

Farmer's Knowledge and Practices on Proper use of Pesticides on Tomato Production to Ensure Safety among Consumers: a Case Study of Mvomero District, Morogoro

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Abstract

Farmer's knowledge and practices on proper use of pesticides in vegetables production is very crucial for increasing productivity while reducing the associated health risks. However, knowledge and practices on the use of pesticides in tomatoes production is limited. Therefore, this study aimed at assessing knowledge and practices on proper use of pesticides in tomatoes production for appropriate interventions. A cross sectional study was done at Doma and Mlali wards in Mvomero district among 120 randomly selected tomato farmers who were face to face interviewed using a questionnaire. Descriptive and inferential statistics were done using SPSSTM version 20. Results showed that 100% of farmers used pesticides to control tomato pests and diseases of which 54% preferred Snow tiger (Chlorofenapyr) and Dudumetrin (Sumithrin). About 85% reported to be reading pesticide instructions before applying but 45.8% among them did not adhere to the instructions claiming the recommended dosage to be inefficient. About 57% harvest tomatoes after seven days while others harvest at any time when they get customers. Ninety two percent of the farmers know the effects of improper use of pesticides on health however; among them 20% are not sure of the specific health effects. Knowledge on health effects of improper use of pesticide was significantly associated with reading instructional labels (AOR 2.99, 95% CI: 1.06-3.95) after adjusting for education levels and attending trainings on pesticides use. Generally, there is low knowledge on proper use of pesticides in tomatoes production and their associated health effects which creates a need for educating farmers and the public on proper use of pesticides to safeguard the health of consumers.

Keywords: Farmers, Knowledge, Practices, Pesticides Use, Mvomero

Introduction

Agriculture is the major contributor of the food industries worldwide. Likewise, the economy of Tanzania is mostly depending on Agriculture which accounts for 26% of the gross domestic product (GDP) and about two third of the total export (Ministry of Agriculture Food Security and Cooperative, 2012; de Putter *et al.*, 2007). Tomato is one of the most cultivated crops which contributes to about 63% of the total annual produce of fruits and vegetables in Tanzania (Ministry of Agriculture Food Security and Cooperative [MAFSC], 2012; de Putter *et al.*, 2007). According to Mushobozi (2010) and Match-Maker-Associates-Limited [MMA] (2008) among the regions cultivating tomatoes,

Morogoro has the largest area of about 2,442 ha (covering 9.2% of its land), followed by Kagera (2386 ha, covering 9%), Tanga (2,326 ha covering 8.7%), Mwanza (2,235 ha covering 8.4%) and Iringa (2,223 ha that covers 8.4%) of their total regional land. Although tomatoes are mostly produced in Morogoro, they are highly attacked by pests and diseases making the use of pesticides to be the most common practice in tomatoes production. Hence, only 25% of the total agricultural land is cultivated organically worldwide while the rest uses pesticides during production to increase productivity Sabran, *et al.*, (2021).

Pesticides are chemicals used to control or eliminate pests including insects, weeds, fungi

and rodents. Currently they play a vital role in agriculture by protecting crops from pests and diseases to improve yields and ensuring food security. Farmers use different pesticides to manage various pests that can damage crops and reduce productivity (Hossain *et al.*, 2013). The type and quantity of pesticides used vary depending on the type of crop, intensity of crop damage, availability in the market, efficacy of pesticide, farming practices and local pest pressures.

Like other regions, farmers in Morogoro are using different types of pesticides to secure tomatoes from pest and diseases attack without considering the health and environmental impacts (Mdegela *et al.*, 2013; Ngowi *et al.*, 2007). The level of pesticides residues of the end products depends on the way a farmer apply pesticides, method of spraying, materials used during spraying, the spraying period, the spraying parameters of such doses, pre-harvest-period and spraying techniques used which are viewed as anthropological factors causing health effects to human (Matthews and Baleguel, 2003; Rijal *et al.* 2018; Sonchieu *et al.*, 2019).

