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Original Research Article

Factors associated with personal protective equipment use among pesticide handlers in Mwea irrigation Scheme, Kenya

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ABSTRACT

Background: Pesticide use among small scale rice farmers has drastically increased over time globally. Evidence shows that majority of pesticide handlers do not regard PPE use during pesticide application, hence low PPE compliance.
Methods: This study explored factors associated with PPE use among pesticide handlers in Mwea Irrigation Scheme, Kenya. The study was cross-sectional involving 246 respondents.
Results: There was low level of PPE use among pesticide handlers with none using full PPE and only 25.2% using 4-6 PPE items out of 7 possible items. The most used PPE were trousers (74.4%), long-sleeved shirt/jacket (65.9%) and hat (60.6%). The least worn PPE were gumboots (1.6%), gloves (2.8%) and goggles (9.8%). Chi- square tests of independence revealed that sex, age, crop ownership, pesticide safety training, pesticide application experience, pesticide safety knowledge, attitude towards PPE use, perceived environmental health risk and Perceived PPE importance were significantly associated with PPE use. However, level of education, land tenure status and size of the farm were found not to have any association with PPE use.
Conclusions: The results provide insights for future interventions and inform focus areas by health and safety enforcement agencies and policy developers. More training on pesticide safety and PPE use will enhance compliance and promote pesticide handlers' health.

Keywords: Pesticide, Pesticide handler, Personal protective Equipment

INTRODUCTION

The most consumed cereals in Kenya today are maize, wheat and rice in that order.[1] There is increased effort to promote productivity of rice and reduce its destruction by pests in Kenya due to increased demand. Pests lead to huge yield losses in rice production worldwide. 20-45% of rice and other agricultural products are lost every year due to pests and diseases.[2,3] Farmers therefore seek new ways and technologies of pest management, including intensifying pesticide use. Pesticide utilization in developing countries has gone up significantly.[4] Mwea Irrigation Scheme is the biggest public settlement irrigation scheme in Kenya producing about 65,000 metric tons of rice annually.[5] There are 26,000 acres of land under cultivation by 7,022 household farmers in the Mwea Irrigation Scheme.[1,6] The farmer is responsible for pest control, where individualized decisions are made. Pesticide application is done by use of knapsacks since rice farming is largely small-scale in the Mwea Irrigation Scheme. This method leads to more exposure as opposed to use of tractors and aircrafts as practiced in commercial large-scale farming.[7] Occupational exposure to pesticides has been associated with various pneumoconiosis, carcinogenicity, cardiovascular and renal diseases, reproductive toxicity and neurotoxicity among other chronic conditions.[8-10] Several acute health effects of pesticide exposure have been widely documented.[7,11,12] including headaches, skin problems, vomiting, dizziness, respiratory distress and tiredness among others. Personal Protective Equipment (PPE) is usually considered the final and in some cases the most significant safety protection against pesticides' dangerous health risks.[13]

They trap the chemicals before finding their way on the skin or into the handler's body hence preventing the risk from occurring. There has been increased use of pesticides among Mwea rice farmers. Notably, the use of chemical weed control has dramatically increased in the past few years in efforts to reduce manual weeding that is deemed expensive. In most cases the pesticide handlers do not use adequate protection, thereby exposing themselves to the various health risks associated with both acute and chronic exposure. Research in this field has been more on other horticultural farmers, especially tomato farmers, and little attention has been given to exposure and safety of rice farmers.

There is dearth of research information on PPE use by Mwea rice farmers. Being unique in their way of operation, a research on their safety and exposure was necessary. This study aimed to contribute to bridging this knowledge gap through the following objectives: to determine the level of use of PPE by pesticide handlers in Mwea Irrigation Scheme, Kenya, to determine socio-demographic factors associated with use of PPE among pesticide handlers in Mwea Irrigation Scheme, Kenya, and to determine knowledge, attitude and perceptions associated with PPE use among pesticide handlers in Mwea Irrigation scheme, Kenya.

METHODS

The study was carried out in the rice-growing Mwea Irrigation Scheme in Kenya. The Scheme was selected as it is the biggest rice-growing region in the country. The study employed a cross-sectional study design. Snowballing method of sampling was used due to the small and unpredictable number of pesticide handlers in MIS.

