

RESEARCH ARTICLE

Evaluation of Pesticide Safety Measures Adopted by Potato Farmers in Chebiemit Division, Elgeyo/Marakwet County, Kenya

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ABSTRACT

Potato (*Solanum tuberosum*) is the second most important food crop after maize in Kenya. It is popular among smallholder farmers because it has short cropping cycles and large production volumes per area which fulfill both households' food demands as well as generating income. To increase productivity, farmers practice better farming methods which include the use of pesticides. These pesticides if improperly handled impact negatively on the health of the users. The objective of the study was to evaluate the pesticide safety measures adopted by potato farmers in Chebiemit Division of Elgeyo/Marakwet County. The Area of study is shown by Figure 1. Data were collected through stratified simple sampling where 323 potato farmers were administered with structured questionnaires. The data were analyzed using SPSS software. The study found out that 96% of the farmers were aware of pesticide safety labels and the level of awareness was influenced positively by education ($\chi^2 = 4.08, P < 0.05, df = 2$) and training ($\chi^2 = 3.05, P < 0.05, df = 1$). The study established that 64.7% of the farmers had cultivated the crop for more than 10 years and had been using pesticides for the entire period at least thrice in every cropping cycle. The commonly used pesticides were the fungicides Ridomil and Tatamaster which have mancozeb and metalaxyl as the active ingredients as shown in Figure 2. Most farmers rarely practiced safety precautions when handling, mixing, and spraying chemicals and none of them wore the recommended personal protective clothing. Most of the mixing was done either in knapsacks or in basins that were also used for bathing hence increasing exposures. The current study has shown that 58.5% of the pesticide applicators were males and, in those households, where the applicator was female (16.1%), children under the 14 years of age were involved in pesticide application. The study further reported that post-spraying practices among the farmers were poor since only 36.2% of the applicators bathed after spraying as compared to 69% who only washed hands and face. Females practiced better hygiene practices than fathers ($\chi^2 = 31.5, P < 0.05, df = 6$). In addition, most farmers stored pesticides either in stores together with cereals or in living rooms. This study also found out that 35% of the farmers disposed empty pesticide containers by discarding them on the farm as compared to only 6% who disposed them by burying. The mode of disposal was influenced positively by training ($\chi^2 = 70.2, P < 0.05, df = 3$). The study further found out that 85.8% of the farmers who had handled pesticides had experienced pesticide poisoning but only 7.4% of them visited a health facility but the majority took milk/pain relievers or rested after spraying. The study results indicated that most potato farmers and their families were highly exposed to pesticide contamination and poisoning due to poor pesticide safety measures. Since there is a gap in terms of training and education on pesticide safety measures, there is an urgent need to implement training programs to improve the knowledge, perceptions and practices of potato farmers in the study area with regard to safe handling, storage and use of pesticides.

Key words: Farmers, training, pesticide, safety, potato, handling, Chebiemit

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INTRODUCTION

Chebiemit division, Marakwet West district, Elgeyo/Marakwet County, Rift Valley Province of

Kenya lies at latitude of 0.85 and longitude of 35.5 and it has an elevation of 2439 meters above sea level. Potato farmers use fertilizers and pesticides to get higher agricultural yields from small and over-cultivated land. Agriculture is the main economic activity in the division with maize being dominant, followed by potato production. The area has two planting seasons: The long rains season (March, April, and May) and short rains season (October, November, and December). Potato is planted in both seasons of the year. Other crops grown in the district include pyrethrum and horticultural crops such as cabbages, kales, beans, carrots, and passion fruits. The varieties of potatoes grown in the study area include; Tigoni (widely grown), Kenya karibu, Black currant, and Dutch Robjn (Ministry of Agriculture, District Agricultural office, Marakwet West district, 2010). These crops are sold at Eldoret town and other local towns. Pesticides are widely used in most areas of crop production to minimize infestations by pests and thus protect crops from potential yield losses and reduction of product quality (Damalas *et al.*, 2006) but they may also pose potential hazards to human health when inappropriately handled. The exposure of farm workers to pesticides is a major concern for the population in agricultural communities worldwide. The situation is more serious in developing countries where huge quantities of pesticides are used under relatively unsafe conditions (Mwanthi and Kimani, 1993; Lekei and Ngowi, 2006). Studies on pesticide poisoning in developing countries have been few and most of them have addressed the health effects of occupational exposure to pesticides in general and the clinical effects of pesticide poisoning (Mwanthi and Kimani, 1993; Wesseling *et al.*, 1993; Ohayo-Mitoko *et al.*, 1997a; Mbakaya *et al.*, 1994;). Only a few have dealt specifically with the patterns of pesticide handling, knowledge, and practices of agricultural workers (Manda, 1985; Mwanthi and Kimani, 1993). The implication of pesticide use and spraying practices on farmers' health is particularly important in potato-based production systems because it is one of the major agricultural systems on which smallholder farmers' use substantial proportion of pesticides (Cole *et al.*, 2002). Research has often emphasized the need to increase the awareness of farmers about the consequences of unsafe pesticide use and