For example, improper application of pesticides on crops may contribute to accumulation of residues in food materials (Vumilia *et al.*, 2019). Al-Waili *et al.*, (2012) reported that the consumption of pesticides contaminated foods may result into serious exposure to chemicals that may results into health problems. Furthermore, the farmer's knowledge and practices on the application of pesticides are known to significantly impact the effectiveness of pest management and the overall safety of the produce (Seyyed & Christos 2010). Having information on the knowledge and practices related to the application of pesticides can help to understand whether intervention is required. Therefore, this study aims to assess farmer's knowledge and practices on the use of pesticides in tomatoes production in Mvomero district, Morogoro region for appropriate interventions to be designed.

Materials and Methods

Study area, design and the population

A cross sectional study with quantitative approach was carried out in Mvomero district,

Morogoro region particularly in Doma and Mlali wards (Fig. 1). Morogoro region was chosen because it has 6,519 ha (19% of its land), which is largely dedicated to tomato cultivation (MMA, 2008; Mushobozi, 2010). The two wards were selected purposively due to high production of tomatoes compared to other wards. For example, a study conducted among the high tomato producing wards in Mvomero including Doma, Mlali and Dakawa shown that 60.60% of tomatoes were produced in Doma, followed by 48.50% in Mlali and 47.10 % in Dakawa (Ombaeli, 2022). Hence, the first two wards with the highest yields were selected for the study.

This quantitative approach was conducted to gather information on farmer's practices and knowledge on pesticides usage. This survey included both male and female farmers who have been involved in tomatoes production for more than one year and agreed to participate. The farmers who participated in the study were also selected based on their ability to produce for both household consumption and selling. Those who did not meet the stated criteria were excluded.

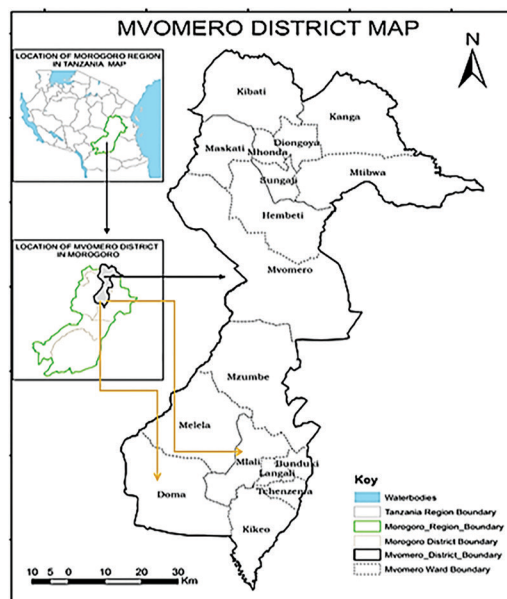


Figure 1: Location of Doma and Mlali Wards in Mvomero District Map (Ombaeli, 2022)

Sampling techniques and sample size determination

The study sites were chosen using a multi-stage sampling method (Levy & Lemeshow, 2013). First, Mvomero district was selected specifically due to high vegetable production in Morogoro region. Second, two wards were chosen based on their ability to produce tomatoes. Thirdly, farmers to participate in this study were purposively selected based on their ability to produce tomatoes for both household consumption and selling. Thereafter, random selection was applied with the help of Agricultural Extension Officers to obtain farmers who are the most producers of tomatoes. A total of 120 tomato farmers were obtained to participate in this survey. This sample size was obtained using the formula for prevalence studies (Daniel, 1999):

$$n = \frac{z^2 * p * q}{d^2}$$

Where: n = desired sample size

Z = standard normal deviation set at 1.96 corresponding to 95% Confidence Interval [CI]

p = Prevalence of certain disease (upper respiratory infections) among women in horticultural regions of Tanzania that could be related to pesticide exposure reported to be 10.52% in Morogoro region as presented in Health Information Management System (HIMS) for OPD patients in 2015 and reported by Mrema *et al.* (2017).

