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Herbicide application in maize and cassava crops, impact on environment and population health in the department of Vavoua (Côte d'Ivoire)

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Abstract

The present study analyses Vavoua department agricultural producer's knowledge, practices and attitudes regarding herbicide application and their impact on human health and the environment. It covered nine (9) selected agricultural sites including Brouafla-Nattis, Bénoufla, Vavoua, Koudougou PK8, Koudougou PK5, Bidiafla, Bahiri (Bafla), Brouafla Kouya and Bonoufla, for a structured quantitative survey involving 72 producers. More than 95% of the surveyed producers systematically use phytosanitary products including glyphosate-based herbicides. The majority of producers (95%) have not received any training on the use of plant protection products and do not have a good knowledge of application rates and treatment frequencies. The diversity of phytosanitary treatment methods is explained by the lack of training and especially by the lack of supervision of producers that could have mitigated the harmful effects on human such as dizziness, nasal congestion, colds, redness of the eyes, nausea and vomiting, etc., and on the physical environment.

Keywords: Maize and Cassava Crops; Herbicides; Producers; Phytosanitary Risks; Vavoua Department; Côte d'Ivoire

1. Introduction

In recent decades, population explosion has put immense pressure on agricultural production, forcing agriculture to be intensified more sustainably in order to meet the ever-increasing demand for food [1]. Agricultural production must increase by 70% to feed a world population that is expected to reach 9.6 billion by 2050 [2].

Thus, to cope with yield losses due to pests, especially those of food crops, producers resort to chemical control through the use of herbicides. These herbicides are certainly one of the factors of agricultural development in a context of intensification of agriculture dictated by both demographic pressure and economic needs. They can, for example, reduce or even cancel the many damages caused to crops by weeds.

However, misuse of these plant protection products can lead to problems at four levels: toxicity for users in agricultural environments, particularly applicators [3], consumer toxicity due to the presence of toxic residues [4], environmental pollution and toxicity to non-target organisms [5, 6].

In Côte d'Ivoire, an agricultural country in West Africa, farmers also use these phytosanitary products. However, herbicide management is a concern for the Ivorian State as Good Agricultural Practices (GAP) in the use of phytosanitary products are not really respected by farmers. Indeed, herbicide use rates and frequency are still not controlled by agricultural producers, most of whom are illiterate. This has an impact on environment, agricultural yield and farmers

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and consomers's health. The intensive use of synthetic herbicides, mainly glyphosate, has been shown to have adverse impacts on the environment and human health, and to develop resistant weeds [7]. In addition, there are almost no marketed bioherbicides apart from those based on pelargonic acid or acetic acid [8]. For this reason, plant protection product industry should introduce classes of herbicides with new mechanisms of action to control changes in herbicide resistance in weeds.

In the localities of Vavoua, food producers use herbicides to control weeds. However, they generally do not comply with hygiene rules and repeatedly adopt counter-environmental practices. This leads us to ask the following question: what are environmental and health risks associated with the use of herbicides in maize and cassava crops in the department of Vavoua? What is population perception on herbicide use? What is population level of knowledge on phytosanitary products? These are the concerns we have tried to address.

2. Material and methods

2.1. Presentation of the study site

Vavoua Department is one of the four departments that make up the Haut-Sassandra region in Côte d'Ivoire (Figure 1). It belongs to a plantation economy region dominated by the coffee-cocoa binomial. The rural population represents 593,453 inhabitants or 55.36% of the total regional population. The department of Vavoua is dominated by the indigenous populations: the Gouro people. In addition to these "established" populations, there is a large migrant population dominated by non-natives (Ivorians) from other regions of the country. They represent 30.81% of the departmental population, to which are added foreigners from the countries of the subregion with 27.69%.

