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Assessment of consumer's knowledge and practices on pesticide residues reduction in tomatoes in Mvomero, Morogoro region, Tanzania

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Abstract

Pesticides are important components of agricultural production but the consumption of crops treated with pesticides, even in small quantities, can accumulate in the human body and cause health problems. Therefore, consumers' knowledge and practices on reduction of these residues is essential however, there is scant of information on consumers' knowledge and practices on pesticide residues reduction in tomatoes in Tanzania. A cross-sectional study was conducted at Mvomero District in Morogoro region among 280 randomly selected consumers. Questionnaires were administered through face-to-face interviews to assess knowledge and practices on the reduction of pesticide residues in tomatoes before consumption. Data were analyzed using SPSSTM version 20 to obtain descriptive and inferential statistics. Results showed that 64.6% of respondents know that pesticides can cause health effects of which, 41% are not sure of the specific health problem with few mentioning cancers. About 80% of respondents know that tomatoes sold in the market have pesticide residues. Majority of respondents (78.9%) believe that the pesticide residues in tomatoes disappear after cooking. Seventy-five percent of respondents reported that they know methods for reducing pesticide residues of which 66.8% reported to be reducing pesticide residues by washing with water. Generally, consumer's knowledge on health effects and practices on reduction of pesticide residues before consumption was relatively poor. Hence, there is a need for improving knowledge on reducing pesticide residues in tomatoes using cost-effective methods that are applicable at the household level. Knowledge on the health effects of pesticide residues was significantly associated with having a mobile phone, reading newspapers, and attending training on pesticides and associated health effects. Therefore, phones, radio, and newspapers may be used as effective methods for communicating health information to the public.

Keywords: *Consumers, Knowledge, Practices, Pesticide Residues, Reduction*

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Introduction

Pesticides are chemical materials comprising compounds with different structures and properties, which are commonly used in various forms to fight against or control plant pests and diseases (Wanlapa *et al*., 2015). They are important components of contemporary agricultural production due to their high ability to

protect crops to assure high yields (Schreinemachers *et al.,* 2017). Over the years, there has been a substantial increase in pesticides used in agriculture, making pesticide poisoning and contamination of consumer products a major public health concern (Kiwango *et al*., 2018). This is because it may expose human to pesticides either, indirectly from environmental contamination (dietary intake or atmospheric contamination) or directly from occupational, agricultural, and household use. The contamination results from the practice of harvesting treated fruits and vegetables without following the correct withholding period/pre-harvest interval leading into unacceptable high levels of pesticide residues and poisons to the consumers (Kiwango *et al.,* 2018). Hence, determining the level of pesticide residues, consumer's knowledge and practices onreduction of these residues is a prerequisite for developing appropriate preventive interventions toreduce health problems among consumers. Studies have reported that surface pesticide residues in fruits and vegetables can be effectively removed by household solutions such as bicarbonate of soda and/or sodium chloride (Rasolonjatovo *et al*., 2017). However, there is no enough data on initiatives taken to reduce pesticide residues on ready to consume tomatoes in Tanzania.

The consumption of crops treated with pesticides, even in small quantities, can accumulate in thehuman body and cause health adverse effects such as cancer, diabetes mellitus, endocrine disruption and infertility (Zhao *et al*., 2012; Al-Othman *et al*., 2015; Mnif *et al*., 2011, Clementi *et al*., 2008). Acute pesticide poisoning has been noted as a serious problem in Tanzania both for children and adults and in other developing and developed countries (Ngowi, 2002; Konradsen, 2007; Jensen *et al.,* 2011; Ncube *et al*., 2011; Hudson *et al*., 2014; Leke *et al*., 2016). The World Health Organization reported that over 30% of the global burden of disease in children can be attributed to environmental factors, whereby pesticides are a major contributor (WHO, 2006).

