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EDUCATION, TRAINING AND AWARENESS OF LAWS AS DETERMINANTS OF COMPLIANCE WITH PLANT PROTECTION LAW: THE CASE OF PESTICIDE USE PRACTICES IN TANZANIA

Mwatawala MW*[1] and GE Yeyeye[2]

Maulid Mwatawala

Gervas Yeyeye

*Corresponding author email: mwatawala@yahoo.com

[1]Department of Crop Science and Production, Sokoine University of Agriculture, Box 3005, Chuo Kikuu, Morogoro, Tanzania

[2]Faculty of Law, Open University of Tanzania, Box 23049, Dar Es Salaam, Tanzania

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ABSTRACT

Pesticide residues in food and environment pose serious health risks to human beings. Plant protection laws, among other things, regulate misuse of agricultural pesticides. Compliance with such laws consequently reduces risks of pesticide residues in food and the environment. Studies were conducted to assess the compliance with plant protection laws among tomato farmers in Mvomero District, Morogoro Region, Tanzania. Compliance was assessed by examining pesticide use practices that are regulated by the Tanzanian Plant Protection Act (PPA) of 1997. A total of 91 tomato farmers were interviewed using a structured questionnaire. Purposive sampling was used in selecting at least 30 respondent farmers from each of the three villages of Msufini, Mlali and Doma in Mvomero District, Morogoro Region. Simple Random Sampling was used to obtain respondents from the sampling frame. Individual and social factors were examined on how they could affect pesticide use practices regulated by the law. Descriptive statistics, mainly frequency, were used to analyze the data while associations between variables were determined using Chi-Square and logistic regression model. The results showed that respondents were generally aware of the existence of laws on agriculture, environment and consumer health, although none of them could name a specific Act. The results revealed further that 94.5% of the farmers read instructions on the pesticides label. However, only 21% used the correct doses of pesticides, 40.7% stored pesticides in special stores, 68.1% used protective gear, while 94.5% always read instructions on the label before using a pesticide product. Training influenced the application rate of pesticide ($p < 0.001$) while awareness of agricultural laws significantly influenced farmers' tendency to read information on the labels ($p < 0.001$). The results showed further that education significantly influenced the use of protective gears by farmers ($p = 0.042$). Education also significantly affected the manner in which farmers stored pesticide-applying equipment ($p = 0.024$). Furthermore, farmers' awareness of environmental laws significantly ($p = 0.03$) affected farmers' disposal of empty pesticide containers. Results of this study suggest the need for express provisions on safe use and handling of pesticides and related offences in the Act, and that compliance should be achieved through education rather than coercion. Results also suggest establishment of pesticide disposal mechanisms and structures to reduce unsafe disposal of pesticide containers. It is recommended that farmers should be educated and trained on proper use of pesticides. Farmers' awareness on laws affecting food, environment and agriculture should be improved.

Key words: compliance, plant protection, pesticides, law, awareness, agriculture, environment, health, Tanzania

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INTRODUCTION

Pests are among the main limiting factors to agricultural production, causing variable losses under different settings. Majority of farmers in Tanzania use pesticides to control pests. The farmers choose a pesticide based on effectiveness, cost and availability [1]. Farmers' heavy reliance on pesticides results from growing crop varieties which are highly susceptible to insect attacks, increased pest incidences, lack of advice on alternative pest control methods, availability of subsidies on pesticides and poor attention to the economics of pest control [2]. Overuse of pesticides in agriculture has resulted in environmental, financial, and socio-economic problems [3-6].