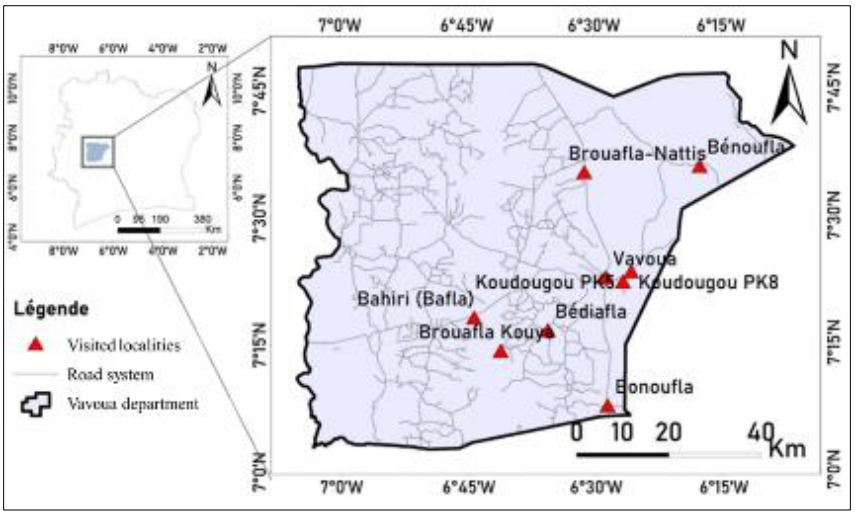

Figure 1 Location of the department of Vavoua

2.2. Data collection

The study was conducted from June 06 to August 29, 2019. Data were collected using non-probability sampling model, precisely, reasoned choice sample. This made it possible to interview 72 people, namely: chiefs and notables, women's and youth associations, peasants and leaders of ANADER (National Agency for Support to Rural Development). Discussions with producers focused on their level of education, the main phytosanitary problems encountered, the control methods used, the plant protection products used, the rate, the means of protection used, the packaging management and their knowledge of chemical risk. In addition, these interviews made it possible to know whether the populations have been trained in the use of phytosanitary products. These data were collected from the surveys consisting of structured interviews [9]. An interview guide was even sent to the officials of the National Agency for Rural Development (ANADER). Direct observations were made using an observation grid during the field survey in order to consider the behavior of farmers in their cultural practice and especially in relation to the use of phytosanitary products. These observations complemented the information provided during the individual and group interviews.

2.3. Data analysis

The collected data was analyzed with the excel software. The crawl plan used is content crawling. Qualitative data were transcribed for individual and group interviews and analysed using an analysis grid. Data from the literature search were also subject to content analysis. This content analysis made it possible to study population's perceptions, thoughts, knowledge and attitudes as well as environmental and health risks associated with herbicide use. The analysis plan was determined based on the objective of the study.

3. Results

3.1. Socio-demographic profile of maize and cassava producers in Vavoua department

The majority of maize and cassava producers in Vavoua department were male, 95.83% compared to 4.17% female (Figure 2). Their mean age was 47.29 with a standard deviation of 14.82 years and extreme limits of 25 and 67 years. As for other socio-demographic aspects, the results of this study showed that 15.2% of producers were illiterate, 42.3% had a primary level and 42.5% were at the secondary level (Figure 3). In terms of marital status, 83.33% of producers were married compared to 16.67% of single people (Figure 4).

