



Obsolete Pesticides, an Environmental Threat: The Case of Office of Tea in Burundi, the Tora Site

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How to cite this paper: Jeanine Ndiokubwayo, Niyongabo Jean Bosco, Victor Barantota, Mutuyeyezu Francine, Nijimbere Evangeline, Akonkwa Majaliwa Eliel, Yaniyo Bisimwa Yannick. (2025) Obsolete Pesticides, an Environmental Threat: The Case of Office of Tea in Burundi, The Tora Site. *Scientific Access*, 1(2), 53-61. DOI: 10.26855/sa.2025.09.001

Received: July 12, 2025

Accepted: August 7, 2025

Published: September 2, 2025

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Abstract

Besides fertilizers, which improve crop yield by promoting the growth of the plant of interest via a supply of nutrients, pesticides also improve this yield by fighting against undesirable organisms. However, if they are not well managed, they can cause harmful effects on the environment, human and animal health, as well as ecological imbalance. This work primarily focuses primarily on the negative impact of obsolete pesticides on the environment and human health. The case study was carried out for the case of the Office of Tea of Burundi (OTB), the Tora site. To collect the field survey data, data collection techniques such as documentary research, survey, and interview were used. Our survey population was made up of 265 households, made up of the households of OTB workers and other individuals in the vicinity of the OTB Tora spread over a distance of 1.5 km. Using Alain Bouchard's formula, the snowball sampling technique was used to reach 70 households that participated in our survey. The questionnaire was administered indirectly and/or directly, depending on whether the respondent was literate or illiterate. The results showed that the obsolete pesticide management system at OTB Tora suffers from a lack of technical expertise of this institution for their collection and destruction; the population does not know the importance of treating empty pesticide containers before use; and People around the OTB Tora do not know the negative impact of inhaling obsolete pesticides on their health.

Keywords

Obsolete pesticides; Environmental threat; Treating empty pesticides; Negative impact of obsolete pesticides

No one can prevent death and waste in our lives, but we can improve how we deal with them. Waste in general and obsolete pesticides are stored in different locations and constitute an obstacle to sustainable development.

Waste remains stored in warehouses and constitutes a serious threat to health and the environment when not properly managed [1]. They often include containers that leak, which causes the dispersal of these products in the environment, sometimes even over very long distances [2] and exposes populations who live and work in the vicinity to health problems [3] without forgetting that they constitute a threat to human life and environmental balance and can trigger merciless threats in the long term.

In order to limit the damage that can be caused by pesticides, days of reflection at both international and continental levels have been organized, and common and effective strategies to promote the good management of pesticides throughout their life cycle have been adopted.

Various international conferences on chemical management have been held, and various conventions and protocols have also been established [4]. WHO and FAO, as those responsible for pesticide management, have prepared a complete set of guiding principles on how to proceed in developing countries to eliminate large quantities of pesticides [5].

The most advanced countries have recognized the impacts of chemicals on health and the environment and have therefore put in place national risk management policies adapted to their context [6].

Similarly, at the continental level, various meetings have been organized to adopt common methods for the rational management of pesticides and to adopt strategies that can facilitate the application of international agreements in order to effectively face environmental challenges in Africa.

The country does not have an exclusive policy for pesticide management [7], although it has demonstrated political will by signing and ratifying all conventions and protocols relating to pesticides as well as several international agreements related to pesticide management [7] and several legal instruments and documents that can help in the proper management of pesticides have been put in place together with several ministries involved in pesticide management [8].

Despite all the provisions for the management of obsolete pesticides put in place at the different levels, their implementation at OTB Tora remains incomplete. In this work, we will contribute to the existing debate on the management of obsolete pesticides in parastatal institutions in Burundi, specifically for the case of the Tora Tea Office.

1. Research Methodology

1.1 Target population

The survey population is the entire human group concerned by the objectives of the survey. It is from this population that the sample will be cut. The survey population is also called the "universe" of the survey [9]. According to [10], the survey population is defined as "the undifferentiated set of elements from which those who will make the observations will be chosen".

According to [11], the population is a group of entities, objects, and events with common characteristics to be observed. It is the set of individuals on whom the study will focus.

Thus, our survey population was made up of 265 households, made up of the households of OTB workers and other individuals from the OTB surroundings spread over a distance of 1.5Km.