Both international and national laws regulate trade and use of pesticides [7]. The Plant Protection Act of 1997 (hereinafter referred to as the PPA) is the main law regulating pesticides use in Tanzania. The status of the implementation of the PPA is not well known. However, non-compliance to the PPA [2, 6, 8, 9] is evidenced by various cases of pesticides misuse [5, 6, 8]. The main causes of pesticide misuse include non-existent or poorly enforced pesticide laws and regulations, poor participation of chemical companies in educating users, inadequate labeling and documentation of the correct use of pesticides, having few trained technicians or supervisors for pesticide use, lack of appropriate application equipment, illegal pesticide marketing channels, government's failure to enforce laws on pesticides, lack of awareness of the dangers of chemicals and low literacy rate among users [10]. Laws and regulations play a key role in preventing misuse of pesticides. The United Nation's Food and Agriculture Organization (FAO) issued guidelines for designing national pesticides legislation [11]. Often there are gaps between policy objectives and what is achieved by the corresponding legislation. The levels of enforcement and compliance can be used to assess the effectiveness of legislation in meeting policy objectives. Generally, high level of compliance is a function of effective enforcement of the law [12]. In Tanzania, compliance with environmental laws was affected by a weak enforcement system including low probability of reporting and prosecuting offenders [13]. However, level of compliance with a given law is not necessarily a function of effective enforcement [13]: for example, compliance can be highly influenced by socio-economic factors [14-18]. Accordingly, the influence of socio-economic factors on awareness and compliance with the PPA has not been determined. It is not known, for example, how farmers' general awareness of the laws, professional training, background education and gender could affect compliance with the PPA. The objective of this study, therefore, was to assess farmers' compliance to the PPA through examining practices that are being regulated by the Act and its regulations, including: (i) reading and following instructions provided on the pesticide label, (ii) wearing of protective gears when handling pesticides, (iii) proper storage of pesticides, (iv) safe disposal of empty pesticide containers, and (v) application of pesticides at the rate indicated on the labels.

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MATERIALS AND METHODS

Surveys were conducted in three villages of Mvomero District, Morogoro Region, Tanzania. Mvomero is one of the 6 districts of the Morogoro Region of Tanzania. The District is administratively divided into 17 wards. Three villages of Msufini (Mvomero ward), Mlali (Mlali ward) and Doma (Doma ward) were selected for the surveys.

Purposive sampling [19] was used to select respondents. The sample frame was a list of smallholder tomato producers from three villages. Simple random sampling was used to obtain respondents from the sampling frame. The sample size was 91 tomato farmers, both males and females with various levels of education.

A structured questionnaire was used to collect primary data. The questionnaire had both open and closed-ended questions and was used to collect both qualitative and quantitative data. A researcher's diary verified some information given during interviews. Secondary data were collected from the existing literature, including books, journals and reports mainly from Sokoine National Agricultural Library (SNAL). Data were analysed by SPSS software version 16.0. Results were reported using descriptive statistics. Differences between sample proportions were determined using one sample z-test while associations among variables were determined by Chi-Square and logistic regression model.

RESULTS

Socio-economic descriptors

A total of 91 tomato farmers (respondents), at least 30 from each of the three villages were interviewed. Males (n = 79), aged between 26 and 35 years dominated the sample. Only 32.2% of the respondents had attained post-secondary education (Table 1).

The results showed that respondents were generally aware of the existence of certain laws, although none of them could name specific legislation. Only 30.8% of the respondents were aware of the existence of laws on consumer health; 45.1% were aware of the existence of laws on environmental protection; and 31.9% were aware of the existence of laws regulating agriculture. However, none of the 91 respondents were aware of the PPA.

Compliance with pesticide use practices that are regulated by law

Compliance with the law was assessed by examining practices of pesticides use that are regulated by the law, including reading and following instructions on pesticide label, using a correct dose of a pesticide, using protective gears and storage and disposal of pesticide products.

The surveys revealed a number of pesticide products that were used for controlling pests in tomato. However, insecticides which were used such as amerat, attakan, selecron, profecron and dursban, were not registered for controlling pests in tomato.

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Surveys also revealed that 94.5% (95% CI = 0.898 – 0.991) of the respondents always read instructions on the label before using a pesticide product, while 15.5% (95% CI = 0.0082 – 0.0101) of the respondents did not read the instructions (z = 12, p <= 0). Farmers always checked for expiry date (53.8%), application rate (26.4%), safety precautions (6.6%), target crops (2.2) %, registration number (2.2%), and general information such as manufacturer's name, commercial name of the pesticide product and disposal of pesticide containers (5.5).

Of all respondents, only 21% (95% CI = 0.1076 – 0.2724) used the correct dose of pesticides while the rest (95% CI = 0.582 – 0.778) did not (z = 6.5, p <0.0001). Other respondents used either lower (12.6%) or higher (65.5%) than the recommended dose of pesticides.

Furthermore, 68.1% of farmers (95%CI = 0.5863 – 0.7777) always used protective gear while 30.8% (CI = 0.2131 – 0.4029) did not (z = 5, p < 0.0001). Farmers usually wore gumboots (58.2%) masks (58.2%), gloves (39.6%), overalls (27.5%), and/or eye goggles (8.8%).

The surveys revealed six places used by respondents to store pesticides that included special agro-input stores (40.7%), in the field (22%), in the bedroom (19.8%), in the food store (15.4%), and in the kitchen (1.1). The rest (1.1%) did not store pesticides.