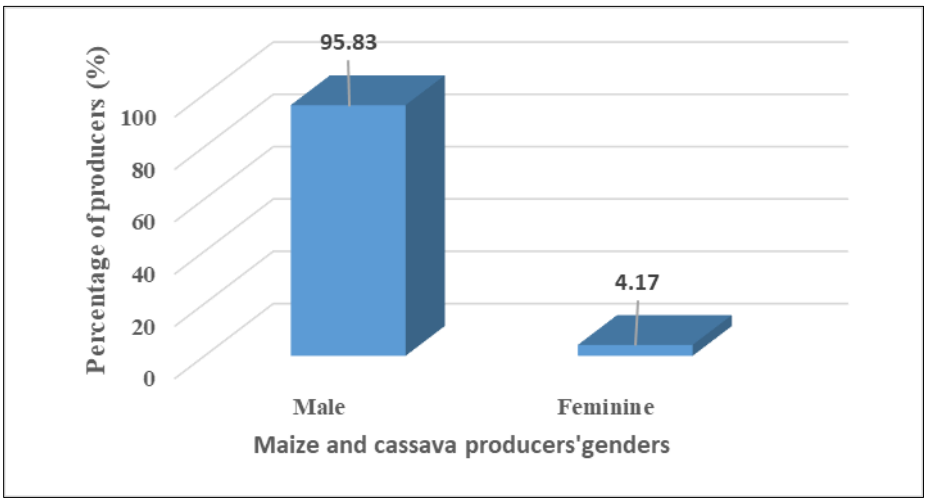

Figure 2 Grouping of Vavoua cassava and maize producers by gender

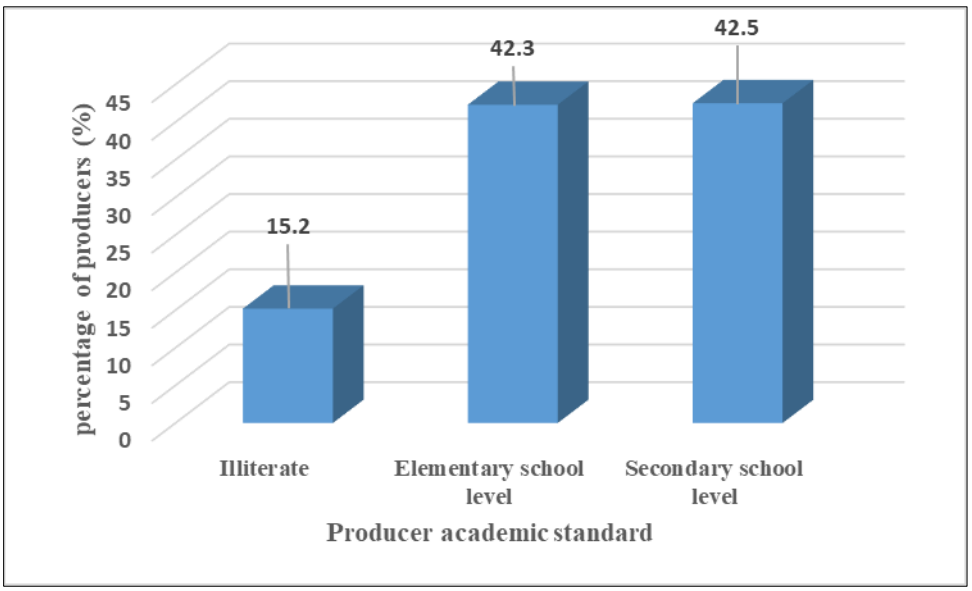

Figure 3 Distribution of Vavoua maize and cassava producers by level of education