$q = 1.0 - p$

d = degree of accuracy desired (0.05)

The formula gives a total of 144 farmers but those who met the selection criteria were 120 farmers who were then involved in the study.

Data collection and statistical analysis

The survey was conducted from August to September 2022 whereby a training of enumerators was done for 3 days. The questionnaire was written in English and translated to Kiswahili for clarity and consistent among enumerators during data collection. After the three days training, all the enumerators were involved in piloting of the tools before administration. This was followed by a debriefing session to make necessary adjustments for

improvements. The questionnaire was administered through face-to-face interviews which covered information on demographic characteristics, practices and knowledge on pesticide use in the cultivation of tomatoes as well as their effects on human health. The collected data was coded, entered and cleaned before being analyzed using the SPSS™ version 20 computer program. Descriptive statistics were done to obtain means, frequencies and percentages of the responses. Further analysis was done for inferential statistics to establish the association between knowledge on health effects of the pesticides with demographic factors whereby knowledge was treated as dependent while demographic variables such as education were treated as independent variables. In this case, multiple logistic regression analysis was done using stepwise backward conditional to obtain odd ratios. Statistical inference was made at 95% confidence intervals (CIs) and significance at p -value<0.05 (Wynants *et al.*, 2017).

Ethical considerations

The study was approved and conducted in accordance with Sokoine University of Agriculture guidelines. The permission to conduct the study was offered by the Morogoro local government authorities. Participation in the study was voluntary and farmers were recruited after providing their consent.

Results

Farmer's demographic information

Table 1 shows the demographic characteristics of respondents which indicate that majority of them were males (75%) with primary level of education (73.3%). Most of the respondents have been producing tomatoes from 1-10 years (73.3%).

Common practices on the use of pesticides among farmers

The results show that, all farmers (100%) control weeds in their tomato farms. The most used methods in controlling weeds were reported to be digging with hand hoes (87.5%) with a very small number using sprays, uprooting and slashing. All tomato producers (100%) use

Table 1: Demographic information of participants (n=120)

Variables	Frequency	Percent %
Sex		
Male	90	75
Female	30	25
Education level		
Never attended school/no formal education	5	4.2
Not completed primary school	10	8.3
Completed primary school education	88	73.3
Not completed secondary school education	4	3.3
Completed secondary school and college education	13	10.8
Experience on tomatoes cultivation		
< 10 years	88	73.3
>10years	32	26.7

pesticides to control pests and diseases in their farms. Famers’ practice on pesticides use shows that majority of them use pesticides throughout the tomatoes production chain and the mostly used are Hexaconazole/Chlorofenapyr and Sumithrin 0.4 (54.1%). The frequency of applying pesticides shown that 85.9% of the farmers applies them after every one week. More than half of the farmers (57.5%) apply more pesticides during the rainy seasons. Also, significant majority of farmers mix different pesticides before applying on tomatoes during production to increase efficiency (Table 2).

Knowledge on the use of pesticides

Table 3 summarizes famers’ knowledge on pesticides use where by 85% of farmers read instructions on the label before application. Most of farmers (56.7%) wait for seven days before harvesting tomatoes after the application of pesticides regardless of the types of pesticides used and the treated conditions. Although few farmers participated in pesticides training, majority of them knows that improper use of pesticides is associated with health effects however, 20% are not sure of the specific health effects while 27.5% mentioned the effects to be stomach ache.

Ensuring safety of consumers and farmers sources of information on the proper use of pesticides

About Sixty three percent of the farmers were leaving tomatoes on the farm for some days without harvesting after application of pesticides as a way of ensuring consumers safety while 35% do nothing to ensure safety. Among those who were ensuring safety of the consumers, 49.2% declared to have obtained the information from the agricultural officers. Additionally, 61.9% of the farmers reported that trainings/education on good manufacturing practices including the proper use of pesticides were offered by Agricultural Officers although not frequently. Furthermore, 62% of the farmers were getting information on mixing different pesticides together from their colleagues and agro vet shops (Table 4).