Difficulty finding adequate number of respondents in the field also contributed to the choice of the technique. The study involved adults found in the paddy fields handling pesticides or those referred to us by other respondents and consented to participate. Those below 18 years or declined to give consent were excluded. Data was collected using interviewer administered questionnaire, an interviewer-filled observation checklist and conducting focus group discussions. The mixed technique approach helps triangulation and builds up the shrewdness and reliability of the results.[14] Data was analysed using Statistical Package for Social Sciences (SPSS) version 26. Chi-square tests were run to evaluate factors associated with PPE use at significance level of $p<0.05$. Content analysis was done to analyse the data gathered from the FGDs.

RESULTS

Response rate

There was a 100% response rate from the respondents. This was made possible by ensuring the respondents understood the conditions of involvement before signing the consent form.

Table 1: Percentage of individual PPE items used by pesticide handlers.

Type of PPE	No. of persons using		No. of persons not using	
	N	%	N	%
Hat/Head Cover	139	60.6	97	39.4
Goggles	24	9.8	222	90.2
Face/Gas mask	80	32.5	166	67.5
Chemical Resistant Gloves	7	2.8	239	97.2
Long Sleeved Shirt	162	65.9	84	34.1
Pair of Trouser	183	74.4	63	25.6
Gum boots	4	1.6	242	98.4
Full PPE	0	0.0	246	100.0

PPE use among pesticide handlers

The most used PPE were trousers (74.4%), long sleeved shirt (65.9%) and a hat (60.6%). About a third (32.5%) of the respondents used a face mask, while gumboots, chemical resistant gloves and goggles were the least used PPE with 1.6%, 2.8% and 9.8% respectively. None of the interviewed pesticide handlers had full PPE gear. (Table 1) shows a summary of the pesticide handler's behavior on PPE use at the time of interview. Most respondents used 2 (24.4%) or 3 (24.4%) PPE items simultaneously. 10.6% of the respondents used no protective gear, with another 15.4% using only one of the basic PPE gear. Only a quarter (25.2%) of the respondents had four or more gears where 16.7% used four gears, 7.7% five gears and 0.8% six gears. (Table 2) summarizes the frequencies of observed number of PPE used by the respondents. Gum boots, gloves, goggles, face masks and full PPE were cited as unusable by 56.9%, 4.7%, 2.4%, 0.8% and 0.4% pesticide handlers respectively in their situations.

Socio-demographic characteristics of Pesticide handlers in Mwea irrigation Scheme

Being female, crop owner (farmer), trained in pesticide and PPE use, older and more experienced in pesticide application was associated with PPE use compliance. Level of education, land tenure and farm size were not found to have a significant association with PPE use in this study. (Table 4) shows a summary of the socio-demographic characteristics of the pesticide handlers in MIS.

Table 2: Number of PPE gear used by pesticide handlers in Mwea Irrigation Scheme.

Number of PPE	N	%	Cumulative %
0	26	10.6	10.6
1	38	15.4	26.0
2	60	24.4	50.4
3	60	24.4	74.8
4	41	16.7	91.5
5	19	7.7	99.2
6	2	0.8	100.0
7 (Full PPE)	0	0	100.0
Total (N)	246	100.0	

Pesticide safety knowledge of pesticide handlers in MIS

The mean knowledge score of the pesticide handlers was 8.378. The data had a standard deviation (s) of 2.404 with a coefficient of variation of 0.2869. The scores were ranked as Inadequate (0-3 points), Moderate (4-6 points), Satisfactory (7-9 points) or Good (10-12 points). The study revealed that most of the pesticide handlers in the irrigation scheme had satisfactory to high knowledge on pesticides and pesticide safety. Out of a possible maximum of 12 points, over three-quarters (77.6%) scored 7 points and above as shown in (Table 5).

Table 3: PPE not usable in pesticide handler's situation.

