, lakes, or rivers, in addition to being burned on the ground, buried, and piled up. It is a widespread practice of farmers in Ecuador, not to manage the residues of pesticide containers after making use of the agrochemicals transported in them. Pesticides are complex substances of chemical origin and are of foremost importance to solve the problems that crops often pose. However, if used incorrectly, the risks can outweigh the benefits [5].

This situation was detected during the execution of a research project at the "La Josefa" farm located in Recinto la Josefa, and during the visit to farms of small and medium agricultural producers in the area of Quinsaloma, both in the province of Los Ríos [6].

Taking into account the above, the present research **aims** to analyze the logistics of management of empty pesticide containers, used by small and medium producers in the area of Quinsaloma and the farm "La Josefa", located in the province of Los Ríos, through a survey, which allows the reduction of environmental risks [7].

2. Materials and methods

This research work will be carried out in two stages. The first stage will be executed in forty farms in the rural sector of the Quinsaloma canton, and in the farm "La Josefa" in Puebloviejo, in the province of Los Ríos in Ecuador. For this purpose, surveys will be applied to employers and small and medium farmers with 6 closed and open-ended questions, focused on the farmer's academic instruction, training in good agricultural practices, productive capacity of their farms and the handling and management of pesticide containers [8]. The sample was taken according to the estimated population of farms larger than five hectares belonging to the precincts of the southern and northern sectors of the canton, with a total of 100 farms. It should be noted that the total area of the farms covers about 1820 hectares.

From this population, a representative sample of 40 producers was calculated according to the formula described below. However, in the actual field work, 42 producers were surveyed.

$$n = \frac{N * z^2 * p * q}{(N - 1) * e^2 + z^2 * p * q}$$

Where

n: sample size
N: Total producers = 100
p: positive variability = 0.95
q: negative variability = 0.05
e: error (5%) = 0.05
z: confidence level (95%) = 1.96

$$n = \frac{100 * 1.96^2 * 0.95 * 0.05}{(100 - 1) * 0.05^2 + 1.96^2 * 0.95 * 0.05}$$

$$n = \frac{18,25}{0,43}$$

n = 42,44= 40 closed surveys

The survey data were processed by organizing them in tables to facilitate their description and interpretation [9]. A Chi-square analysis was performed to determine the relationship between the variable Academic instruction and Knows waste management; and between the variable Receives accompaniment or training and the variables "Knows waste management", "Knows pesticide container management" and "What do you do with agrochemical plastics". IBM SPSS Statistics software was used for this purpose.

In the elaboration of the bibliographic review, the evaluation and selection of the information that was in line with the research topic was carried out. Inclusion and exclusion

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criteria were used for this purpose, which will be explained below.

The inclusion criterion used was that the documentation reviewed should be related to the impact of microplastics on soils and runoff water. Another inclusion criterion used was that the reviewed papers could belong to any date of publication or elaboration; however, at the time of selection, the paper that provided the most information related to the investigated topic was taken into account. [9].

The exclusion criterion used was to exclude all information that does not correspond to the research topic.

The information analyzed was structured according to the themes related to the topic studied. A matrix was generated by themes, in which the information obtained in each work consulted was included. This information was analyzed and used according to the one that provided the most information [10].

Especially on the negative effects of microplastics that are released from pesticide containers left inside agricultural lands, with special attention to soils that remain in direct contact when the respective management process does not exist, and their decomposition process begins [11]. The current regulations on the management of pesticide containers on agricultural land were analyzed with the APCSA company to identify effective treatment methods and all the contamination processes that can be avoided if pesticide containers are correctly managed, thus reducing environmental and visual damage. The authors' experiences with plastics and field work are also incorporated. The fact that the plastics industry is vast and dynamic, despite the fact that they are sold in different shapes, compositions and sizes, was highlighted [12].