Factors associated with knowledge on health effects of pesticide residues

The selected factors were analyzed using multiple logistic regression analysis with a stepwise backward selection to find out their association with knowledge on health effects of pesticides. A significant association was found with the tendency of reading instructional labels on the pesticide pack (AOR 2.99, 95% CI: 1.06-3.95) even after adjusting for education levels,

Table 2: Farmers practices on the use of pesticides

Variables	Frequency	Percent
Control weed at your farm (N=120)		
Yes	120	100
No	0	0.0
Method used to control weed (N=120)		
Digging	105	87.5
Spraying	5	4.2
Uprooting	10	8.4
Use of pesticides to control pest and diseases during production		
Yes	120	100
Common pesticides used (N=120)		
Sumithrin 0.4%	8	6.7
Propineb 700g/kg and Metalaxyl 60g/kg	1	0.8
Mancozeb 640g/kg and Cymoxanil 80g/kg	11	9.2
Chlorofenapyr and Sumithrin 0.4%	65	54.1
Mancozeb and celecron	6	5.0
Mancozeb 640g/kg and metalaxyl 80g/kg	6	5.0
Frequency of applying pesticides		
After one week	103	85.9
More than 5 times in a month	17	14.2
Season of the year applying more pesticides		
Rainy season	69	57.5
Dry season	44	36.7
Throughout the year	7	5.8
Mix different pesticides during application (N=120)	2	1.7
Yes	97	80.8
No	23	19.2
Reasons for mixing pesticides		
Make it effective	52	43.3
Reduce application costs	37	30.8
Not sure	6	5.0
Reduce application costs and make it effective	4	3.4

Table 3: Farmer’s knowledge on the use of pesticides

Variables	Frequency	Percent
Reading instructions before applying pesticides		
Yes	102	85.0
No	18	15.0
Follow the instructions (N=102)		
All the time	55	45.8
Sometimes	47	39.2
Never	4	3.3
Days stayed after application before harvesting		
<5 days	17	14.2
5-6 days	4	3.3
7 days	68	56.7
7-13 days	17	14.2
14 days	7	5.8
>14 days	2	1.7
Do not wait	5	4.2
Attended training on the use of pesticides (n=120)		
yes	41	34.2
No	79	65.8
Do you know health effects of misusing pesticides?		
Yes	110	91.7
No	10	8.3
Mentioned health effects		
Diarrhea	7	5.8
Stomach ache	33	27.5
Heart diseases	1	0.8
Breathing problems	14	11.7
Cancer	16	13.3
Skin disease	17	14.2
Not sure	24	20.0

number of years engaged in producing tomatoes and attending trainings on the proper use of pesticides (Table 5).

Discussion

The current study aimed to explore farmer’s knowledge and practices on the use of pesticides

Table 4: Ensuring safety of consumers and farmers sources of information on the use of pesticides

Variables	Frequency	Percent
How do you ensure safety of the consumers?		
Leave tomatoes for some days without harvesting after application of pesticides	76	63.3
Wash the tomatoes before taken to the market	2	1.7
Do nothing to ensure safety	42	35.0
Where do you get information on when to harvest tomatoes after application of pesticides		
Leaflets	1	0.8
Agricultural officers	59	49.2
Colleagues	21	17.5
Pesticides instructions/leaflets	30	25
Agro vet shops when purchasing the pesticides	10	8.3
Where do you get information on mixing the pesticides		
Fellow farmers	62	62.0
Agro vet shops	26	26.0
Agricultural offers	12	12.0
Who is normally offering trainings/education on good farming practices including proper use of pesticides		
NGO	9	21.4
Agricultural officers	26	61.9
College/Seminar/workshop/Agriculture officers/researchers	7	16.6

Table 5: Odd ratios for factors associated with knowledge on health effects of pesticide residues