PPE Item	N	%	Reasons for non-use
Face mask	2	0.8	Unnecessary
Gloves	11	4.7	Expensive
Goggles	6	2.4	Unnecessary
Gumboots	140	56.9	Bulky Cause crop destruction
Full PPE	1	0.4	Expensive

Independence between pesticide handler's knowledge score and level of PPE compliance was run. The results revealed a strong positive association (ψ=0.648) statistically significant association between the two, χ^2 (54, N=246) =103.30, $p<0.001$. Pesticide safety knowledge aspects found to be associated with PPE use compliance were knowledge on routes of entry ($p<0.001$), safe pesticide handling procedures ($p=0.002$), accurate pesticide measurement ($p=0.001$), awareness on toxicity colour code ($p=0.013$) and awareness on banned pesticides ($p=0.001$).

Pesticide handlers' attitude and perceptions on pesticides and PPE use

A Likert scale based on five points was used to test on pesticide handlers' attitude. The degrees of agreement used were: Strongly Agree, Agree, Not Sure, Disagree and Strongly Disagree.

Table 4: Summary of Socio-demographic characteristics of pesticide handlers in MIS.

Variable	Categories	%	χ^2 P values (CI: $p<0.05$)
Sex	Male	95.1	.025
	Female	4.9	
Education	None	10.2	0.088
	Primary	24.4	
	Secondary	46.3	
	Tertiary	19.1	
Age (years)	20-29	22.8	0.001
	30-39	43.9	
	40-49	22.4	
	50-59	11.0	
Training in pesticide safety	Yes	32.5	0.000
	No	67.5	
Ownership in relation to crop	Farmer	40.7	0.000
	Hired worker	59.3	
Experience in pesticide application (years)	0-2 years	17.5	0.002
	3-5 years	35.8	
	>5 years	46.7	
Land tenure	Free-hold	46.3	0.061
	Leased	53.7	
Farm size (acres)	<1	35.8	0.556
	1-2	49.2	
	3-5	14.2	
	>5	0.8	

Table 5: Pesticide safety knowledge scores of pesticide handlers in Mwea Irrigation scheme.

Score	N	%	Cumulative Percent	Ranking
3.00	5	2.0	2.0	Inadequate (2%)
4.00	18	7.3	9.3	Moderate 20.4%
5.00	10	4.1	13.4	
6.00	22	8.9	22.4	
7.00	21	8.5	30.9	Satisfactory 44.7%
8.00	50	20.3	51.2	
9.00	39	15.9	67.1	
10.00	25	10.2	77.2	Good 32.9%
11.00	28	11.4	88.6	
12.00	28	11.4	100.0	
Total	246	100.0		100%

The mean attitude score, standard deviation and the coefficient of variation for the study population were 3.75, 0.50 and 0.13 respectively. 90.7% of the respondents had a score of 3.0 and above. A Chi-Square test of independence showed that there existed a significant relation between respondents' attitude and the level of PPE worn, $\chi^2(162, N = 246) = 221.86$, p = .001. Majority of the respondents thought that the pesticides they were using were likely to affect their health during and after use (96.3%), as well as the environment and other animals (82.9%). Additionally, 94.3% thought personal protective equipment (PPE) are useful during pesticide application. Chi-Square tests of association were run for each of the three aspects of perception measured. Environmental health risk perception (χ^2=12, N=246, 26.68, p=0.009) and perceived PPE importance (χ^2=6, N=246, 40.11, p<0.001) were significantly associated with PPE use compliance. Pesticide handlers with a higher PPE importance perception during pesticide application had a higher tendency to utilize higher number of PPE gear than pesticide handlers with a lower PPE importance perception. However, this study did not find any significant association between perceived individual health risk and PPE use compliance, χ^2=12, N=246, 10.93, p=0.535.

DISCUSSION

Level of use of PPE among pesticide handlers in Mwea irrigation scheme

From our findings, there is low level of PPE utilisation by pesticide handlers in the Mwea Irrigation Scheme (MIS). There were no sprayers found using full PPE at the point of interview. This agrees with studies done in Ethiopia and Rwanda, where more than 95% of growers did not show compliance with the minimum threshold for secure utilization of pesticide.[11,14] The health implication of this trend is increased risk of exposure to pesticides hence higher risk of developing complications associated with this exposure. Other researchers found relatively lower rates of PPE use non-compliance at 44-60% and 58.9%.[7,15] at Meru in Kenya and Northern Greece respectively. From our group discussions, it was noted that cost of PPE, comfort during pesticide application and slowing movement during pesticide application were some of the reasons that contributed to PPE non-compliance. Protective equipment's unavailability (45.7%), high cost (39.5%), discomfort (64.3%) and slowing work (43.8%) were cited as the reasons given for not using PPE in Ethiopia.[14] These explanations by pesticide handlers make good target points in improving usability of PPE in rice farming.

