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 fulfil both households' food demands as well as generating income. In order to increase productivity and quality, farmers use pesticides and other agrochemicals. 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. Data was collected through stratified simple sampling where 323 potato farmers were administered with structured questionnaires. The data was 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 ten 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. 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 study show that 58.5% of the pesticide applicators were males, 16.1% were female and children under the 14 were involved in pesticide application. The study further reported that post-spraying safety 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 males ($\chi^2 = 31.5$, $p < 0.05$, $df = 6$). Most farmers stored pesticides either in stores together with cereals or in living rooms. This study also found that 35% of the farmers disposed used 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 found 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 programmes 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, pesticide, safety, potato, Chebiemit

1.0 Introduction

Chebiemit Division, Marakwet West District, Elgeyo Marakwet County, 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, 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; Mbakaya *et al*., 1994; Ohayo-Mitoko *et al*., 1997a). 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.

Figure 1: Map of Chebiemit Division as represented as Moiben / kuserwo © 2013 flickr.com

2.0 Materials and Methods

2.1 Sample Selection

In Chebiemit Division, approximately 2,000 households engaged in potato production at the time of this study (KNBS, 2009). The small-scale farmers produced potatoes in farms ranging from less than 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.

2.2 Data Collection

Primary data collection involved the use of questionnaires, structured interviews and direct field observations. Data on safety labels and pesticide practices and spraying was 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.

2.3 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.

2.4 Data Analysis

The Data was Analysed Using Statistical Package for Social Sciences (SPSS).

3.0 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 did not have training on pesticide safety while 28.5% had training. 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 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 successful in the study area due to the small-scale nature of potato farming in addition to lack of awareness on the existence of this programme. 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.

3.1 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 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 were all aware of the meanings of the pictograms whereas those with primary level education only managed 96% awareness level. All the farmers who reported to have been trained (n = 92) had knowledge on the pesticide labels. A careful understanding of meaning 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.

3.2 Pesticide Handling and Spraying Practices

Potato farming in the study area is characterised 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 had cultivated potatoes for a period of more than years, 4.3% had cultivated them for 7 to 9 years, and 20.4% for a period between 4 and 6 years and 7.1% had done so for between 1 to 3 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 to protect their potato crop from pests and diseases. The study established that a wide range of pesticides (carbamates and organophosphates) were 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.

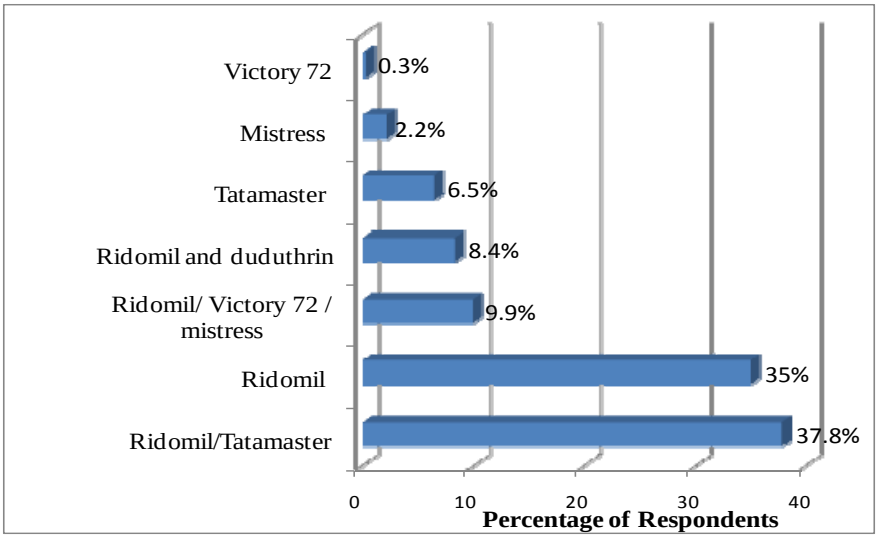

Figure 2: Pesticides used against potato pests and diseases in Chebiemit Division

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 organophosphate (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 reported 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 organophosphate (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).

3.3 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. 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.

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

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 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.

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

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

3.4 Pesticides Storage sites

The study found out that 56.3% of the farmers stored pesticides in a cereal store, 38.7% stored them in the living rooms with 3.1% who stored them in bedrooms, and 1.9% of the farmers stored them in lockable tin or wooden boxes. 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.