Variables	COR	95% CI	P-value	AOR	95% CI	P-value
Reading instruction on labels						
No	Reference					
Yes	4.57	1.15-12.24	0.031*	2.99	1.06-3.95	0.04*
Education level						
Not attended or completed primary						
Completed primary	0.252	0.054-1.18	0.080		NA	
Completed secondary/college	0.788	0.111-5.60	0.812			
Number of years planted tomatoes	1.012	0.94-1.09	0.76			
Attended training						
No	Reference					
Yes	1.19	1.02-3.57	0.013*	0.22	0.03-1.83	1.16

Note: *Significance at $p < 0.05$, COR=Crude Odd Ratio, AOR=Adjusted Odd Ratio, CI= Confidence Interval.

in tomatoes production and their health effects in Mvomero district, Morogoro region for appropriate interventions to be designed to reduce their effects on health. The majority of respondents were males with primary-level of education. This implies that the production of tomatoes is mostly dominated by males rather than females which may be attributed by tomatoes been used as a cash crop in the area. Another study was done among vegetable farmers and supported these findings that the role of women in vegetables production was supportive in nature while men performed all the dominative roles (Olowa, *et al.*, 2015). Another similar study which was conducted in Cameroon reported that there is more involvement of males in vegetable farming activities (Jean *et al.*, 2019).

It was also found that majority of farmers had primary level of education which implies poor handling practices of pesticides use during tomatoes production however, inferential statistics shown that education level have no influence on knowledge and proper practices on the use of pesticides. This information is also supported by Kiwango *et al.* (2018) who reported that a significant number of farmers had limited education. In addition, farmers have been reported to have a low level of education and limited professional pesticide application training. This is in line with a similar study conducted in Morocco (Khadda *et al.*, 2021). Another study was conducted in the Bambout mountain area in Cameroon and reported more involvement of males with also low level of education in vegetable farming activities (Jean *et al.*, 2019).

Farmers practices on the use of Pesticides

Farmers employ different techniques on applying pesticides such as spraying, dusting, or soil application despite the fact that the spraying method is mostly used than other methods. It was also observed that farmers do control weeds before transplanting the seedlings whereby majority of them use hand hoes for digging. Farmers mentioned different types of pesticides that they are using depending on the nature of pests or diseases they want to deal with such as Chlorofenapyr, Sumithrin 0.4%, Propineb

700g/kg, Metalaxyl 60g/kg, Mancozeb 640g/kg, Cymoxanil 80g/kg and Mancozeb 640g/kg and metalaxyl 80g/kg. However, the most preferred pesticides included Chlorofenapyr and Sumithrin 0.4% which they claimed to be more effective than others. Regardless of the type of pests, majority of respondents apply pesticides after every one week or less depending on the situation of the farm being attacked by pests or diseases. The frequencies of applying pesticides may increase due to climatic conditions whereby, majorities apply more frequently during the rainy season. This is because during the rainy season, there is high humidity which favors the growth of mold and fungi.

Due to climatic changes, there is high occurrence of pests and diseases which attack vegetables especially tomatoes. Therefore, farmers tend to mix different pesticides at high doses to increase its effectiveness. Mixing more than one pesticides may be dangerous due to chemical interactions as these farmers were getting the information from colleagues and agro vet shops when they buy pesticides. This is likely a result of their conviction that applying more pesticides and more regularly application is the only way to eradicate pest issues (Dinham, 2003). Another study done in India supports the current findings that the use of pesticides has been cheered up by pesticides dealers who advise farmers to use them in mixture of 2-3 chemicals together (Keshavareddy *et al.*, 2018).

However, the practice is more worrisome for precise and safe use of pesticides, which leads to environment pollution and health effects to consumers (Keshavareddy *et al.*, 2018). It may also be the source of creating pests resistance to some pesticides which may encourage more use of pesticides and reduced effectiveness of some pesticides. The study conducted in northern Tanzania concur with the current findings that 90% of farmers mix three or more pesticides in the cultivation of vegetables (Ngowi *et al.*, 2007). Similar study was conducted in Mang'ola ward in Arusha, Tanzania and found that farmers blend two or more pesticides with the same active ingredients but different brands to increase its efficacy which in turn results to numerous pesticide residues in vegetables (Mhauka, 2014).