1.2 Determining the sample size

The sample is the part of the universe that will actually be studied and that will allow us to know the characteristics of the entire universe by extrapolation [12].

Table 1. Table sample size determination according to Alain Bouchard

Size of population	Precision								
	90 times out of 100			95 times out of 100			99 times out of 100		
	10%	5%	1%	10%	5%	1%	10%	5%	1%
Infinite	68	271	6 765	96	384	9 601	166	664	16 589
1 000 000	68	271	6 720	96	384	9 513	166	663	16 319
100 000	68	270	6 336	96	383	8 763	166	659	14 229
50 000	68	269	7 959	96	381	8 057	165	655	12 459
10 000	67	263	4 035	95	370	4 899	163	622	6 239
5 000	67	257	2 875	94	357	3288	161	586	3 842
1 000	63	213	871	88	278	905	142	399	943
500	60	176	466	81	217	475	125	285	485
100	41	73	99	49	80	99	63	87	99
50	29	42	50	33	44	50	39	47	50

According to [13], "Making a choice of sampling is choosing a limited number of individuals, objects, or events whose observation allows us to draw conclusions or inferences applicable to the entire population within which the choice is made". In other words, it is the choice of a sample of statistical interest.

Determining the sample from which the survey will be conducted results from a series of essential and precise operations whose function is to ensure representativeness. That is to say, the conditions that will guarantee the subsequent generalization of the results to the entire population. Alain Bouchard has developed a table to guide the determination of the size of a sample. He has established a formula for determining the sample size, as shown in the table below.

According to Bouchard's idea, when the survey universe is greater than 1,000,000 respondents, it is considered infinite; it is made to correspond to a sample of 96 respondents with a margin of error of 10%. And when the survey universe is finite, that is to say, less than 1,000,000 respondents, we apply the formula for the corrected sample size [14].

The surrounding households of the OTB Tora are 265 units. This is a survey universe whose parent population is less than 1,000,000 respondents; this, therefore, allowed us to apply the corrected sample size. We then calculated the corrected sample by applying Alain Bouchard's formula as follows:

$$n_c = \frac{n}{1 + \frac{n}{N}}$$

Where:

n_c = corrected sample size

N = size of the parent population

n = sample size for an infinite population [14].

Our sample is therefore 70 households obtained as follows:

$$n_c = 96 / (1 + 96 / 265) = 96 / ((265 + 96) / 265) = 96 / 1 \times 265 / (265 + 96) = 70$$

2. Results

The analysis of socio-demographic characteristics was carried out using the variables that are gender, age, and level of education. Thus, the table below shows the identification of households surveyed according to gender.

Table 2. Distribution of respondents by gender

Sex	Effective	Frequency	Percentage
Male	41	0,6	60%
Female	29	0,4	40%
Total	70	1	100%

The values shown in Table 2 show that the surveyed households were represented by 41 men, or 58.6%, and 29 women, or 41.4%.

Thus, the difference in proportion between the participants in the survey is explained by the fact that Burundian society is patriarchal and patrilineal, and all decisions are under the control of the head of the family. Only widows or geographically single women are those who can make decisions.

Table 3. Identification of surveyed households according to age

Age	Male			Female		
	Effective	Frequency	Percentage	Effective	Frequency	Percentage
18-25	6	0.09	9	4	0.06	6
25-35	14	0.2	20	9	0.12	12
35-45	11	0.16	16	12	0.17	17
45-55	8	0.12	12	4	0.05	5
55-beyond	2	0.03	3	0	0	0
Total	41	0.6	60	29	0.4	40

From Table 3, it appears that the men surveyed who are between 25 and 35 years old are in the majority, as well as those who are between 35 and 45 years old. They are respectively 14 in number, or 20% and 11 or 16%. On the other hand, the majority of women are those who are between 35 and 45 years old, who are 12 in number or 17% and those who are between 25 and 35 years old, who are equal to 9 or 13%. Those who are between 18 and 25 years old are less numerous, they are 6 for men or 8% and 4 for women or 6% as well as women aged between 45-55 years old.

The low proportion of participants aged between 18 and 25 is explained by the fact that the Personal and Family Code authorizes men to marry at the age of 21 and girls at the age of 18 (Art. 89). In addition, the social phenomenon of rural exodus means that young people leave rural areas to look for jobs in cities.

As for households represented by people aged between 55 and over, they are fewer in number because Burundians have a life expectancy that is too low, even lower than this age [15].