the importance of communication and education programs aiming to reduction of risk (Ibitayo, 2006; Hashemi *et al.*, 2008; Oluwole and Cheke, 2009). Training programs can play a crucial role in pest control decisions, providing farmers with the technical knowledge that is necessary for the selection of appropriate pest management methods and also for safe and effective pesticide use (Carr, 1989). Potato farmers in the Chebiemit Division have constantly and consistently used pesticides without proper training and monitoring thus the purpose of the study was to evaluate pesticide safety measures adopted by these farmers in relation to level of their understanding of pesticide labels, field spraying practices, pesticide storage sites, and disposal of pesticide containers.

MATERIALS AND METHODS

Sample Selection

In Chebiemit Division approximately 2000 households engaged in potato production at the time of this study (KNBS, 2009).^[1-10] The small-scale farmers produced potatoes in farms ranging from <1 acre to more than 5 acres falling under categories at $t = 1.96$ and 95% confidence level. Using the table for determining minimum returned sample size for a given population size for continuous and categorical data by Bartlett *et al.* (2001), the sample size for this population was 323. Stratified simple sampling procedure was applied to identify the 323 farming households within the study area. Mugenda and Mugenda (1999), points out that stratified sampling method ensures inclusion of small groups which otherwise could have been omitted entirely by other sampling methods. Chebiemit division has two locations namely Kuserwo and Moiben. Kuserwo had a large intensity of potato growers. Potential respondents were interviewed for questionnaire administration.

Data Collection

Primary data involved the use of questionnaires, structured interviews, and direct field observations. Data on safety labels and pesticide practices and spraying were collected using structured questionnaires. This was supplemented by direct

field observation of pesticide spraying operations and field notebooks. Secondary data included cited literature from libraries, the internet, various publications, and Ministry of Agriculture records.

Ethical Considerations

Approval was sought from the Board of Post Graduate Studies of JKUAT and the Institute of Energy and Environmental Technology before commencement of this research work. Informed consent was also sought from the farmers before the questionnaires were administered.^[11-20]

Data Analysis

The data were analyzed using Statistical Package for the Social Sciences.

RESULTS AND DISCUSSION

The respondents comprised 75% male and 25% female. This was a clear indication that potato production was mostly carried out by men. The respondents had formal education with 42.2% of them having completed secondary school, 39.9% having attained primary education, and 10.8% had progressed beyond secondary school. In the present study, 71.5% of the farmers had never received any training on pesticide safety while 28.5% indicating that they had been trained. Out of those who had been trained, 53% had obtained training from the Agricultural Extension Officers, 29% received it from other farmers while 18% were trained by pesticide sellers. However, it should be noted that although farmers received training from pesticide sellers during field days, pesticide manufacturers put more emphasis on maximizing sales than on safety. The findings indicated that farmers mainly received informal training. The Ministry of Agriculture through its extension staff has implemented what is known as “Mkulima-Driven Programme” or “Demand- Driven Programme” which requires the farmer to seek the assistance of the Agricultural Field Officers when need arises. The program has not been practical in the study area due to the small-scale nature of potato farming; apart from lack of awareness on the existence of this program, farmers

also regard it as an additional cost. In addition, the Agricultural officers are ill equipped with pesticide safety skills, an aspect that makes it literally difficult for them to implement safety programs. More so, training received from other farmers is not reliable since majority lack technical know-how and the findings show that most of them are primary and secondary school leavers.