Most of the studies in Tanzania and other countries have been done to assess the levels of pesticide residues in different food products and the levels of exposure to consumers (Leke *et al*., 2016Ngowi, 2002; Jensen *et al*., 2011; Ncube *et al*., 2011; Konradsen, 2007). Another study was done in Tanzania to assess farmers' knowledge and practices regarding pesticide use and pest management in vegetables and their implications for human health and the environment (Masomo,2019). Furthermore, many other studies have been done to assess the adverse effects of pesticides and found that the effects are due to overuse and misuse of pesticides including deviation from the recommended application procedures and dosages; the use of obsolete and banned pesticides; and improper storage, handling, and disposal of pesticides (Ngowi and Semali, 2011; Damalas and Koutroubas, 2016; Jallow *et al*., 2017; Kiwango *et al*., 2018).
However, there is limited information on consumer's knowledge and practices on reduction of pesticide reduce in tomatoes before consumption. Therefore, this study aims to assess consumer'sknowledge and practices on pesticide residues reduction in ready to eat tomatoes in Mvomero district, Morogoro for appropriate interventions to be carried out. Generally, this will contribute to the National Integrated Pest Management policy framework which aims to improve pesticide useand practices.

Materials and Methods

Description of the Study area and design:
Morogoro is one among the regions in Tanzania Mainland which occupies a total of 72,939 square kilometers which is approximately 8.2% of the total area of Tanzania Mainland (NBS, 2012). The region is comprised of seven districts

including Ulanga, Gairo, Kilombero, Kilosa, Mvomero, Morogoro rural and Morogoro urban. The region has a population of 3,197,104 people, where 1,579,869 are males and 1,617,235 are females (NBS, 2022). The main economic activity done in the region is agriculture. Morogoro region was selected because it has the largest area of about 2,442 ha (9.2% of its land) which is cultivating tomatoes (MMA, 2008; Mushobozi, 2010). The study was conducted at Mvomero district which is considered a high potential area for growing most of vegetables, especially tomatoes. A cross-sectional study design with quantitative approach was applied in which a field survey was carried out to obtain information on the knowledge and practices on reduction of pesticides residues. The study involved male and female consumers who have stayed in the area for at least one year and above as they may be familiar with the environment as compared to the newly. The study excluded those who are new in the area, not involved in cooking activities in any way and those who refused to sign an informed consent.

Sampling techniques and procedures

A multi-stage sampling was used to select the study sites and consumers to be included in the study. Firstly, Mvomero district was purposely selected due to high production of vegetables in Morogoro region. Secondly, 2 villages (Doma and Mlali) in Mvomero district were selected based on the tomatoes production capacity. Thirdly, simple random sampling using a table of random numbers was used to select households and individuals within the selected households to be involved in this study. In each household, one participant was selected purposively based on the most involved in food preparation in the household to reach a total of 280 consumers.

Participants sample size determination

A total of 280 respondents were obtained using a formula for prevalence studies.
This sample size was obtained using the formula for prevalence studies (Daniel, 1999):

$n = [z^2*p*q]/d^2$

Where: n = desired sample size

Z = standard normal deviation set at 1.96 corresponding to 95%

CIq = 1.0 – p

d = degree of accuracy desired (0.05)

p= proportion of the target population who are affected by pesticide poisoning

The rate of food items contaminated with unknown pesticides = 20.8% according to Lekei *et al*. (2017). The response rate was assumed at be 95%; yielding a consideration of 5% non-respondent rate.

Data collection

An interview-administered questionnaire with closed and open-ended questions was administered to 280 consumers. The questionnaire was used to collect information from the study respondents who consented to participate in the study. The questionnaire covered the details on the knowledgeand practice on reduction of pesticides residue in tomatoes before consumption including demographic information. This questionnaire was prepared in English and translated into Kiswahili for easy understanding and consistent during interviews. A three day training of the enumerators was conducted and pretesting of the tool was done to 20 randomly selected consumers at Magadu ward in Morogoro region. Necessary changes were made during debriefing after pretesting to improve the questionnaire.

Statistical analysis

Data were coded, entered, cleaned and analyzed using SPSS™ version 20 where descriptive statistics such as mean, frequencies, standard deviations, and percentages were obtained. In addition, inferential statistic was done to determine association among factors including knowledge on the health effects of consuming pesticide residues which was used as dependent variables with education level, income, age and ways of accessing information which were used as independent variables. This was done through logistic regression analysis to provide the crude (COR) and adjusted odd ratios (AOR) (Wynants *et al*., 2017) for factors associated with knowledge using backwards elimination method. Statistical inference was based on 95% confidence intervals (CIs) and significance at $p<0.05$.