Notably, the most commonly used PPE in MIS are trousers (74.4%), long sleeved shirt (65.9%), hat (60.6%) and face mask (32.5%). These figures agree with a global review which posted compliance rates on these four protective gears at 71.1%, 66.1%, 47.3% and 43.2% respectively.[16] Majority of people put on trousers, long sleeved shirts and a head cover (either a hat for men or a turban for women) naturally, hence the results. The least worn were goggles, chemical resistant gloves and gumboots at 9.8%, 2.8% and 1.6% respectively which confirm a research done in Rwanda among small-scale rice farmers.[11] This coincides with those PPE most handlers indicated as unusable in their cases due to perceived bulkiness and causing crop destruction (gumboots), expensive (chemical resistant gloves) as well as unnecessary (goggles). However, significantly contradicting results for boots (42.3%), gloves (40.5%) and goggles (24.3%) have been reported globally.[16] Moreover, it was found that 31.4% of small-scale farmers used boots during pesticide application in Ethiopia.[14] This could be explained by the nature of the working environment, considering that most rice farming in MIS is done using flooded irrigation system. Lack of specific PPE gear among the pesticide handlers in MIS posed even a bigger challenge. It was reported that majority of them use the same attire to tend to all agricultural activities related to rice production. The other challenge is lack of creativity where one can improvise PPE from the readily available nylon papers used to pack fertilizer.

Socio-demographic factors associated with PPE use

Pesticide application activities in MIS are male dominated with 95.1% of pesticide handlers interviewed being male and only 4.9% female. This has been the typical trend over years since pesticide application activities and agriculture in general has been traditionally a male affair. Other researchers found similar results in Morocco, Ethiopia and Mwea in Kenya respectively.[14,17.18] This may be due to the strenuous nature of the activity. Additionally, conclusions drawn from discussion groups pointed to underlying cultural beliefs and practices where hard manual work is a preserve for men, as is the case in most African settings. The study found a significant statistical relation between sex and level of PPE use, X2=6, N=246, 14.43, p=0.025. Female pesticide handlers observed more PPE compliance than their male counterparts. A similar association was reported where groups of pesticide sprayers with more women demonstrated higher PPE use compliance.[19] From this study, it was noted all the women involved in the study used a head cover. While this was useful in minimising exposure to pesticides, it was reported from the discussion forums that the covers were meant for preventing their hair from carrying the pesticide smell. In essence, socio-cultural differences in dressing code partly gave female pesticide handlers a higher rating in terms of PPE use compliance than their male counterparts. However, women are generally more cautious than men, and this could explain the higher levels of compliance.

There was low PPE use compliance among pesticide handlers in Mwea Irrigation Scheme irrespective of high literacy levels. Similar results where 96% of tomato farmers in MIS had received at least primary education had been reported.[18] However, contradicting findings were reported in Morocco and Ethiopia where small scale farmers had illiteracy levels of 34.1% and 41.4% respectively.[14,17] Higher literacy levels have been associated with higher PPE use compliance and safe pesticide behaviour.[14,16,17,20] In the case of our investigation, there was not found any significant association between pesticide handlers' level of education and PPE use compliance, p=0.088. this confirms a study done in Rwanda.[11] This phenomenon could be due to a higher proportion of the participants having obtained basic education. It could also be due to a norm in the society that undermines the place of education in promoting health.