Thus, Table 4 shows the identification of respondents according to the variable level of education and by gender.

Table 4. Identification of respondents according to their level of education

Level of education	Male			Female		
	Effective	Frequency	Percentage	Effective	Frequency	Percentage
Illiterate people	3	0,045	4,5	3	0,04	4
Who can read and write	3	0,045	4,5	3	0,04	4
Primary	7	0,1	10	5	0,07	7
Secondary	20	0,29	29	13	0,18	18
Higher education	8	0,12	12	3	0,04	4
Other trainings	0	0	0	2	0,03	3
Total	41	0,6	60	29	0,4	40

Analyzing Table 4, it appears that illiterate men and women and those who can read and write as well as women of higher education, are all equal to the number of 3 or 4%.

We also note that households represented by men of primary, secondary, and higher education are more numerous than households represented by women. They represent the value of 7 or 10%, 20 or 29% and 8 or 11% respectively, for men of primary, secondary, and higher education. Households represented by women of primary, secondary, and higher education reach the value of 5 or 7%, 13 or 19% and 3 or 4% respectively.

Illiterate people and those who can read and write are less numerous. This is due to the fact that tea cultivation has increased household income, which means that the population of this locality has easy access to school. In addition, the establishment of the OTB in this locality contributes enormously to socio-economic development, particularly in the tracing and maintenance of roads, which promotes communication, including easy access to institutions.

2.1 Effect of pesticides in the environment

Chemicals are dangerous for both the environment and human health. Surface runoff carries pesticides to the level of the water sources we consume, and part of it infiltrates into the soil, and certain residues remain there and will pollute the food grown there [16]. The most exposed people are farmers who face several risks [17].

The most significant negative impacts of pesticides on human beings concern poisoning. They can enter the body via the oral, dermal, and respiratory routes and cause acute or chronic damage to human health depending on the type of exposure [18].

Pesticides are dangerous to health and the environment, and obsolete pesticides are doubly so. On one hand, obsolete pesticides retain some initial properties, and on the other hand, as they deteriorate, other properties appear following several chemical phenomena (oxidation, hydrolysis, hydrogenation, etc.) which aggravate their severity.

Stockpiles of obsolete pesticides also pose a serious threat to health and the environment when not properly managed [1]. These stocks often include leaking containers, which cause the dispersal of these products into the environment, sometimes over very long distances [2] and expose populations living and working in the vicinity to health problems [3].

2.2 The disposal of obsolete pesticides

The mismanagement of pesticides and the resulting adverse effects have led the world to organize international and continental workshops and reflection days to adopt common and effective strategies to promote the proper management of pesticides throughout their life cycle. International conventions and protocols related to the management of hazardous waste and their disposal have been established.

WHO [19] indicates that once a pesticide has passed its expiry date, it must be disposed of in accordance with the method that complies with international standards for the disposal of hazardous materials. Similarly, equipment that is no longer in use must be removed from storage, decontaminated, and dismantled so that it is not used for other purposes.

FAO [5] states that the safest way to dispose of pesticides is to use the pesticides as intended by following the instructions on the label. Similarly, at the continental level, various meetings have strategies that can facilitate the application of international agreements in order to effectively cope with environmental challenges in Africa.

The most been organized to adopt common methods for the rational management of pesticides and to put in place advanced countries have recognized the impacts of chemicals on health and the environment and have therefore put in place national risk management policies adapted to their context [6].

Burundi does not have an exclusive policy for pesticide management [7], although it has demonstrated political will by signing and ratifying all conventions and protocols relating to pesticides as well as several international agreements related to pesticide management [7]: Several legal instruments and documents that can help in the proper management of pesticides have been put in place without forgetting several ministries involved in pesticide management [8].

2.3 The contribution of OTB Tora within the limit of the damage caused by pesticides

The factory manager states that the factory has the Rainforest Alliance certification. This certification requires them to hold awareness sessions for all partners so that they know the impacts of obsolete pesticides, the dangers of using pesticide containers, etc. He states that the obsolete pesticides stored in the warehouse of this institution have started to ooze, also giving off odors felt through piercing the window, which prompted them to hermetically seal the stock of obsolete pesticides.