Results

Respondents Socio-Demographic characteristics

The results show that 53.9%, of the respondents were females. The average age of the respondents was 38 ± 14 SD. More than half (64.6%) of the respondents completed primary education level. while the least (1.8%) have completed college/University level. Majority (77.1%) were self-employed mostly in crop production (52.5%) followed by those who are doing small business (32.9%). About 54% of the respondents were the head of households and 50.7% had formal marriages (Table 1).

Table 1.

Demographic information of participants (n=280)

Variables	Frequency	Percent
Sex		
Male	129	46.1
Female	151	53.9
Education level		
Never attended school/no formal education	15	5.4
Not completed primary school	23	8.2
Completed primary school education	181	64.6
Not completed secondary school education	15	5.4
Completed secondary school education	41	14.6
College/University	5	1.8
Position in the household		
Head of household	151	53.9
Dependent	46	16.4
Domestic help	5	1.8
Relative	4	1.4
Wife	74	26.4
Marital status		
Single	63	22.5
Married	142	50.7
Divorce/Separated	31	11.1

Widowed	16	5.7
cohabitating	28	10.0
Employment status		
Government employee	1	0.4
Non-governmental employee	12	4.3
Self employed	216	77.1
Student	4	1.4
Home maker	5	1.8
Unemployed	42	15
Source of income		
Salary	9	3.2
Wages	10	3.6
Business	92	32.9
Crop production	147	52.5
Animal keeping	3	1.1
Remittance	19	6.8

Consumer's awareness and knowledge on pesticide residues reduction.

Table 2 shows that majority of the respondents have heard about the use of pesticides in tomato production of which most of them have got information from their colleagues. About 61% of the consumers are aware of the health effects of consuming pesticides however, more than half of them are not sure of the specific health problem associated with the consumption of pesticide residue. High percentage of consumers (80.7%) know that the pesticides applied on tomatoes at the farm may also be present when tomato is sold in the market and over (80%) of consumers reported to notice its presence by colour of the pesticides applied. More than half (55%) of consumers know that pesticides applied in tomato at farm can also be present on tomato when eaten raw and their presence can be noticed through smell.

Table 2. Awareness and Knowledge of Consumers on the use of Pesticides and their Effects

Variables	**Frequency**	**Percent**
Heard of pesticides (N=280)		
Yes	271	96.8
No	9	3.2
Where they obtained information (n=271)		
Hospital	4	1.5
Colleague	102	37.6
Mass media (Radio,TV, Newspaper)	48	17.7
Extension offices	42	15.5
Others specify (internet, what saps etc,)	75	27.7
Know that Pests and diseases attack tomatoes on the farm (280)		
Yes	276	98.6
No	4	1.4

Know that pesticides are used to control pests and diseases in vegetable (n=280)		
Yes	274	97.9
No	6	2.1
Know that farmers use pesticides to control pests and diseases in tomato farm (n=280)		
Yes	273	97.5
No	7	2.5
Know the effects of using pesticides on human health (n=280)		
Yes	172	61.4
No	108	38.6
The mentioned effects (n=172)		
Cancers	17	9.9
Skin problems	27	15.7
Breathing problems	13	7.6
Not sure	115	66.9

On the other hand, almost 81% of the consumers reported that pesticide applied on tomatofarms cannot be present in cooked tomatoes while 19% declared that even if a tomato is cooked, the pesticides will still be present and can be noticed through smell **(**Table3).

Table 3. Knowledge of Consumer on Pesticide Residues on Read to Eat Tomatoes

Variables	Frequency	Percent
Pesticide applied in farm can be present on tomatoes sold in the market (n=280)		
Yes	226	80.7
No	54	19.3
Can they be noticed (n=226)		
Yes	197	87.2
No	29	12.8
How can they be noticed (n=197)		
Color	158	80.2
Texture	12	6.1
Smell	27	13.7
Pesticides applied in tomato farm present on tomato eaten when raw (n=280)		
Yes	155	55.4
No	125	44.6
Can the presence of pesticides be noticed while eaten raw? (n=155)		
Yes	114	73.5

No	41	26.5
How can they be noticed when eaten raw (n=144)		
Color	11	9.6
Texture	8	7.0
Smell	95	83.3
Pesticide applied in tomato farm can be present in cooked tomatoes (n=280)		
Yes	54	19.3
No	226	80.7
Can one notice its presence (n=54)		
Yes	36	66.7
No	18	33.3
How to it be noticed (n=36)		
Color	2	5.6
Texture	2	5.6
Smell	32	88.9

Consumers reported that the main method for pesticide residues reduction before consuming tomatoes is washing with water. Respondents reported that washing with water helps to reduce pesticides while others believe that it is the means of removing dirty. Majority of consumers (70%) haveknowledge on the health effects of pesticide residues and they reported mass media such as radio, TV and newspaper as major means of obtaining that information (Table 4).