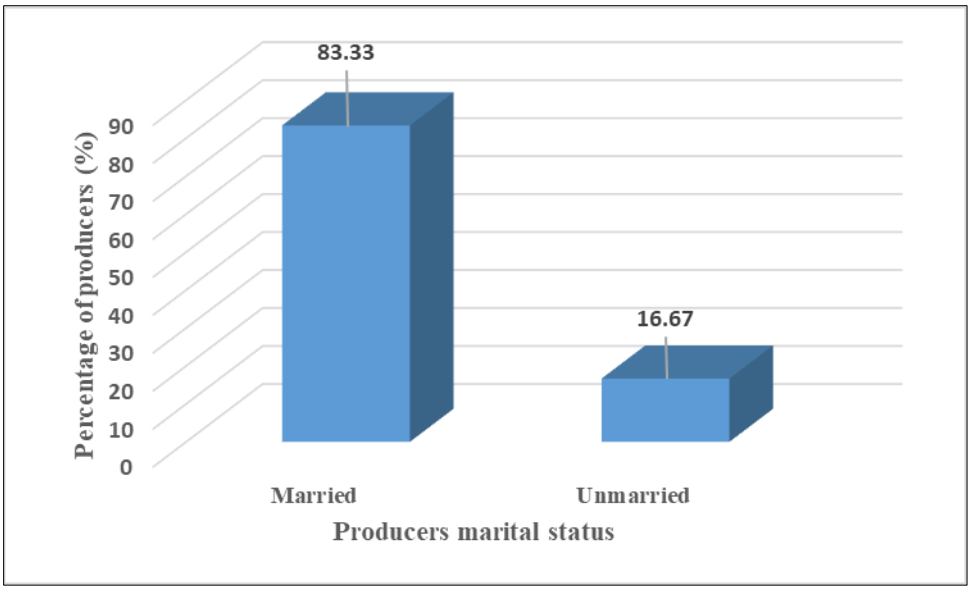

Figure 4 Distribution of Vavoua maize and cassava producers by marital status

3.2. Herbicides used in maize cultivation in the department of Vavoua

Two herbicide formulations are used by farmers: powder or solid herbicides (Figure 5A) and liquid formulation herbicides (SL) as shown in Figure 5B. The range of herbicides in liquid formulation is more varied. There are, among others, herbicides whose trade names are Adwuma wura480g/l (SL) or wura super 480g/l (SL), Gramoquat Super 360g/l (SL), Glyphander 480g/l (SL), Detru-herb 360g/l (these are non-selective herbicides not registered in Côte d'Ivoire observed on study sites), Glydel 480g/l SL (non-selective herbicides based on 480g/l of glyphosate Isopropylamine salt / isopropanylamine shaped), GlyFort 360g/l SL (glyphosate-based systemic herbicide), Killer 480g/l SL (glyphosate-based total herbicide), Ladaba 480g/l SL (non-selective systemic herbicide), Lamachete 757WG (total non-selective herbicide for weeding crops and non-cultivated areas), Herbextra 720g/l SL, Weadkill 720g/l SL, Herbigro 720g/l SL (selective herbicides), etc. As for chemical weedkillers in powder formulation, it was identified mainly rapid max 750WG (non-selective herbicide for weeding crops and non-cultivated areas). The herbicide of solid formulation is also the most used in the scope of investigation.

A- Herbicide in powder or solid formulation B- Herbicide in liquid formulation (SL)

Figure 5 Selected ranges of herbicides used by growers

These different herbicides are used either for the clearing of plantations of perennial crops (cocoa, coffee, cashew and rubber), or for the weeding of food crops (lowland rice, maize, yams, cassava, ...) before seeds or cultivation and post-emergence. They are therefore effective for the control of annual weeds, perennial grasses, perennial species.

3.3. Protective measures used during pesticide application

Any herbicide application activity requires special protective measures. However, through this study, it appears that 87% of producers in the department of Vavoua do not use protective measures and/or do not protect themselves during pesticide application activity (Figure 6). Very few producers have adequate or adapted protective equipment (masks, gloves, glasses, boots, coveralls).

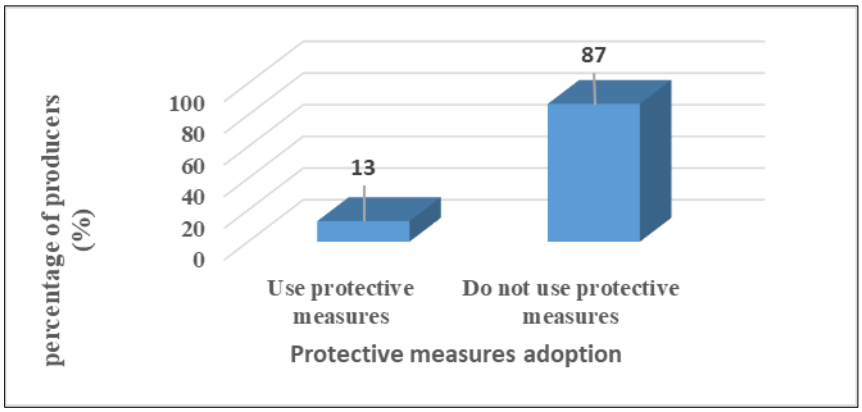

Figure 6 Distribution of Vavoua maize and cassava producers by compliance or non-compliance with phytosanitary protection measures

3.4. Producer knowledge, practice, and training of pesticide application

The results reveal that 100% of growers are systematically aware of and use herbicides in their crops.

The rate of producers trained on pesticide application is overall very low (6.3%) as shown in (Figure 7). In practical terms, producers refer to the advice of other farmers or suppliers. Those who can read consult the instructions for use on the packaging and those who cannot read use the instructions for use recommended by their colleagues/parents.