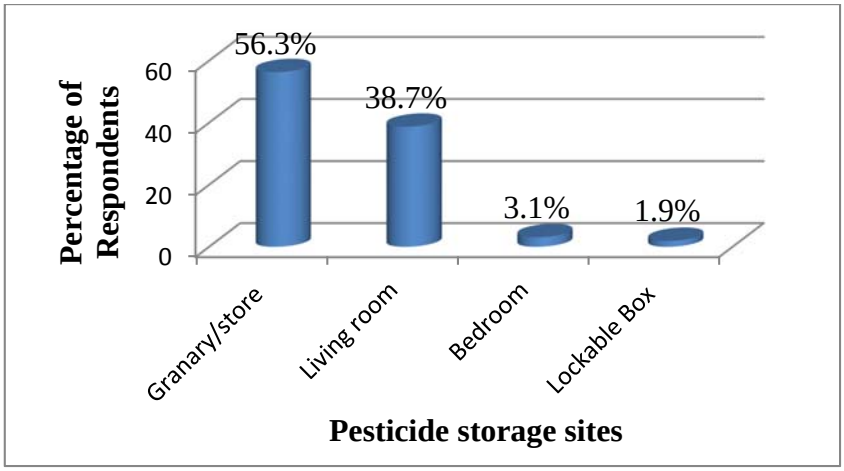

Figure 3: Pesticides storage areas

3.5 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. 86.0% farmers washed contaminated clothes together with other clothing but only 13% isolated and washed the contaminated clothing separately as shown in the Figure 4. The poor personal hygiene practices lead to further exposure to pesticides and especially through dermal absorption and inhalation of chemical fumes.

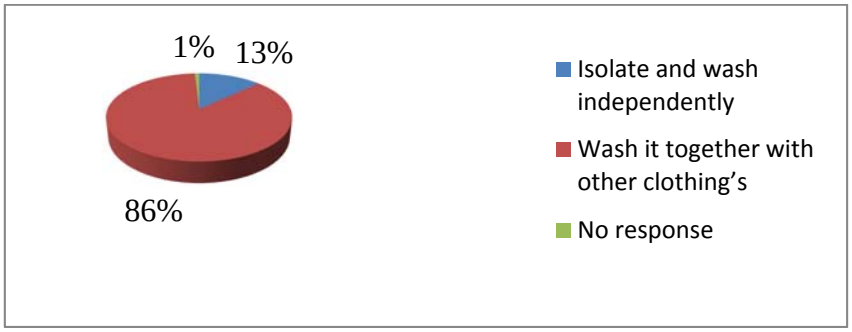

Figure 4 : Handling of contaminated clothing

3.6 Disposal of Empty Pesticide Containers and Left Over Chemical

Farmers disposed off empty pesticide containers in various ways. 35% of them discarded the containers on the farm. Such disposal method may pose some risks to nearby stream, animal food and children health. 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. 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 (χ^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 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.

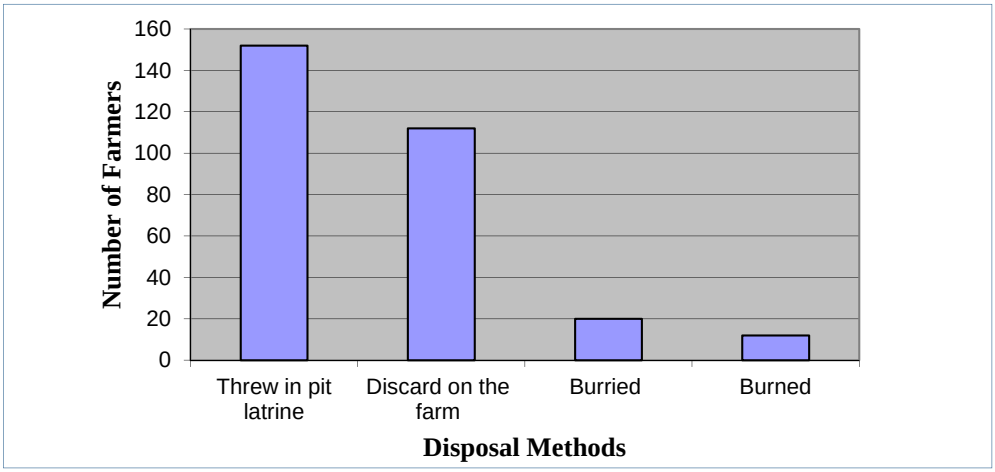

Figure 4: Disposal of empty pesticide containers

3.7 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 seven 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. Out of those who had experienced poisoning, 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. 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. 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. The pesticides used in the study area are mainly carbamates and the symptoms exhibited are usually short - term.

4.0 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. Additionally, 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 (DOSHS) and other stakeholders should be enhanced in order 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. Additionally, 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 in order to determine the extent of pesticide Exposure among farmers in Kenya.

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References

Abdel, A., Mechael, A., Rohlman, M. and Ismail, A. (2008). *Effects of occupational pesticide exposure on children applying pesticides*. Community, Environmental and Occupational Medicine Department, Faculty of Medicine, Menoufia University, Shebin Elkom, Egypt.

Ajayi, C. (2005). User Costs, Biological Capital and the Productivity of Pesticides in Sub-Saharan Africa. *Int. J. Agric. Sust.,* **3 (3)**, pp. 154-166.