Factors associated with knowledge on health effects of pesticide residues consumption

Tendency of reading newspaper/magazine, owning a mobile phone and received information/training/education on pesticide residue and its health effects was significantly associated with knowledge on the health effects of consuming pesticide residues with Adjusted OR (3.638; 95%CI 1.901-6.963), (2.405; 95%CI 1.07-5.4), 8.05,95%CI 4.03-17.93) at $p<0.05$ respectively. These remained to be significant even after adjusted for other factors including education levels, income and age. Other factors like education levels,listening to a radio, watching television, income and age were not significantly associated with consumer's knowledge (Table 5).

Table 4

Knowledge on reduction of pesticide residues before consumption of tomatoes

Variables	Frequency	Percent
Know the method for pesticide residues reduction before consuming tomatoes (n=280)		
Yes	211	75.4
No	69	24.6
Mentioned methods (n=211)		
Washing with water	186	88.2
Washing with salt	1	0.5

Washing with bicarbonate of soda	1	0.5
Peeling	8	3.8
Washing followed by peeling	15	7.1
Know the importance of washing tomato with water before eating		
Yes	211	75.4
No	69	24.6
Reason for washing with water (n=211)		
Reduce pesticides residues	87	41.2
Remove pesticide residues completely	44	20.9
Remove dirty	53	25.1
Reduce dirty and pesticides	6	2.8
Remove dirty and pesticide residues	21	10.0
Ever got information on pesticide residue and its health effect (n=280)		
Yes	84	30.0
No	196	70.0
Where got information on pesticide residues and health effects (n=84)		
Hospital	6	7.1
Colleague	21	25.0
Mass media (Radio, TV, Newspaper)	32	38.1
Extension offices	25	29.8

Table 5

Factors associated with knowledge on health effects of pesticide residues consumption

Variables	**Adjusted OR**	**95%CI**		**P value**
		Lower	**Upper**	
Read newspapers /magazine				
No	1	1	1	1
Yes	3.638	1.901	6.963	0.000
Own mobile phone				
No	1	1	1	1
Yes	2.405	1.071	5.399	0.033
Got information on pesticide residue and its health effects				
No	1	1	1	1
Yes	8.05	4.03	17.93	0.000

Note: OR=Odd ratio and CI=Confidence interval. Level of significant was set at $p<0.05$ andvariables with a value of 1(No) were used as references.

Consumers practices on pesticide residues reduction

Half of the respondents choose tomatoes based on the ripeness criteria. About 58.9% of respondents wash the purchased tomatoes with water before consumption where by 34.6% of consumers wash tomatoes with water followed by peeling. Other practices that are reported by respondent on pesticides reduction are as detailed on Table 6.

Table 6.

Consumers Practices on Reduction of Pesticide Residues on Tomatoes

Variables	Frequency	Percent
Criteria used when purchasing/selecting tomato (n=280)		
Ripeness	143	51.1
Size	36	12.9
Texture	21	7.5
Smell	48	17.1
Others specify (shining etc.)	32	11.4
What to do with tomato before consumption (n=280)		
Washing with water	165	58.9
Washing with water and soap	3	1.1
Peeling	15	5.4
Washing with water followed by peeling	97	34.6
Reasons for doing the procedure before consumption (n=280)		
Reduce pesticides residues	81	28.9
Remove pesticide residues	28	10.0
Remove dirty	105	37.5
Reduce dirty and pesticides	18	6.4
Remove dirty and pesticide residues	28	10.0
Not sure	20	7.1

Discussion

The current study aimed at assessing consumers' knowledge and practices on pesticide reduction in tomatoes before consumption at Mvomero district in Morogoro region, Tanzania. The response indicated that female were more included than men in the study as they are primarily involved in food preparations in the households.