Level of Awareness of Potato Farmers on Pesticide Safety Labels

The farmers’ awareness level on the meaning of various pesticide safety labels was 96% and 97.5% of them positively identified the pictograms on wearing gloves, overalls, washing hands, and keeping the pesticides in locked stores away from the reach of children. Wearing face masks or eye protection received highest correct responses as expressed by 97.8% of the farmers. Education ($\chi^2 = 4.08$, $P < 0.05$, $df = 2$) and training ($\chi^2 = 3.05$; $P < 0.05$, $df = 1$) had a positive influence on the level of awareness. Those farmers who had progressed beyond secondary school level were all aware of the meanings of the pictograms whereas those with primary level education only managed 96% awareness level. The results indicated that training had a positive influence on awareness levels. All the farmers who reported to have been trained ($n = 92$) had knowledge on the pesticide labels. A careful understanding of meanings of various pictograms was necessary in determining how well farmers practiced correct safety precautions when handling pesticides. Thus finding is in line with Ajayi and Akinnifesi (2007) who found out that farmers interpreted pesticide safety labels reasonably correctly.

Pesticide Handling and Spraying Practices

Potato farming in the study area is characterized by production of the crop on small pieces of land ranging from ½ acres to 6 acres. The results indicated that 64.7% of the respondents reported more than 10 years in potato production, 20.4% a period between 4 and 6 years, 7.1% had done so for 1–3 years, and 4.3% had cultivated them for 7–9 years. From the study, 51.4% of the farmers used pesticides, 46.5%

practiced IPM (pesticides and to crop rotation), and 2.2% reported the use of crop rotation alone to protect their potato crop from pests and diseases. The study established that a wide range of pesticides (carbamates and organophosphates [OP]) was used against potato pests and diseases in the study area. These included the fungicides Ridomil, Tatamaster, Mistress, Oshothane, Victory 72, Milnor, Milthane Super and Duduthrin. A combination of Ridomil and Tatamaster (which contain the active ingredients mancozeb and metalaxyl) accounted for 37.8% usage while Ridomil, Victory 72 and Mistress accounting for 9.9%. A combination of Ridomil and a broad-spectrum synthetic parathyroid insecticide was used by 8.4% of the respondents. Ridomil alone was the commonly used pesticide as reported by 35.0% of the respondents compared to 6.5% who used Tatamaster, Mistress 2.2% or Victory 72, 0.3% alone.^[21-31]

Heavy usage of pesticides is a critical challenge in the developing nations as indicated by Muller (2002), a view that Lekei and Ngowi (2006) agree with and argue that workers, who mix, load, and apply pesticides extensively, are exposed especially when they are not well protected. They further postulate that the primary route of farm workers' pesticides exposure is the skin, except for fumigants which are inhaled in the form of gases. Although previous research has examined adult pesticide exposures in farm workers in Kenya (Ohayo-Mitoko *et al.*, 1997a), no research has examined the health effects in adolescents. A study carried out among adolescent sprayers in Egypt demonstrated that increased years of exposure to OP pesticides is associated with cognitive deficits. This is one of the several studies demonstrating that functional cognitive effects are positively correlated with increased years of exposure to OP pesticides, though primarily in adult populations, building confidence in the association (Abdel *et al.*, 2008). The current study indicates that 58.5% of those responsible for pesticide handling were males, 18.6% comprised both parents and 16.1% involved a female and child. Children under the age of 14 years were engaged in pesticide spraying. Most farmers heavily used pesticides in pest and disease control. This finding concurs with Damalas *et al.* (2006) who noted that pesticides are widely used in most areas of crop production to minimize infestations by pests and thus protect crops

from potential yield losses and reduction of product quality. Although previous research has examined adult pesticide exposures in farm workers in Kenya (Ohayo-Mitoko *et al.*, 1997a), no research has examined the health effects in adolescents. A study carried out among adolescent sprayers in Egypt demonstrated that increased years of exposure to OP pesticides is associated with cognitive deficits. This is one of the several studies demonstrating that functional cognitive effects are positively correlated with increased years of exposure to OP pesticides, though primarily in adult populations, building confidence in the association (Abdel *et al.*, 2008).