The results showed further that 98% of the respondents (95%CI = 0.9512 – 1.0088) disposed of pesticide containers after use; while only 1.1% (95%CI = 0.457 – 0.1743) re-used the containers (z =11.8, p = 0). Farmers disposed of pesticide containers by burying (45.1%), burning (25.3%), burning then burying (9.9%), throwing in a pit latrine (14.3%) and leaving containers in the field (5.5%).

Individual and social factors affecting pesticide use practices regulated by law

The present study examined the influence of individual and social factors (age, sex, education, training and awareness of laws) on pesticide use practices regulated by law, including; application rate, reading information on pesticides label, the use of protective gear, storage and disposal of empty pesticides containers. In each assessment, predictors that did not contribute significantly to the model were dropped. The results indicated that sex, education, training and awareness of laws significantly affected different practices of pesticide use by the farmer, while age did not have any influence on the pesticide use practice.

Awareness of agricultural laws had a significant influence on the farmers' tendency to read information on pesticide labels (X^2 = 106.99, df = 2, p < 0.001). The respondents were 36 times more likely to read information on pesticide label if they were aware of agricultural laws (Table 2).

Training was significantly associated with the dose of pesticides used by farmers (X^2 = 15.866, df = 2, p < 0.001). Farmers who were trained on pesticide use were more likely to use the recommended dose of pesticides. However, sex, education, and awareness of

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environmental and agricultural laws had no significant effect on the dose of pesticides used by farmers.

The proportions of individuals who used different types of protective gear are shown in Table 3. The influence of both education (X^2 = 4.141, df = 1, p= 0.042) and awareness of agricultural laws (X^2 = 6.203, df =1, p = 0.013) on the use of protective gear by farmers was significant. The odds of using protective gear increased with an increase in education level and awareness of environmental laws. The respondents were two times more likely to use protective gear if they advanced from primary to post-primary education (Table 4).

Education level and sex had significant effects on how farmers stored pesticide applying equipment at (X^2 = 12.91, df = 5, p < 0.024) and (X^2 = 11.193, df = 5, p < 0.048), respectively. However, awareness of laws and training did not have significant effect on how farmers stored pesticide application equipment.

Finally, awareness of environmental laws significantly affected the method used by respondents to dispose of empty pesticide containers (X^2 = 19.903, df = 6 p= 0.03). The respondents were 3.4 times more likely to dispose of empty pesticide containers by burying than by throwing them in a pit latrine, if they knew environmental laws. Similarly, the respondents were 2 times more likely to change from disposing empty pesticide containers in a pit latrine to disposing them by burning, if they were aware of environmental laws (Table 5).

General compliance with the law

The respondents reported to have complied with the law due to a sense of obedience (62%), fear of the fines (14%), understanding the consequences of misuse (7%), fear of imprisonment (2%) and incentives (1%).

DISCUSSION

This study revealed many pesticide use practices that are in contrast with the PPA, which include applying products which had not been registered for the crop (tomato) and non-use of protective gear, thus confirming previous reported findings [8, 21]. Section 34 of PPA regulations requires pesticide applicators to use protective gear. Non-use of protective gear during application of pesticides exposes farmers to health problems [2, 22].

The law also governs storage and disposal of empty containers. Section 37 (1) of the PPA Regulations states that unwanted pesticides and empty pesticides containers shall be disposed of after authorization has been given by the National Plant Protection Advisory Committee (NPPAC), which will recommend the methods of disposal. In this respect, however, there were no mechanisms of seeking authorization to dispose of pesticides. Storage of pesticides in undesignated stores is contrary to the PPA. Pesticides are to be kept in marked, locked, and regularly inspected stores (Section 34,

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3-6 of the PPA regulations). Pesticides are not supposed to come in contact with unintended objects including foodstuffs. Thus, pesticides should not be stored in bedrooms and kitchens.

Applying pesticides at non-recommended dose violates the law. The PPA does not explicitly require users to follow recommended application rates of pesticides. However, it is implied in Section 27(1) of the PPA, that protection substances shall be used in accordance with good professional practice. Only 21% of the respondents in the present study used the correct dose. The cumulative amount of pesticides used in a season also depended on the frequency of application, apart from the dose. For example, frequent application and mixing of several pesticides in a tank resulted in high-level use of pesticide in Arusha, Tanzania [5].