Awareness and knowledge on the reduction of pesticide residues in tomatoes

The majority of consumers understand that pesticides applied on tomato farms can be present on tomatoes sold in the market and can be noticed through colors remaining on the tomato surfaces. This implies that there are no actions taken by the farmers to reduce the presence of pesticide residues on ready-to-eat tomatoes or it may be due to fact that

the time between treatmentand harvesting is short. A similar study was also done by Mahugija *et al.*, (2021) in Iringa, Tanzania, and found the presence of pesticide residues in unwashed and washed tomatoes. Another study done in India supports the current findings that pesticides are usually applied on the surfaceof vegetables, therefore, there is a possibility of the residues to be present however, they can be reduced through household operations like washing, peeling and cooking singly or in combination(Tomer and Sangha, 2013).

About half of the consumers know that pesticides applied in tomato farms can be present on tomatoes when eaten raw while a high percentage of consumers reported that pesticides applied on tomato farms cannot be present in cooked tomatoes. This indicates that the knowledge of consumers on pesticide residue reduction is very low as they can cook tomatoes without washing thinking that pesticide residues disappear after cooking hence, safe for their health. A study done by Mahugija *et al.*, (2021) in Iringa, Tanzania reported that cooking processes enhance the hydrolysis and volatilization of chemicals, thus altering their level in the food. The same study reported that cooking reduces deltamethrin residues in vegetables by 19-40%. Although cooking has been reported to reduce pesticide residues, it only reduces small amount of residues but not remove it completely as what our consumers think. The method also works on a specific active ingredient of pesticides. Hence, it is not a reliable method of reducing pesticides that one can merely rely on.

Few consumers, who claimed that pesticide residues can be present on cooked tomatoes, revealed that their presence can be noticed through smell. This shows that farmers may be usinghigh doses of pesticides during application and harvest before the recommended time lapse. Thanh*et al.*, (2018) reported that increased use of pesticides is not the only problem; but there has been a tendency of over dosage as well as mixing of different types of pesticides which may expose consumers to more health risks.

Majority of respondents have heard about the use of pesticides in tomato production from their colleagues and others from meetings, internet etc. Almost all consumers know that pests and diseases attack tomatoes and majority of the farmers in their area use pesticides to control them. However, almost half of them are not aware of the effects of using pesticides to human health. This is because they were not sure of the specific health problem associated with the consumption of pesticide residues mentioning skin problems, vomiting, stomach ache and diarrhea which are only acute effects. Very few consumers mentioned cancer which is a chronic effect of pesticide residues consumption. Studies report that symptoms associated with acute exposure to pesticide residues in humans include coughing, nausea, vomiting, abdominal pain,headache, diarrhea and loss of vision (Lekei *et al.,* 2014). Chronic exposure to pesticide residues is associated with endocrine disruption, cancers, neurotoxicity, cytogenetic damage and effects in the reproductive and immunological system, affecting neurologic and cognitive development in children (Nasreddine *et al.,* 2016). Another study also reported that exposure to pesticides result into acute and chronic health effects, depending on doses of exposure, types of pesticides,and route of entry, including cancers, diabetes, chronic kidney disease, asthma, and neurological diseases (Kim *et al.,* 2017; Lakshmi *et al.,* 2020; de Graaf *et al.,* 2021). Understanding the acuteeffects of pesticide residues only does not guarantee that consumers have enough knowledge on the associated health effects. This is because one can get short time symptoms which may not make him/her to be very sensitive on the long-term consumption of pesticide residues. Lowknowledge on the effects of pesticide residues on health may be attributed by lack of information among consumers. This has been revealed in this study whereby majority of consumers lack information on the health effects of pesticide residues. Although knowledge of pesticide residues consumption on the health effects of consumers is found to be low, it was significantly higher among consumers who have the tendency of reading newsletters/magazine, owning mobile

phones and ever received information/training/ education on pesticide residue and its health effects. Education was expected to influence the level of knowledge on the effects of pesticides but it was not found so. This may be due to fact that majority of the respondents had completed primary school and what they know is mostly obtained from their colleagues regardless of its correctness. Ben Khadd *et al.*, (2021) reported that most of the farmer's in Morocco had no notion about the exposure risks associated with pesticides residues which is similar to our study findings where majority of the study respondents do not know the specifichealth effects of using pesticides. The source of information regarding reducing pesticide residues in vegetables and fruits is an important factor for consumers' behaviorchange. The study done in Thailand reported that consumers had the potential to access the internet to get the information which provides a useful insight into the potential channels to provide food safety information to consumers. On the other hand, it was reported in the same study that consumers who got their information from a broadcasting tower were more likely to have higher behavior scores than the ones who did not. Hence, there is a need to put more efforts into risk communication to educate consumers about food safety related matters needed to promote the reliability of regulatory procedures and sources of information as well as suitable dissemination systems, to link regulators and the general public (Williams and Hammitt, 2001; Han *et al.,* 2020).