3. Results

The farmers in the study area have 60% primary schooling, which has generated productivity on their farms thanks to the expertise acquired over the years in the exercise of their daily agricultural work. The lack of agricultural training for these producers has prevented them from increasing their productivity over the years. The same problem is caused by not knowing about good agricultural practices and the management and handling of pesticide containers, which has led to the degradation of the ground water table through contamination or soil erosion.

Table 1 shows the frequency table of the results when comparing the academic education of the respondents and the knowledge of waste management of the agricultural activity they carry out on their farms. As can be seen from the 40 respondents (100%), 34 (85%) do not know about waste management.

Table 1. Cross-tabulation of the relationship between the variable Academic education and Knowledge of waste management.

		Knows waste management		Total
		yes	no	
Academic Instruction	Primary	0	24	24
	High School	2	10	12
	University degree	4	0	4
Total		6 (15%)	34 (85%)	40 (100%)

The results of the statistical analysis showed that there is a significant relationship (X^2<,001) between the level of education that farmers have with respect to the use of good agricultural practices on their farms (Table 2).

Table 2. Relationship between academic education and the use of good practices.

Chi-square tests

	Value	gl	Asymptotic significance (bilateral)
Pearson's Chi-square	27,937 [a]	4	< 0,001
Likelihood ratio	24,084	4	< 0,001
Linear by linear association	13,039	1	< 0,001
N of valid cases	40		

He results of Table 3 show that those who do not receive technical assistance or support are those who do not apply good practices, because they do not know them 27 (67,5%).

Table 3. Cross-tabulation of the relationship between the variable Academic instruction and apply good practices.

		Applies good practices			Total
		yes	no	do not know	
Receives accompaniment or training	no	0	7	27	34 (85%)
	sometimes	6	0	0	6 (15%)
Total		6 (15%)	7 (17,5%)	27 (67,5%)	40 (100%)

The statistical analysis showed that there is a significant relationship (X^2<,001) between the accompaniment received and the application of good agricultural practices (Tabla 4).

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Table 4. Relationship between the variable Receives accompaniment or training and applies good practices.
Chi-square tests

	Value	gl	Asymptotic significance (bilateral)	Exact significance (bilateral)	Exact significance (one-sided)
Pearson's chi-square	40,000 [a]	1	< 0,001		
Continuity correction[b]	32,541	1	< 0,001		
Likelihood ratio	33,817	1	< 0,001		
Fisher's exact test				< 0,001	< 0,001
[4]Linear-by-linear association	39,000	1	< 0,001		
N of valid cases	40				

Table 5 shows that respondents who do not receive support or training are those who are not familiar with waste management (85%).

Table 5. Crosstabulation of variables Receives support or training and knows about waste management.

		Knows waste management		Total
		yes	no	
Receives accompaniment or training.	no	0	34	34 (85%)
	sometimes	6	0	6 (15%)
Total		6 (15%)	34 (85%)	40

The statistical analysis showed that there is a significant relationship (X^2<,001) between the support or training received and the farmers' knowledge of waste management (Tabla 6).

Table 6. Relationship between variable Receives accompaniment or training and Knowledge of waste management.
Chi-square tests

	Value	gl	Asymptotic significance (bilateral)	Exact significance (bilateral)	Exact significance (one-sided)
Pearson's chi-square	40,000[a]	1	< 0,001		
Continuity correction[b]	32,541	1	< 0,001		
Likelihood ratio	33,817	1	< 0,001		
Fisher's exact test				< 0,001	< 0,001
Linear by linear association	39,000	1	< 0,001		
N of valid cases	40				

Table 7 shows that of the 40 (100%) respondents, 34 (85%) stated that they did not know how to manage pesticide containers because they did not receive support or training on the subject. This result shows the relationship between both variables.

Table 7. Cross-tabulation of the relationship between the variable Receives accompaniment or training and knows about pesticide container management.

		Knows pesticide container management.		Total
		yes	no	
Receives accompaniment or training	no	0	34	34 (85%)
	sometimes	6	0	6 (15%)
Total		6 (15%)	34 (85%)	40

The statistical analysis carried out shows the existence of a significant relationship (X^2<,001) between the effect that accompaniment or training has on the farmers' knowledge of pesticide container management (Tabla 8).