Education, training and awareness of laws positively influenced pesticide use practices among farmers. In Iran, farmers with post-primary education were more likely to use pesticides properly than illiterate farmers [23]. Extension and education courses influenced attitude towards pesticide-specific issues [23]. Lack of training was one of the causes of misuse of pesticides by farmers, as it was the case in Pemba, Tanzania [2]. Results of the present study confirmed these previous reports [2, 3].

The relationship between age of the farmer and pesticide misuse is still controversial. The present study found no relationship between age and misuse of pesticides. Baral *et al.* [17] reported high pesticide misuse among old age farmers who owned large farms in India while in Ghana younger farmers sprayed more pesticides than older farmers [24].

The present study showed that lack of education was the main factor for general non-compliance with the law. There was a strong association between awareness and compliance with natural resource management by-laws in Uganda [25]. In that case, compliance with by-laws was high among more educated adults who had access to credit organizations [25].

CONCLUSION

This study showed that large a proportion of individuals does not comply with plant protection laws, specifically the PPA, as exemplified by pesticide use practices that are contrary to the law. Such practices have negative health and environmental consequences. The study also showed that awareness of the laws, education, and training influenced pesticide use practices, and hence compliance with the PPA. In this respect, farmers should be trained on pesticides use. They should also be educated on various laws governing the use of pesticides. Greater awareness about Integrated Pest Management (IPM) technologies as well as awareness about technological failures of chemical pesticides may also reduce the level of pesticide misuse.

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Table 1: Social background of respondents

Socio economic parameter	Response	Frequency (n)	Percent (%)
Gender	Male	79	86.8
	Female	12	13.1
Age	15-25	13	14.3
	26-35	30	33
	36-45	27	29.7
	46-55	12	13.2
	56 and above	9	9.9
Education	Primary education	75	82.4
	Secondary education (Ordinary level)	12	13.2
	Secondary education (Advanced level)	1	1.1
	College education	3	3.3
Training on pesticides use	Yes	9	9.9
	No	81	91.1

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Table 2: Factors influencing the tendency of reading information on pesticide label

Reading information[a]	Value	Co-efficient	SE	Wald	df	P value	Exp (B)	95% CI for Exp (B)
Read information on pesticide label	Awareness of agricultural laws	3.584	1.014	12.495	1	0.000	36.000	4.936 – 262.57

Overall fitness of the models (X^2 = 106.999, df = 2, p < 0.0001) with Cox and Snell R^2 of 69.1%

a. The reference category is: Do not read information on the label (Redundant parameters excluded from the table)

Table 3: Use of protective gear by farmers

Protective gear	Users		Non users		z-value	p-value
	%	95% CI	%	95% CI		
Goggles	8.8	0.8132-0.9468	91.2	0.8538 – 0.9702	0.7	0.4795
Gloves	39.6	0.2955-0.4965	60.4	0.5035-0.7045	2	0.005*
Mask	58.2	0.4807-0.6833	41.8	0.3167-0.5193	2.2	0.0269*
Overall	27.5	0.1833-0.3667	72.5	0.6333-0.8167	6.1	<0.0001*

*Sample proportions are statistically different

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Table 4: Factors influencing the use of personal protective gear

Using personal protective gear [b]	Value	Co-efficient	SE	Wald	df	P value	Exp (B)	95% CI for Exp (B)
Use protective gear	Post primary education	0.693	0.297	5.445	1	0.02	2.00	1.117 - 3.58
	Awareness of environmental laws	1.705	0.796	4.586	1	0.032	5.50	1.155 - 26.179

Overall fitness of the model (X^2=47.460, df = 3 p < 0.001); Cox and Snell R^2 of 40.6%

b. The reference category is: Not using protective gear (Redundant parameters excluded from the table)

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Table 5: Factors influencing the method of disposal of pesticide containers

Disposal method[c]	Value	Co-efficient	SE	Wald	df	P value	Exp (B)	95% CI for Exp (B)
By burying	Awareness of environmental laws	1.224	.509	5.786	1	0.016	3.400	1.254 – 9.216
By burning	Awareness of environmental laws	.693	.548	1.602	1	0.206	2.000	.684 – 5.851
Other	Awareness of environmental laws	.336	.586	.330	1	0.566	1.400	0.444 – 4.411

The overall fitness of the models (X2= 19.903, df = 6, p = 0.03); Cox and Snell R^2 of 20%

c. The reference category is: to throw in the pit toilet (Redundant parameters excluded from the table)

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