Practices on pesticide residues reduction

Half of the respondents purchase tomatoes based on the ripeness and good appearance (shinning) criteria. This implies that consumers in the studied area are less concerned about safety of the foods during purchasing. This is because there were no consumers who reported being concerned with the pesticide residues on the tomatoes while they all know that pesticides are used by their farmers and they can feel the smell as well as see the colour of the pesticides on tomatoes sold in the market. Another study supports our findings that factors influencing consumer choice in vegetableand fruit purchases are freshness, appearance, and price (Chikkamath *et al.,* 2012; Massaglia *et al.,* 2019). Another study was contrary to the current findings that the selection of the product wasbased on it being pesticide-free (Sapbamrer, 2022).

The majority of the consumers reported that the main method for reducing the effects of pesticideresidue is washing with water. Almost half of the consumers wash the purchased or produced tomatoes with water before consumption while few consumers wash tomatoes with water followed by peeling. A good number of consumers who wash tomatoes with water or peel them before eating believe that, they remove pesticide residues completely while very few believe that they reduce some amount of residues. This implies that consumers have low knowledge of the reduction of pesticide residues before consumption as the reality of what they practice is just reduction and not the removal of pesticide residues completely. Studies reveal that washing itself does not guarantee the removal of pesticides residue (Mahugija *et al.*, (2021) as the presence of residues wasdetected in washed tomato samples including chlorothalonil, endosulfan ether, and endosulfan sulphate. Tomer and Sangha (2013) reported that pesticides are usually applied on the surface of vegetables, so they can be reduced in the peeling process. Another study by Bonnechère *et al.*, (2012) reported that they could not find any considerable reduction of pesticide residues by peeling. The controversy may be attributed by differences in adherence to good agricultural practices (recommended practices) with regards to the application of pesticides including time lapse between treatment and harvesting, type of pesticide used or mixed with another, and the dosage. Although peeling has been

reported to reduce pesticide residues in tomatoes, it is not a good practice as it leads to food loss as well as nutrient losses which are beneficial for human health hence, a need for alternative ways that can be combined with washing to reduce pesticide residues effectively. A study done in the United States reported that one of the first steps during the processing of tomatoes is the removal of the peel which may result in more than 25% of fruit loss (Ayvaz *et al.,* 2016). The bulk of tomato's nutrients and health benefits are within the skin and seed components, and currently, both are removed for home and commercial canning processes. The tomato skin contains high levels of carotenoids such as lycopene and β-carotene which have been correlated to lower incidences of prostate cancers and lower oxidative stress through antioxidant activity and gene regulation (George *et al.,* 2004; Reboul *et al.,* 2005; Vinha *et al.,* 2014).

Conclusion

The findings of this study conclude that majority of consumers are not well informed on the health effects associated with pesticides residue consumption hence, there is low knowledge among consumers on the health effect of pesticide residues consumption. The study respondents are aware that in the cultivation of tomatoes, farmers use pesticides as a means of controlling diseases and pests attack. They also believe that pesticides that have been applied in the farm can be present inraw tomatoes but removed when cooked. Majority consider washing tomatoes with water as one of the method of reducing and removing pesticides residues and other effective methods were least considered to be used by the household in the reduction of pesticides. Knowledge on the health effects of pesticides residues is significantly associated with access to media specifically reading of newspapers, having mobile phones and attending training/education on pesticides and associated health effects which may be the bases for health communication interventions.

Based on the results of this study, there is a need to create awareness to consumers on the cost effective methods to be used at household level to reduce pesticide residues in tomatoes before consumption. Training should be conducted to consumers and Agricultural Extension Officers on the health effects that are associated with consumption of pesticides residues. In this case the National Integrated Pest Managementoffice should formulate simple educative messages, which can be sent to consumers on health effects of consuming pesticide residues and the reduction methods. This can be an effective way of educating the public because most of the consumers have access to mobile phoneswhich can be used to share information with their colleagues and other stakeholders.

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