Table 8. Relationship between variable Receives accompaniment or training and Knows pesticide container management.
Chi-square tests

	Value	gl	Asymptotic significance (bilateral)	Exact significance (bilateral)	Exact significance (one-sided)
Pearson's chi-square	40,000 [a]	1	< 0,001		
Continuity correction[b]	32,541	1	< 0,001		
Likelihood ratio	33,817	1	< 0,001		
Fisher's exact test				< 0,001	< 0,001
Linear by linear association	39,000	1	< 0,001		
N of valid cases	40				

From this analysis it can be understood that the farmers surveyed run a great risk to the health of themselves and their families, because pesticides are products used in agriculture that can be highly toxic and harmful if they and their containers are not handled properly, since those elements that contain in their chemical structure, when applied continuously and excessively to crops, come to generate a severe impact on the ecosystem [13].

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Microplastics are the product of the decomposition of larger plastic parts over the years due to temperature, ultraviolet light or organisms or microorganisms in the soil [14].

Pesticide containers can take 100 to 1000 years to decompose completely [15], and the microplastics particles they release allow contamination with toxins that can be lethal to existing soil-dwelling microbial life [16].

Table 9 shows that 55% of the respondents recognize that after using agrochemical plastics, they leave them anywhere. This result can affect the environment, since it can damage the existence of soil microorganisms, which are responsible for the decomposition of organic matter and conversion of assimilable mineral substances for the plant, when there are no microorganisms due to erosion or contamination, this process is reduced and its consequences are reflected in the final production of agricultural crops [17].

On the other hand, this situation can generate another problem, taking into account that many people tend to use single-use plastic products, which has caused that more than 75% of the plastic produced to date has been wasted, since it is thrown anywhere, and is not recycled" [18].

Table 9. Crosstabulation of variables Relationship between variable Receives support or training and What do you do with agrochemical plastics.

		What do you do with agrochemical plastics?					Total
		keep it	sell it	leave it anywhere	throw it in running water	burn it	
Receives accompaniment or training	no	0	4	22	3	5	34
	sometimes	6	0	0	0	0	6
Total		6 (15%)	4 (10%)	22 (55%)	3 (7,5%)	5 (12,5%)	40 (100%)

The statistical analysis showed the existence of a significant relationship (X^2<,001) between the accompaniment or training on the use of agrochemical plastics.

Tabla 10. Relationship between variable Receives accompaniment or training and What do you do with agrochemical plastics.

Chi-square tests

	Value	gl	Asymptotic significance (bilateral)
Pearson's Chi-square	40,000 [a]	4	< 0,001
Likelihood ratio	33,817	4	< 0,001
Linear by linear association	20,091	1	< 0,001
N of valid cases	40		

4. Conclusions

Sixty percent of the farmers in the area have primary schooling, which has influenced their knowledge of good agricultural practices.

The lack of training of farmers in good practices has resulted in 85% of those surveyed not knowing the proper way to manage waste and pesticide container handling, and 55% make inadequate use of plastic waste management.

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5. Annex

Annex 1: Survey

"Impact of plastic pesticide containers on agricultural soils: a cultural problem in Ecuadorian agriculture".

OBJECTIVE Culture of good agricultural practices and management of pesticide containers

1. Academic education?
a) Primary school
b) Secondary school
c) University degree
d) Post Graduate / Doctorate

2. Do you apply good agricultural practices on your farm?
a) Yes
b) no
c) Do not know

3. Do you receive any support, technical assistance, or training from public entities?
a) Yes
b) No
c) Sometimes

4. Do you know about solid waste management?
a) Yes
b) No

5. Do you understand pesticide container management?
a) Yes
b) No

6. What do you do with agrochemical plastics?
a) Keep them
b) Sell them
c) Leave them anywhere
d) Throw them in running water
e) Burn them
f) Manages them with APCSA