Use of Protective Clothing

Out of the 74.9% of the farmers who were involved in the operation of mixing pesticides, only 18.3% reported that they always prevented contact with pesticides, 20.1% prevented contact sometimes, and 61.6% reported that they never protected themselves against contact with pesticides. Among those who reported protection against contact, 49.6% reported that they wore gumboots only, 26.6% used ordinary clothing, as 7.7% reported a combination of gumboots, gloves, and overalls for protection against contact with pesticides. About 6.4% of the farmers used gloves for protection with 1.5% reporting the use of eye shields/goggles for protection. However, it was noted that those who reported to be using eye shields were people who in normal circumstances put on spectacles for medical reasons, therefore the study concluded that none of the farmers protected either the face or the eyes, 4.6% of them did not respond [Tables 1 and 2].

Although OSHA, 2007 points out that PPE are mandatory at all times when dealing with chemicals, very few farmers could be aware of the adverse effects of the chemicals as they took minimal measures to protect themselves. Donald Cole, a physician and scientist from McMaster University's Institute of Environment and Health in Hamilton, Ontario observed that farmers did not wear protective clothes and mixed pesticides with their bare hands and their knapsack sprayers often leaked which increased chemical exposure (Cole *et al.*, 2002). Finding is also in line with Ajayi and Akinnifesi (2007) who found out that although farmers interpreted pesticide safety labels reasonably correctly and knew about



Plate 1: Potato farmers spraying and mixing pesticides without personal protective clothing

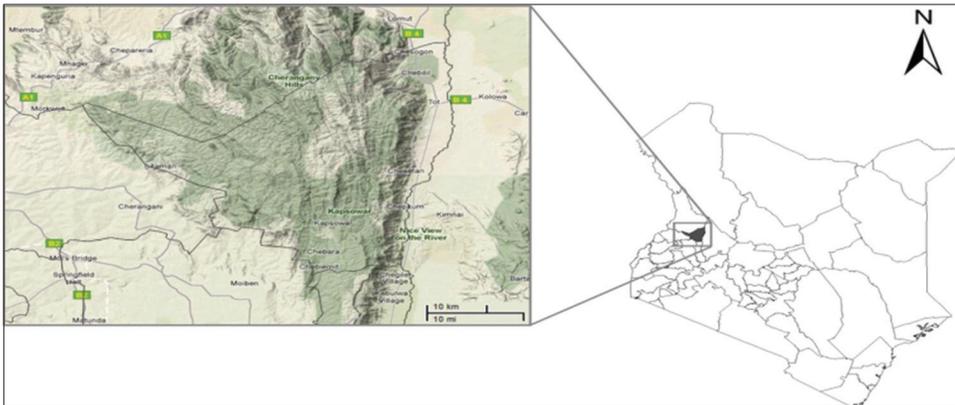


Figure 1: Map of Marakwet district to the left and map of Kenya to the right. © 2012 Google

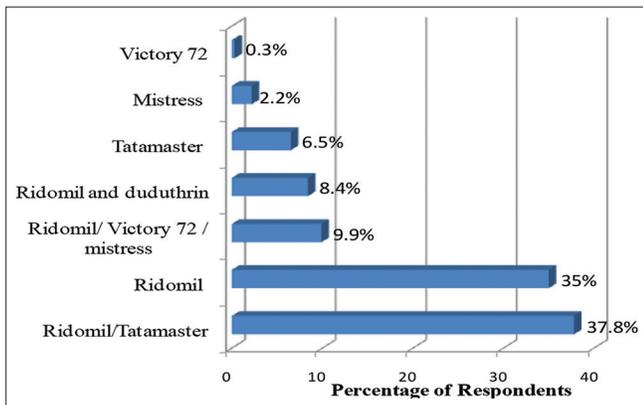


Figure 2: Pesticides used against potato pests and diseases in Chebiemit division

the potential health risks, the precautionary measures taken against exposure were inadequate since in majority of the cases pesticide users did not wear any protective clothing during pesticide spraying.