He states that there may be empty containers that can be useful for the population in households, but that each time they appear, they are collected to quarantine them and later forwarded to the Ministry of the Environment via the plant protection department. He also states that it is prohibited in their home by the rules of the "Rainforest Alliance" certification to give or sell empty pesticide containers to other people.

The plant manager specifies that Rainforest Alliance certification requires them to dig a hole to put any empty pesticide containers, those that are biodegradable in one hole and those that are not in another. He also says that this technique has been sensitized to households where the OTB supervises. However, he emphasizes that though these holes facilitate the management of pesticides, they constitute a community threat because they are not covered, and the containers are continually thrown into them, which therefore leads to pollution of the atmosphere as well as the water table.

The effects of pesticides on the environment are numerous. The following table shows the negative impacts of pesticides on the environment.

Table 5. The main negative impacts linked to the use of pesticides, according to the Burundi Ministry in charge of Environment [4]

Environment	Nature of impact
Soil	Decrease in Fertility
	Acidification
	Alkalization
	Salinization
Surface water	loss of quality (contamination)
	change in pH
	change in salinity
Groundwater	contamination of fish species
	loss of quality (contamination)
	modification of pH

Table 5 Continued

Environment	Nature of impact
Biodiversity	Chemo resistance of pests
	Intoxication of fauna
	Poisoning and mortality
	Reduction in numbers and/or biomasses
	Disappearance of species or groups of species
Human health	Disruption of the ecological balance
	Acute poisoning: headaches, dizziness, nausea, chest pain, vomiting, skin rashes, muscle pain, excessive sweating, cramps, diarrhea and breathing difficulties, nail discoloration and loss,
	Poisoning, Death
	Chronic poisoning: Decrease in cholinesterase levels, Effects on the nervous system (neurotoxins), Effects on the liver, Effects on the stomach
	Decrease in the immune system
	Disruption of hormonal balance (brain, thyroid, parathyroids, kidneys, adrenal glands, testicles and ovaries)
	Risk of abortion (embryotoxins)
	Stillbirth (fetotoxins)
	Sterility in men (spermatotoxins)
	Air contamination
Air	Odor nuisances

The constraints that the OTB faces in disposing of or destroying obsolete pesticides as well as the main factors that promote the accumulation of obsolete pesticides.

The plant manager reports that ignorance, lack of space for obsolete pesticides, lack of control over supplies (inaccurate assessment of needs), administrative procedures (administrative delays in processing requests which sometimes mean that pesticides arrive too late), excessive storage of products with a short shelf life, product bans, lack of expertise in pesticide management, lack of pesticide suppliers who know the seriousness of obsolete pesticides, which prevents them from collecting them as well as the Ministry responsible for pesticide management which is not fully involved, are the main obstacles that prevent them from getting rid of obsolete pesticides.

The table shows the level of knowledge of the population about the knowledge of importance of treating empty pesticide containers used in their household.

Table 6. Level of knowledge of the population on the importance of treating empty pesticide containers before use

Response	Workforce	Frequency	Percentage
Yes	33	0.47	47
Non	25	0.36	36
Non-respondents	12	0.17	17
Total	70	1	100

The table below shows that out of 70 respondents, 33 or 47% answered that they know the importance of treating empty pesticide containers used in their household; 25 respondents or 36% answered no, while 12 or 17% did not answer the question.

The low knowledge about the severity of the use of pesticide containers that have not been scientifically treated means that the population uses them despite the degree of treatment. The lack of public or private service ensuring the treatment of empty pesticide containers encourages the use of untreated packaging.

Thus, the table below shows the level of knowledge of respondents about the harmful effects of inhaling obsolete pesticides.

Table 7. The level of knowledge of respondents on the harmful effects of inhaling obsolete pesticides on human health

Response	Workforce	Frequency	Percentage
Yes	41	0.59	59
Non	6	0.09	9
I don't know	22	0.31	31
Non-respondents	1	0.01	1
Total	70	1	100

Out of 70 respondents, 41 or 59% know that inhaling obsolete pesticides has harmful effects on human health; 6 or 9% do not know, 22 or 31% have no idea that inhaling obsolete pesticides can cause acute or chronic diseases in human beings, and 1 or 1% did not answer the question. The obsolete pesticide warehouse, installed very close to homes and offices, releases pesticide fumes that the population constantly breathes in. These answers show that the respondents are not sufficiently informed about the damage that obsolete pesticides can cause to their health and the environment.