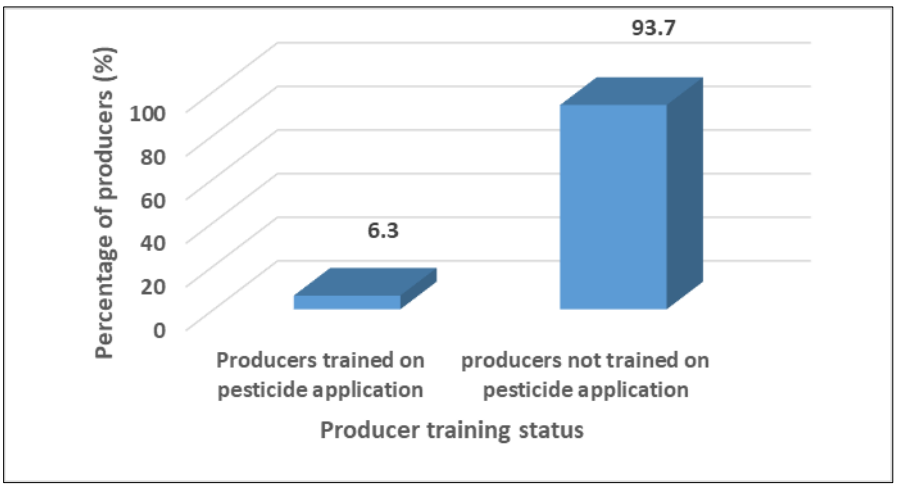

Figure 7 Distribution of respondents into trained and untrained producers in the use of plant protection products

3.5. Protective measures during phytosanitary treatments

This study shows that no producer has complete protective equipment such as gloves, boots, masks, dust covers, coveralls, aprons, glasses. Only 28.9% of producers use two or three pieces of protective equipment mentioned above (Figure 8). Nose masks appear to be the most widely used protective equipment by producers (57.1%), followed by boots (52.4%) and gloves (35.2%).

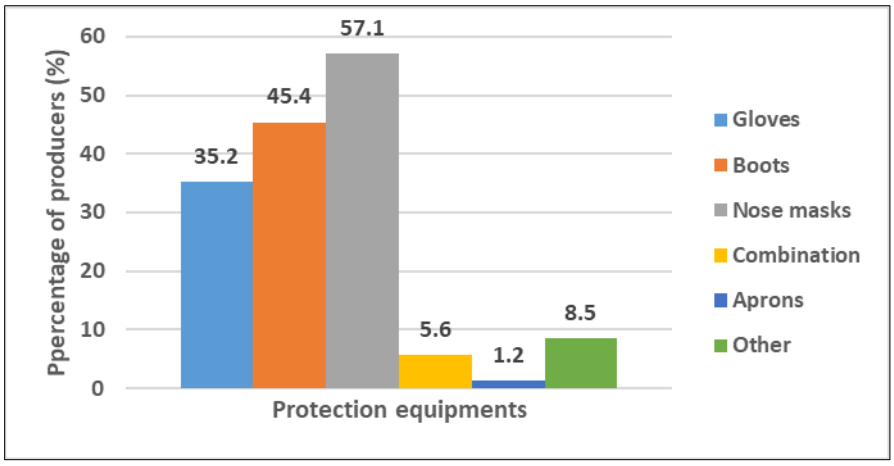

Figure 8 Distribution of respondents according to the phytosanitary protection equipment used

3.6. Producers health after pesticide application

Figure 9 summarizes the different assessments made by producers of the potential adverse effects associated with pesticide use. Among these effects, dizziness (21%), nasal congestion and colds (22.3%), redness of the eyes (10.3%), nausea and vomiting (14.5%), cough (16.1%), headache (10.3%) and blurred vision (2.3%) were cited by the producers interviewed while 3.2% of farmers said they did not experience specific symptoms related to pesticide use during spraying.

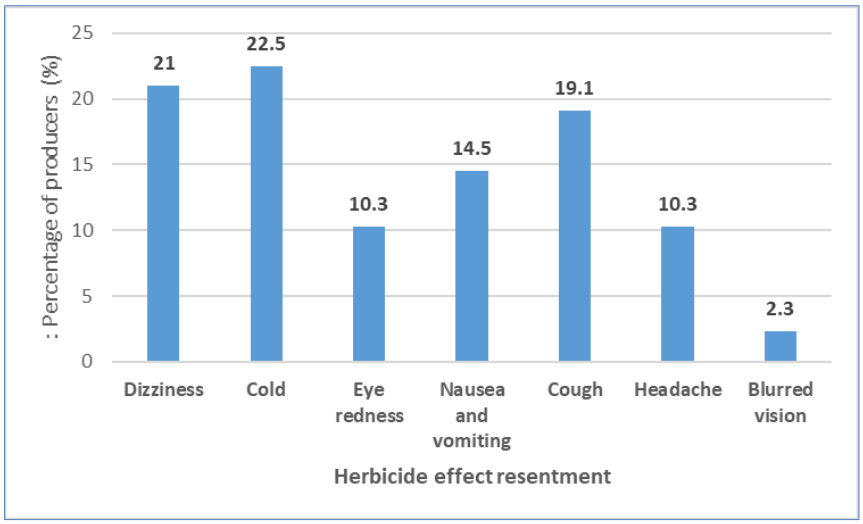

Figure 9 Distribution of growers, based on resentment of herbicide effects.