Ajayi, C. and Akinnifesi, K. (2007). Farmers' understanding of pesticide safety labels and field spraying practices: a case study of cotton farmers in northern Côte d'Ivoire. *Scientific Research and Essay*. **2 (6)**, pp. 204-210.

Bartlett, E., Kotrlik W. and Higgins, C. (2001). *Organizational Research*: Determining Appropriate Sample Size in Survey Research

Carr, S.J. (1989). *Technology for small-scale farmers in Sub-Saharan Africa: Experience with food crop production in five major ecological zones*. World Bank – Technical Papers, Paper 109, World Bank: Washington, DC.

Cole, C., Sherwood, S., Crissman, C., Barrera, V. and Espinosa, P. (2002). Pesticides Health in Highland Ecuadorian potato production: Assessing Impacts and Developing Responses. *Int. J. Occup. Environ. Health.* **8**, pp. 182–90.

Damalas, A., Georgiou, B. and Theodorou, G. (2006). Pesticide use and safety practices among Greek tobacco farmers: A survey. *Int. J.Environ. Health Res*. **16(5)**, pp. 339 – 348.

Government Printer (1985). *The Pest Control Products Act.* Nairobi: Government Printer, Nairobi Kenya.

Government Printers (2007). *Occupational Safety and Health Act (OSHA),* 2007: Government Printers, Nairobi Kenya.

Hashemi, M., Mokhtarnia, M., Erbaugh, J. And Asadi, A. (2008). Potential of extension workshops to change farmers' knowledge and awareness of IPM. *Sci. Total Environ.,* **407**, pp. 84–88.

Ibitayo, O. (2006). Egyptian Farmers' Attitudes and Behaviours Regarding Agricultural Pesticides: Implications for Pesticide Risk Communication. *Risk Analysis.* **26**, pp. 989–995.

Kamotho, A. (2004). *Pesticide handling, use and disposal- A guide for smallholder farm*ers.

Kenya National Bureau of Statistics (2009). National census

Kimani, N. and Mwanthi, M. (1995). Agrochemical exposure and health implications in Githunguri location – Kenya. *East Africa Medical Journal.* **72 (8)**, pp.531–5.

Lekei, E. and Ngowi, F. (2006). Self-reporting of pesticide exposure and health effects among workers at a coffee estate in Tanzania. *African Newsletter on Occupational Health and Safety,* **16**, pp. 56−58.

Manda, R. (1985). *Pesticide use by the cash crop farmers in Malawi; pesticides management in Eastern and Southern Africa.* Proceedings of a Regional Workshop, Nairobi, Kenya, Mar 10-15.

Mbakaya, C., Ohayo-Mitoko, A., Ngowi, F., Mbabazi, R., Simwa, M., Maeda, N., Stephens, J. and Hakuza, H. (1994). The Status of Pesticide Usage in East Africa. *African Journal of Health Sciences.* **1**, pp.37-41.

Ministry of Agriculture, District Agricultural records, Marakwet west (2010).

Mugenda and Mugenda (1999). *Research Methods; Qualitative and Quantitative Approaches*. ACTS press, Nairobi Kenya.

Muller, U. (2002). Chemical crop protection research: methods and challenges. *Pure Appl. Chem.* **74**, pp. 2241-2246.

Mwanthi, A. and Kimani, N. (1993). "*Agrochemicals: A Potential Health Hazard Among Kenya's Small-Scale Farmers" in G. Forget, T. Goodman, A. de Villiers (eds.), Impact of Pesticide Use on Health in* Developing Countries, International Development Research Centre.

Ngowi, V. (2002). *Health impacts of exposure to pesticides in agriculture in Tanzania*. Helsinki, Finland: Tampere University Press

Norman, O., Frederick, M. and Mark, M. (2005). *Toxicity of pesticides*. University of Florida.

Ohayo-Mitoko, A., Heederik, J., Kromhout, H., Omondi, O. and Boleij, M. (1997a). Acetylcholinesterase inhibition as an indicator of organophosphorus and carbamate poisoning in Kenyan Agricultural Workers. *Int. J. Occup. Environ. Health,* **3**, pp. 210-220

Oluwole, O. and Cheke, R (2009). Health and environmental impacts of pesticide use practices: a case study of farmers in Ekiti State, Nigeria. *International Journal of Agricultural Sustainability* **7(3)**, pp. 153-163

PCPB (2004). *Pest Control Products Board*, July, 2003 – June, 2004 Annual Report.

ILO guide (1991). Safety and health in the use of agrochemicals

Wesseling, C., Castillo, L. and Elinder, G. (1993). Pesticides poisoning in Costa Rica. *Intern J Health Services*; **19**, pp. 227–35.

WHO (ILO/UNEP) (1994). *The WHO recommended classification of pesticides by hazard and guidelines to classification 1994-1995*. WHO, Geneva, 1994.