Majority of the sprayers were hired workers. Ownership in relation to crop was significantly associated with PPE compliance, p<0.001, a fact displayed in a global review.[16] A possible link exists between noncompliance and prior preparation by the worker for the activity. From the group discussions, a majority of casual workers in the forums claimed not having time to change and that they have a common set of clothes for all the works in the paddy fields. Another explanation was carelessness on the part of the workers. Pesticide handlers working on leased farms were slightly more than those working on freehold farms. This is because majority of landowners in MIS prefer leasing their farms due to financial burden of growing rice. Unlike the case with ownership in relation to crop, land tenure showed no significant association with PPE compliance, p=0.061. Corresponding findings were found in Morocco.[17] However, contradicting results were reported in Pakistan where land tenure seemed to influence pesticide safety behavior, including PPE use.[21] In this study, size of the farm did not seem to influence PPE use compliance, p=0.556. This is because majority of the pesticide handlers (85%) were working on farms less than 2 acres of land. A similar relationship was reported in Pakistan.[21] However, contradicting results in Greece[15] and worldwide[22] respectively were reported where land size was an important predictor of PPE use compliance and pesticide safety behaviour observance. Given the time of exposure, persons tending large portions of land may consider using more PPE gear than persons working in smaller portions of land.

About a half of the pesticide handlers in MIS (46.7%) had pesticide experience above 5 years, a third with 3-5 years and the rest less than 2 years of experience. The study found a significant relationship between experience in pesticide application and PPE use compliance, p=0.002. On the contrary, a negative relationship between experience and PPE use was reported in Himalayas.[23] The finding is in agreement with most research findings on the association between age and PPE compliance where more young people have been reported as more PPE use compliant than the older pesticide handlers.[17,23] From the findings of this research, there was a positive relationship between age and PPE use compliance where older pesticide handlers use PPE more than their younger counterparts, p=0.001. This relationship between levels of PPE use and age as well as pesticide application experience is highly expected since experience relates directly proportionally with age. We found a very strong positive correlation between age and experience, ψ=0.929; p<0.001. Half of the pesticide handlers were youths between 22 and 35 years. The Kenyan constitution refers to a youth as an individual in the age bracket of 18 and 34 years, and as people aged 15 and 35 years by the African Youth Charter.[24]

Only a third (32.5%) among the respondents had been trained in pesticide safety or PPE use prior to the study. Between 32% and 43% small scale farmers were reported having been trained in pesticide safety behaviour in Meru, Kenya.[7] There is a general low level of training in pesticide safety behaviour as well health effects in Africa. In Rwanda, only 41.7% of farmers had received some kind of training from different organizations with only 1.9% of them having received definite training on human wellbeing and danger of pesticides.[11] In Morocco, just 15.1% of small-scale cultivators had previously gone through training in pesticide safety.[17] The situation is worse in Ethiopia where only 4.2% of pesticide handlers having been trained in appropriate utilization and management of pesticides.[14] This research uncovered a meaningful link between training in pesticide safety or PPE use and level PPE use, p<0.001. Several other studies reported a similar relationship.[13,17,19,21] This confirms the potential there is in training farmers on matters PPE use, and pesticide safety and associated health hazards towards enhancing PPE use compliance and improving health of pesticide handlers.

Knowledge on pesticides used and pesticide safety

Most of the pesticide handlers in MIS (77.6%) showed a high level of pesticide safety knowledge. This coincides with findings made in Bangladesh and Kenya.[7,22] Contradicting findings were in Ethiopia where 95% of small-scale farmers had poor knowledge on pesticides. However, there was low PPE use level among the respondents despite the high pesticide knowledge levels.[14] A low PPE compliance was noted irrespective of laborers' awareness of exposure hazards in South Africa.[19] The study revealed a significant relation between knowledge on pesticide safety and PPE use compliance p<0.001. This indicates that pesticide handlers with higher pesticide safety knowledge used more PPE during pesticide application compared to those with lower pesticide knowledge. Similar findings were made globally, Himalayas, Greece and Ethiopia.[14,16,23] This relationship is expected since pesticide safety knowledge enhances risk perception. Training in pesticide safety and health risks has a high potential of increasing observance of pesticide safety behavior, including PPE usage among pesticide handlers. These trainings may uncover important, yet ignored pieces of information regarding pesticides. For instance, only 28.5% of pesticide handlers in this study knew pesticide toxicity color code/toxicity color triangle. This figure closely relates to the percentage of trained pesticide handlers which stood at 32.5%. In Zimbabwe,[25] it was reported that 41.5% of respondents knew the triangle color code while only 4.8% was reported in Ethiopia.[14] This is usually found on pesticide labels and only persons aware of their meaning can interpret them accordingly. It could also inform pesticide handlers on reasons for banning or restricting usage of some pesticides. In this study, only a half (50.8%) of the pesticide handlers knew the reason for pesticide ban. This figure corresponds to the 56% proportion reported in Ethiopia.[14]