Pesticides Storage Sites

The study found out that 56.3% of the farmers stored pesticides in a cereal granary or store, 38.7% farmers stored them in the living rooms with 3.1% who stored

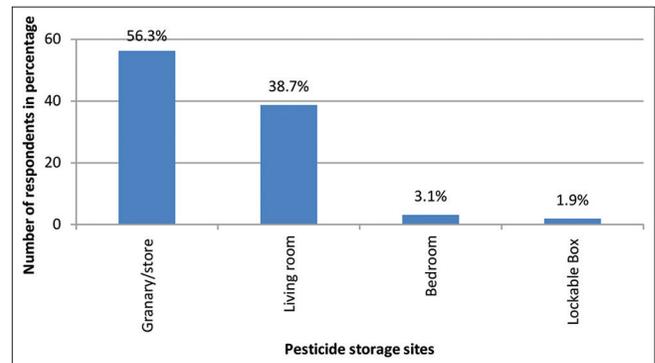


Figure 3: Pesticides storage areas

them in bedrooms, and 1.9% of the farmers stored them in lockable tin or wooden boxes as portrayed by Figure 3. The findings of this study on the pesticide storage sites concurs with that of Cole *et al.* (2002) that found out that farmers poorly stored pesticides with majority storing them in the farmhouse and this increased exposures.

Post-Spraying and Pesticide Disposal Practices

The current study indicated that 62.5% of the farmers only washed their hands and face after spraying in

order to avoid contamination, while 36.2% bathed after spraying. Whenever they suspected cases of serious exposure to pesticides, they applied home grown remedies such as drinking fresh milk, taking pain relievers, or just resting after spraying. They believed that these items would nullify negative health effects of pesticides. All the females who applied pesticides would either wash their hands and face or bath because of their role as home makers since they have to do other chores in the family such as cooking and washing dishes after handling pesticides hence the need to clean up. There was a significant number (26% $n = 51$) of male applicators who did nothing after applying pesticides and this would be attributed to the other roles they have such as looking for fencing materials from the forest after spraying. About 86.0% farmers washed contaminated clothes together with other clothing but only 13% isolated and washed the contaminated clothing separately as shown in Figure 4. The poor personal hygiene practices lead to further exposure to pesticides and especially through dermal absorption and inhalation of chemical fumes.

Disposal of Empty Pesticide Containers and Left Over Chemical

Farmers disposed off empty pesticide containers in various ways. About 35% of them discarded the containers on the farm. Such disposal method may pose some risks to nearby stream, animal food and children health. About 12% of the farmers burnt the empty pesticide containers but it was observed that that they did not follow the recommended way of burning, 47% threw them in a pit latrine, and 6% buried them as depicted by Figure 5. It is advised that disposal be done by burning or burial. Incineration sites should be constructed to have an impermeable floor and a containment sill, or a perforated steel drum be used to suffice for smaller quantities. From the practices of the farmers, it was found out that most farmers did not comply with the safety standards set out by the Safety and Health in Agriculture Convention, 2001 (No. 184). Training had a positive influence on the mode of disposal of empty pesticide containers ($\chi^2 = 70.2$; $P < 0.05$, $df = 3$). The left over mixed chemical is either poured out on the ground, repeated on the sprayed crop till the sprayer is left empty or used on other plants such

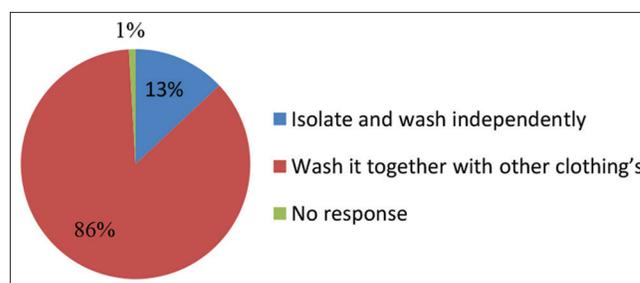


Figure 4: Handling of contaminated clothing

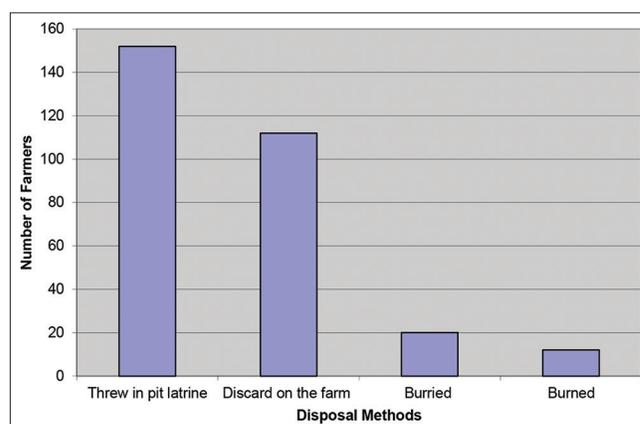


Figure 5: Disposal of empty pesticide containers

Table 1: Usage of pesticides, mixing, and prevention of contact with pesticides

Responses on usage, mixing and prevention of contact	Usage of pesticides	Mixing	Prevention of contact
Yes	292 90.4%	241 74.6%	59 18.3%
No	31 9.6%	82 25.4%	199 61.6%
Sometimes	-	-	65 20.1%
Total	323 100.0	323 100.0	323 100.0