3.7. Moments of phytosanitary treatment

Pesticides application times are very variable in the surveyed sites. There are no specific times for this phytosanitary treatment. For example, 61.3% of producers apply the products in the morning, 12,2% of producers process their crops at any time of the day while 21,3% do so in the afternoon and 2,1% after a rain (Figure 10).

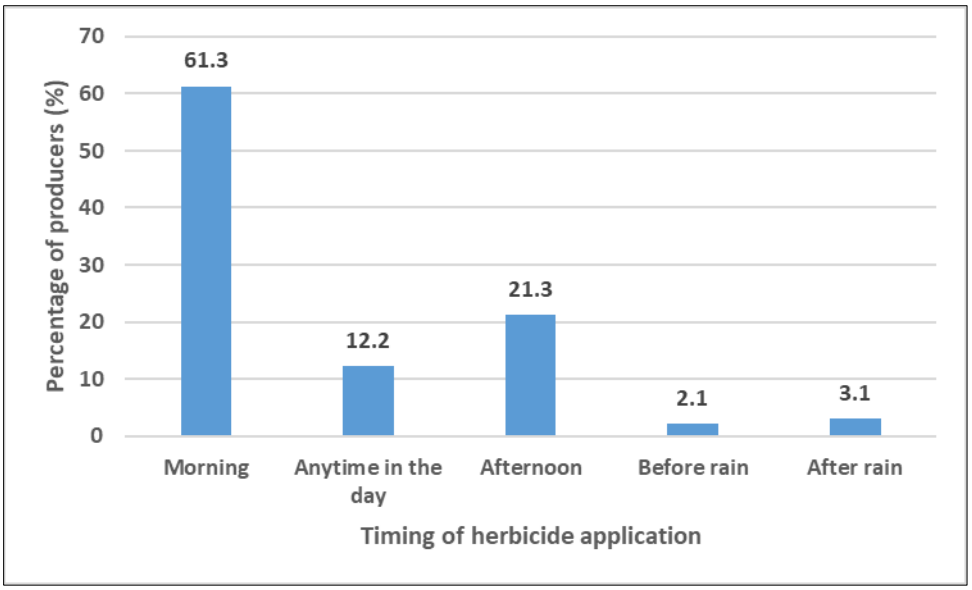

Figure 10 Proportion of producers by time of treatment of plant protection products

3.8. Rating methods and pesticides spray

Despite the multitude of tools used, more than 90% of producers do not apply the rates indicated by manufacturers on packaging. Also, the rate varies from one producer to another, from one treatment to another without taking into account the recommended rate on the label. Only less than 10% of producers comply with this regulation (Figure 11).

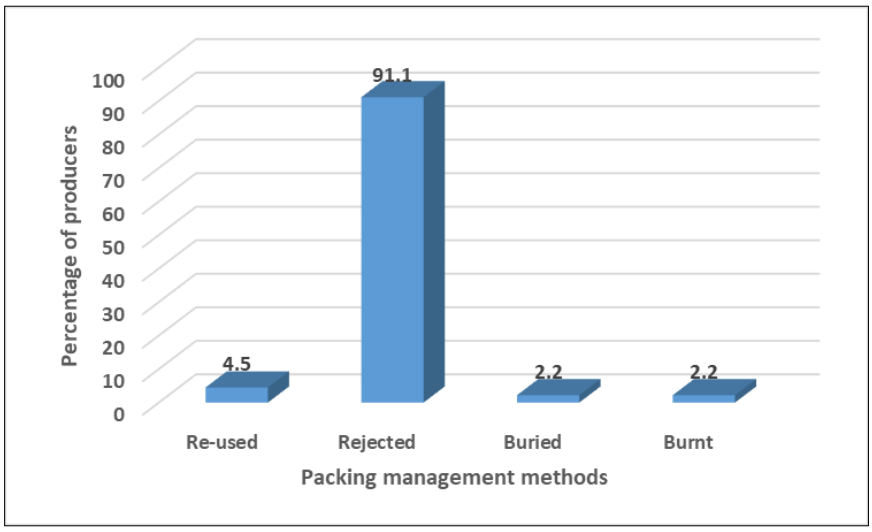

Figure 11 Method of packaging management by producers

4. Discussion

Maize and cassava crops are highly developed in the department of Vavoua. These are intensive agricultures that use a lot of agricultural inputs (fertilizers and pesticides). The use of plant protection products by producers is systematic because they control insect pests and weeds in order to reduce crop losses and increase yields. However, their uncontrolled use due to lack of training can be a source of nuisance for human health and the environment [10, 11].