Pesticide handlers' attitude and perceptions on Pesticides and PPE use

Most of the pesticide handlers in MIS see pesticide use as potentially harmful to their health (96.3%), as well as their environment and other animals (82.9%). Similar observations were posted in Ethiopia and Bangladesh.[14,22] 94.3% also view PPE as important during pesticide application activities. It was noted from FGD forums that the number of fish in the farrows and canals draining the paddy fields had drastically reduced over time. This phenomenon convinced majority of the participants that pesticide effects were real in the environment.

Perceived environmental risk and perceived PPE importance had a statistically significant association with PPE use compliance, p =0.009 and p<0.001 respectively. However, perceived health risk did not have a significant association, p=0.535. Thi is probably because almost everyone thought pesticides as potentially harmful to their health. This contradicts findings made in Iran, South Africa and Greece.[15,16,23] They found pesticide risk perception as an important predictor of safe pesticide behavior and PPE use. There was a high positive attitude towards PPE use among pesticide handlers in MIS in general. Attitude towards PPE use showed a significant statistical association with PPE compliance, p=0.001. Pesticide handlers displaying a more positive attitude had higher chances of putting on PPE during pesticide application than those with lower scores. Similar associations were found in Himalayas and globally.[16,23]

Limitations

This study did not involve pesticide handlers from other rice-growing regions in Kenya outside the Mwea irrigation Scheme due to logistical and feasibility constraints. Limited time-frame within which the research had to be concluded affected the speed at which data collection took place which had potential to negatively affect the study. However, this was addressed by covering as much ground as possible during data collection.

CONCLUSION

There is a low level of PPE use among pesticide handlers in Mwea irrigation scheme. Being female, older, crop owner, trained in pesticide and PPE use, experienced in pesticide application, knowledgeable in pesticide safety, and having a more positive attitude towards PPE use are associated with PPE use. The results provide insights for future interventions and inform focus areas by health and safety enforcement agencies and policy developers. More training on pesticide safety and PPE use will enhance compliance and promote pesticide handlers' health.

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REFERENCES

1. Reddy V, Kimani M. Mwea Rice Growers Multipurpose public case report. Available at: https://www.idhsustainabletrade.com/uploaded/2020/11/200828_MRGM-Case-Final-Public-Report.pdf. Accessed on: 20 February 2020.
2. Chatterjeea S, Gangopadhyaya C, Bandyopadhyaya P, Bhowmicka M, Roya S, Majumderb A, et al. Input-based assessment on integrated pest management for transplanted rice (Oryza sativa) in India. J Crop Protect. 2021;141:23-8.
3. Rahaman MM, Islam KS, Jahan M. Rice Farmers' Knowledge of the Risks of Pesticide Use in Bangladesh. J Health Pollut. 2018;8(20):181203.
4. Ren Z, Jiang H. Risk cognition, agricultural cooperatives training, and farmers' pesticide overuse: Evidence from Shandong Province, China. Front Public Health. 2022;10:1032862.
5. Koskei VK. Diversity of weed and their integrated management practices in paddy rice (Oryza sativa) production. Available at: http://erepository.uonbi.ac.ke/bitstream/handle/11295/97678/Koskei_Diversity%20Of%20Weed%20And%20Their%20Integrated%20Management%20Practices%20In%20Paddy%20Rice%20(Oryza%20Sativa)%20Production.pdf?sequence=1. Accessed on 20 February 2022.
6. Mwea Irrigation Scheme. Available at: https://www.irrigation.go.ke/projects/mwea-irrigation-scheme/. Accessed on 20 February 2022.
7. Marete GM, Lalah JO, Mputhia J, Wekesa VW. Pesticide usage practices as sources of occupational exposure and health impacts on horticultural farmers in Meru County, Kenya. Heliyon. 2021;7(2):e06118.
8. Buralli RJ, Ribeiro H, Mauad T, Amato-Lourenço LF, Salge JM, Diaz-Quijano FA, Leão RS, Marques RC, Silva DS, Guimarães JRD. Respiratory Condition of Family Farmers Exposed to Pesticides in the State of Rio de Janeiro, Brazil. Int J Environ Res Public Health. 2018;15(6):1203.
9. Pesticides in Kenya: Why our health, environment and food security are at stake. Available at: https://routetofood.org/wp-content/uploads/2019/08/RTFI-White-Paper-Pesticides-in-Kenya.pdf. Accessed on 20 February 2022.
10. Tarmure S, Alexescu TG, Orasan O, Negrean V, Sitar-Taut AV, Coste SC, Todea DA. Influence of pesticides on respiratory pathology - a literature review. Ann Agric Environ Med. 2020;27(2):194-200.
11. Ndayambaje B, Amuguni H, Coffin-Schmitt J, Sibo N, Ntawubizi M, VanWormer E. Pesticide Application Practices and Knowledge among Small-Scale Local Rice Growers and Communities in Rwanda: A Cross-