Table 2: Types of protective clothing

Use of protective clothing	Number	%
Wearing gumboots	161	49.8
Ordinary clothing	86	26.6
Overall/gloves/gumboots	25	7.7
Gloves	20	6.2
Others	15	4.6
Eye shield/goggles	5	1.5
Total	323	100.0

as trees on the farm. It was reported that a farmer had used a spraying tank to mix Round-up (broad-spectrum herbicide) but did not clean it before using it with pesticides for controlling blight in his potato crop and he ended up losing his entire crop cover and even some cypress trees that the farmer had sprayed with the remaining pesticides.

Reported Cases of Pesticide Poisoning

From the study, 65% of the farmers sprayed their potato crop at least thrice in every cropping cycle. This finding concurs with Cole *et al.*, (2002) who found out that some potato farmers in countries like Ecuador were involved in spraying more than 7 times in a cropping cycle. He further argued that most farmers continuously sprayed without protection against chemical contamination and subsequent poisoning. The more the number of times one is involved in spraying using pesticides, the greater the chances of exposure. The results indicated that 85.8% had experienced pesticide poisoning during pesticide handling. About 14.9% reported runny nose, 14.9% dizziness, 5.9% skin irritation, 5.0% headache, 1.9% coughing, 0.9% eye irritation, 0.6% chest pain, and 0.3% high fever. Runny nose, skin irritation, throat irritation, and headache accounted for 13.3%, while 3.7% reported a combination of runny nose, skin irritation, and throat irritation. Another group of 3.4% reported runny nose, skin irritation, and coughing. Those who experienced runny nose, dizziness, and throat irritation were 1.2%. Chest pain and throat irritation accounted for 0.6% of the cases. About 7.4% of the farmers reported no symptoms of pesticide poisoning. Although 85.8% of the farmers had experienced pesticide poisoning, only 7.4% of them visited Kimnai and Cheptobot dispensaries for treatment while 92.6% employed other measures such as drinking milk or taking pain relievers. About 20% of them drank one to two glasses of milk after spraying, 6% took pain relievers with 69% continuing with their normal duties with the knowledge that the symptoms would disappear after sometime. The female sprayers took remedial measures after spraying that their male counterparts ($\chi^2 = 7.54, P < 0.05, df = 3$) because of the cultural belief that men are strong and therefore are not supposed to be put down by a headache or any other minor ailment.

CONCLUSION AND RECOMMENDATION

Majority of the farmers were aware of the pesticide safety labels. Education and training had positive influence on the level of awareness on pesticide safety labels. Most farmers rarely practiced safety precautions when handling, mixing, and spraying

pesticides. None of the farmers in the study area wore the recommended personal protective clothing and most of them only washed hands and face after spraying. In addition, most farmers stored pesticides either in the stores together with cereals or in living rooms and they disposed empty pesticide containers in such unsafe ways as discarding them on the farm or throwing in pit latrines. Farmers sprayed their crops at least thrice in every cropping cycle. Most of the farmers who had handled pesticides had experienced pesticide poisoning but only a few visited a health facility but the majority took milk, rested or took pain relievers. The study results indicated that most farmers and their families were highly exposed to pesticide poisoning due to poor pesticide handling measures.

The study recommends that sensitization seminars and workshops by the ministry of agriculture, directorate of occupational safety and health services and other stakeholders should be enhanced to equip the farmers with knowledge and skills that can enable them to handle chemicals well with minimal risks. Training should be done continually to ensure that new potato farmers are duly informed on the safe ways of handling pesticides. In addition, a better policy on inspection programs aimed at increasing the number of PCPB inspectors to allow for extension of regular inspections down to the pesticide users should be formulated. Finally, further research on suitable methods of effective training on pesticide safety measures among small-scale farmers in Kenya should be carried out. Epidemiology/toxicological studies need to be carried out to determine the extent of pesticide exposure among farmers in Kenya.

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