This study showed that 28.9% of growers had one or two pieces of protective equipment (gloves and/or nose masks) at the time of herbicide application. On the other hand, the studies carried out in Benin [12] have shown that farmers do not regularly protect themselves when using pesticides because of the high cost of equipment, they are most often satisfied with a minimum protection such as pieces of fabric of any kind. The lack of protective equipment during

pesticide application is a violation of Article 2 of the FAO Code of Conduct [13] which recommends that all pesticide handlers be equipped with personal protective equipment. Producers protect themselves very little at the time of treatment, as in studies conducted elsewhere [12, 14]. Thus, the use of protective equipment during treatments is not a differentiating criterion for farmers even if many producers use minimal protection when applying pesticides. Also, [15] believe that producers do not protect themselves because of the high cost of protective equipment. However, the lack of body protective equipment has been shown to increase the risk of poisoning, which, initially minor, can become serious by bioaccumulation [16, 17, 18]. Several cases of poisoning and diseases related to pesticides in agricultural environments were identified by producers during the investigation. Cases of symptoms raised by farmers in Togo are linked to non-compliance with hygiene rules during and after phytosanitary treatments, as shown by [19] in Ethiopia and [20] in Ghana. Aware of the health risks involved, some producers take some precautions after treatments: hand washing, bathing, etc. In the context of packaging management, it is noted that the disposal of packaging of plant protection products can only be carried out in special facilities classified for the protection of the environment and authorized for the treatment of such waste. However, these packagings are found in nature directly within the reach of peasant populations, especially children. Thus, the release of empty packaging into the wild is a violation of the relevant regulations because [13] recommends the return of empty packaging to distribution houses. It is also a major environmental risk as has been shown in cocoa, coffee, banana and vegetable growing areas in Côte d'Ivoire [21]. According to [12, 16, 22], these packages are often reused for other purposes. This way of managing packaging must be corrected to preserve the quality of the environment, including water, soil, biodiversity and especially the lives of producers and consumers [23].

Regarding the time of treatment of phytosanitary products in the department, these moments vary according to the stages of the vegetative cycle and can be done at any time depending on the means available. This observation was also made by [15] who note that the timing of treatment is also a function of sprayer availability. Indeed, if the use of sprayer seems common, this tool is not always available.

Producers are unaware of the treatment period and the different mixtures. Compared to protective measures during phytosanitary treatments, it should be noted that the use of pesticides reduces crop losses due to pests and stabilizes yields [12]. Nevertheless, their uncontrolled use can be a source of nuisance for human health and the environment [18, 24, 25]. To this end, the results of the study present the conditions of use, the inadequacy of the storage places for plant protection products and the problem of managing empty packaging. According to [21, 26], this set of practices harms the environment, the health of consumers and that of users.

In addition, the results obtained in this study challenge the state of Côte d'Ivoire, in particular, and the entire West African sub-region in general, because we believe as [27] that the environmental risks and poisonings identified are the reflection of dysfunction in a country or a region, because reflecting the regulatory and economic inadequacies and a low level of education of the population. They also highlight the need for rigorous enforcement of existing regulations, as well as increased training and awareness of stakeholders in the communities concerned. Faced with all these shortcomings in the field of phytosanitary products among producers, the training of farmers by the State remains the only asset to save the environment of the peasant world.

5. Conclusion

Maize and cassava cultivations are important activities that reduce unemployment, the food crisis and are also means of obtaining income to meet family needs. However, producers in the Vavoua department are not trained in the use of pesticides and packaging management. They practice risky agriculture based on empirical experience. Cases of discomfort during and after treatment are proven and the most mentioned are dizziness, nasal congestion, colds, redness of the eyes, nausea and vomiting, fatigue, headaches.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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