Sectional Study. Int J Environ Res Public Health. 2019;16(23):4770.

12. Tijani A. Pesticide Use Practices and Safety Issues: The Case of Cocoa Farmers in Ondo State, Nigeria. J Hum Ecol. 2010;19:183-90.
13. Sookhtanlou M, Allahyari MS. Farmers' health risk and the use of personal protective equipment (PPE) during pesticide application. Environ Sci Pollut Res Int. 2021;28(22):28168-78.
14. Mergia MT, Weldemariam ED, Eklo OM, Yimer GT. Small-scale Farmer Pesticide Knowledge and Practice and Impacts on the Environment and Human Health in Ethiopia. J Health Pollut. 2021;11(30):210607.
15. Damalas C, Koutroubas S, Abdollahzadeh G. Drivers of personal safety in agriculture: A case study with pesticide operators. J Agri. 2019;9(2):35-8.
16. Ratana S, Ajchamon T. Factors affecting use of personal protective equipment and pesticide safety practices: a systematic review. J Environ Res 2020;185:23-9.
17. Benaboud J, Elachour M, Oujidi J, Chafi A. Farmer's behaviors toward pesticides use: insight from a field study in Oriental Morocco. Environ Anal Health Toxicol. 2021;36(1):e2021002-0.
18. Nguetti J, Nuwamanya AM, Runo S, Mwangi M. Farmers' perceptions on tomato early blight, fungicide use factors and awareness of fungicide resistance: Insights from a field survey in Kenya. PLoS One. 2023;18(1):e0269035.
19. Andrade-Rivas F, Rother HA. Chemical exposure reduction: Factors impacting on South African herbicide sprayers' personal protective equipment compliance and high risk work practices. Environ Res. 2015;142:34-45.
20. Lekei EE, Ngowi AV, London L. Farmers' knowledge, practices and injuries associated with pesticide exposure in rural farming villages in Tanzania. BMC Public Health. 2014;14:389.
21. Mobushar M, Aldosari F, Baig M. Assessment of farmers on their knowledge regarding pesticide usage and biosafety. Saudi J Biol Sci. 2009;26:1903-10.
22. Rahaman MM, Islam KS, Jahan M. Rice Farmers' Knowledge of the Risks of Pesticide Use in Bangladesh. J Health Pollut. 2018;8(20):181203.
23. Ganaie MI, Ganaie SA, Lone FA, Mayer IA, Ahmed P. Attitudinal behaviour of agriculturalists towards pesticide use in Pir Panjal Range of Kashmir Himalayas. Int Arch Occup Environ Health. 2022;95(9):1859-70.
24. Youth and Children. Available at: https://www.ngeckenya.org/SpecialInterestGroups/YouthandChildren#:~:text=Article%20260%20of%20Kenya's%20Constitution,thirty%20four%20(34)%20years. Accessed on 29 December 2022.
25. Magauzi R, Mabaera B, Rusakaniko S, Chimusoro A, Ndlovu N, Tshimanga M, Shambira G, Chadambuka A, Gombe N. Health effects of agrochemicals among farm workers in commercial farms of Kwekwe district, Zimbabwe. Pan Afr Med J. 2011;9:26.

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