Mixing different pesticides during application is a common practice in some agriculture and pest control scenarios as it is often done to achieve a broader spectrum of control that is targeting multiple pest species concurrently. However, it is important to note that the compatibility of different pesticides should be carefully considered before mixing them because some pesticides may have chemical interaction that can reduce their effectiveness, cause adverse effect or result in toxicity to plants (Kiwango *et al.*, 2021).

Farmer's knowledge on the use of pesticides and the associated health effects

The current study reveals that understanding of specific health effects of pesticides is still ambiguous hence; it is possible for the majority of farmers to misuse pesticides since they are unaware of how they affect their health. The similar observation reported by Abang *et al.*, (2013) and Rijal *et al.*, (2018) in Cameroun. This may be attributed by many factors including reading of instructions on the label concerned with the proper use of pesticides but not following them due to claim that the recommended usage and dosage do not bring positive outcomes as they expected. Farmers who were reading pesticide label instructions were 3 times knowledgeable on the health effects of improper use of pesticides than their counterparts even after adjusting for education levels, number of years engaged in planting tomatoes, attending trainings on the proper use of pesticides. Most of these trainings were reported to be offered by the Agricultural officers although not frequently. Not following instructions during application of pesticides may have both direct and indirect implications on the safety of the produce and finally the consumer. Literature reveals that following pesticides use instructions is crucial for personal safety, products safety, environmental protection as well as effective pests' control and resistance management (Jean, 2019).

Some farmers in the current study leave their tomatoes for seven days before harvesting after application of the pesticides which implies adherence to the time recommended before harvesting. This practice is done for the purposes

of ensuring consumers safety while 35% of the farmers do nothing to ensure safety. Those who left their tomatoes for some days to ensure safety they declared to have obtained the information from the Agricultural Officers which reveals the roles of these persons in farming practices. A similar study supports these results that most of the farming information is provided by the Agricultural officers (Mubushar *et al.*, 2019).

However, there were other farmers who reported to be harvesting their tomatoes before seven days or whenever they get customers which may impose risks to consumer's health. Similar findings were reported by Jean *et al.*, (2019) that the majority of farmers are aware of the recommended time frame to wait before harvesting the produce. Kiwango *et al.*, (2021) support the current study that, harvesting crops before pre-harvest intervals and overdosing, increases the danger of human exposure to unacceptable high levels of pesticide residues through vegetables consumption. This may be attributed by low knowledge on the exact health effects of improper use of pesticides. This may be due to fact that most of the farmers have never attended any training on the integrated pest management or any other related courses about pesticides management. This makes farmers and consumers to be more exposed to health risk of the pesticide's residue due to poor handling of the pesticides. Evidence supports that most farmers in Tanzania are unaware of good practices for pesticide application (Kariathi *et al.*, 2016), calling for actions.

Study Limitation

The study did not consider non-response rate during sample size calculation causing the sample size to drop from 144 to 120 as a result of some farmers not meeting the selection criteria. However, due to the nature of the study, the obtained information is valuable for informed interventions.

Conclusion and Recommendations

High use of pesticides in cultivation of tomatoes especially during rainy season was reported in the current study. This may result to high level of pesticide residues in tomatoes which pose major threat to the environment and

consumer health creating a need to analyze the levels of pesticides during rainy and dry seasons. Majority of farmers have low knowledge on the proper use of pesticides in tomatoes production, which calls for a need to provide more education to the farmers on Integrated Pest Management (IPM) and Good Agriculture Practices by extension officers. Also, majority of tomato farmers in Morogoro region are unaware of good practices on pesticides use as majority mix more than one pesticides during application to increase effectiveness without been informed of the health effects on human. Therefore, Agricultural Extension Officers and other stakeholders should continue and increase the frequent of providing education and trainings to farmers on the proper use of pesticides to ensure safety of tomatoes to humans.

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