3. Discussions of Results

The results of interviews and those of surveys made it possible to confirm the hypotheses put forward for this work entitled "Obsolete pesticides, an environmental threat". The first hypothesis: "The obsolete pesticide management system at OTB Tora is linked to the lack of technical expertise of this institution for their collection and destruction", is confirmed since the interview held with the factory manager revealed that obsolete pesticides are stored in a house, but they ooze out to pollute the environment and poison the population.

The factory director also points out that lack of knowledge, lack of control over supplies, and lack of expertise in pesticide management are the main obstacles stopping them from getting rid of obsolete pesticides.

The second hypothesis: "The population does not know the importance of treating empty pesticide containers before use", is confirmed since the field survey showed that, as to the question of knowing the level of the population's knowledge about the importance of treating empty pesticide containers before use, 33 answered yes while 25 answered no. Those who answered no are a significant number. The population does not know the importance of treating empty pesticide containers before their use.

The third hypothesis: "People around the OTB Tora do not know the negative impacts of inhaling obsolete pesticides on their health", is confirmed since the field survey showed that 29 respondents out of 70 do not know about it. The warehouse is not only built near the offices of this institution but also opposite the residential houses of the institution's workers. This also shows the lack of awareness of the severity of inhaling obsolete pesticides by the managers of this institution.

4. Contributions

In order to reduce the effects of obsolete pesticides in stock through the ocular, respiratory, and cutaneous routes, the construction of the warehouse away from residential houses and offices with a chimney a few meters high can contribute to reducing the contamination of humans and their livestock.

While waiting for the cleaning of obsolete pesticide stocks throughout the country, the construction of a chimney on existing stocks is also necessary to reduce the effects that weigh heavily on the population and the environment without realizing it.

The establishment of public infrastructure responsible for the treatment of empty pesticide packaging and a well-trained committee responsible for the management of the life cycle of pesticides can help revitalize the management of obsolete pesticides.

As [8] reports that the population is not aware of the dangers of POPs since our country does not have trained and qualified personnel on pesticide management. It is necessary for our country to have qualified and trained personnel on pesticide management in order to promote human health and environmental protection. In order for the entire population to be informed of the harmful effects of reusing pesticide packages, the OTB Tora should make best efforts to initiate mass awareness initiatives and techniques.

5. Conclusion

The high parasitic pressure that threatens farmers means that they resort to the use of pesticides to deal with crop pests. Although they contribute to solving some of the problems of today's world, they are also responsible for the environmental disruptions we are experiencing and for human overexposure to substances whose long-term effects are unknown (Ministry of Land Use Planning, Water and the Environment [6]).

Just as grenades, mines, and other unexploded explosives constitute a social and community hazard and continue to weigh after the end of hostilities for several decades, obsolete pesticides that have not been destroyed also constitute a social, community, and economic hazard, not to mention a long-term environmental imbalance. Obsolete pesticides locked in stocks constitute a hidden bomb that will one day go off against man, his livestock, and the environment, not to mention maintaining the environmental balance, with serious consequences at the human, social, and economic levels.

Although they are silent for the moment, with damage to human, veterinary, and environmental health in the short term that we do not directly notice, they will erupt one day (in the long term), and it will be difficult to control. In order to promote the sustainable management of obsolete pesticides at OTB Tora and to protect humans from the damage that can be caused by obsolete pesticides in stock, the construction of a chimney of a few meters high on the warehouse could minimize human contamination by respiratory pesticides.

While the literature on environmental policy instruments in general and pesticide management in particular is very developed at all levels, their implementation at the OTB TORA remains incomplete. In this work, we tried to show the level of the population's understanding about the dangers of obsolete pesticides stored in their vicinity and the challenges that the OTB faces following these products locked in their stock, using a qualitative survey conducted among the population neighboring the OTB, the OTB agents, and an interview conducted with the factory manager.

The survey results showed that the population does not have sufficient knowledge about the harmful effects of pesticides in general, and ignorance and poverty are the main causes that contribute to the reuse of empty, untreated pesticide packages.

The introduction of mass awareness initiatives and techniques towards the population is necessary so that the population knows the harmful effects of pesticides. The installation of a chimney on the warehouses of obsolete pesticides will contribute to the reduction of human contamination by inhalation. The genes of each individual determine the degree of sensitivity to pesticides. Obsolete pesticides, therefore, constitute a threat to sustainable development.

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