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Research Article

# Farmers' Perceptions and Practices in Managing Vegetable Pests and Pesticide Use in the Upper Blue Nile Basin, Ethiopia: In the Case of the Koga Irrigation System

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## Abstract

This experiment was carried out to assessment of farmers' perceptions, knowledge, and current management practices on the major pests among vegetable growers in the Koga irrigation system, Ethiopia. Understanding the farmers' awareness and pest management is essential for designing a research agenda, and awareness creation. The survey was carried out from November 2020 to March 2021 in Koga irrigation, with a total of 63 vegetable growers. A semi-structured questionnaire was used. Almost all farmers in the study area overwhelmingly depend on pesticides to control the pests on their vegetable crops. Profenofos, Dimethoate, and Lambda-cyhalothrin were dominantly and commonly used insecticides in the study area with different trade names for more than two vegetables. There are two common and widely used fungicides named Metalaxyl-M 68 %WG and Mancozeb regarding disease control. The farmers used wrong application techniques, inappropriate spraying, wrong storage practices, and protective measure of pesticides. This wrong perception and practice could be associated with their limited knowledge about pesticides and related activities. Hence, it is recommended that government or non-governmental organizations should focus to improve the misuse and misperception of farmers in pesticide use, including personal and environmental protection through education and community intervention.

## Keywords

Miss-Use of Pesticide, Wrong Protective Measure, Pest Management Practices, Vegetable Crops

## 1. Back Ground and Justification

Two major types of studies discuss the use of vegetables revealed that vegetables are important edible crops and are essential parts of the human diet [1, 21]. Considering vegetables' importance for the human diet, recommended that vegetable consumption should be 200 g/day/person, 73 kg/person/year.

Irrigation is the reliable method of increasing agricultural production and productivity and has greater impacts in solving food security problems in many parts of Ethiopia [18]. Realizing irrigation importance for food production, Ethiopia has been allocating huge investments for irrigation infrastructure development over the last two decades. This investment, together with improved crop production technologies has enabled the country to move towards achieving self-sufficiency in food production [18]. Koga irrigation is one of the irrigation scheme found in northwestern Ethiopia, which

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is a typical catchment for Ethiopian Vegetable production. This irrigation scheme is suitable for different crops like wheat, barley, bean, maize, cabbage, potato, tomato, onion, shallot, and pepper [18]. Cabbage, potatoes, tomatoes and onions are the most important irrigated vegetable crops grown in Koga irrigation. According to [13] in Koga irrigation, onion and potato are the second and third important crops grown next to wheat.

Northwestern Ethiopia, where Koga Irrigation Scheme is located contributes about 40% of the national potato production [7]. Regarding onion production in Ethiopia, it covers an area of 48,443.36 ha with a total production of 374,704 tons [7]. However, the national average productivity of onion and potato in Ethiopia is 7.734 t ha−1 and 12.3 Mg/ha respectively, which is low compared to the world average of 19.49 t ha−1 [8] onion and 50 Mg/ha potato under good management practices and using improved varieties [3].

Biotic and abiotic factors are among the major constraints of vegetable production; pests are one of the major production constraints that vegetable growers face throughout Ethiopia [20]. This above mentioned study further observed and found that the major biotic constraints that have severely affected vegetables production in Ethiopia are blight in potato and tomato, onion thrips and downy mildew in onion, aphids in cabbage. Pesticides are substances used for preventing, destroying pests and weeds and constitute an important input when producing a crop [19, 9].

Different studies conducted on knowledge, attitude, and behavior among stallholders [2, 20] have shown that unsafe use of pesticides is common in the central rift valley of Ethiopia. However, the knowledge, attitude and behavior of irrigated vegetable producers at Koga Irrigation, West Gojam did not explore. According to [10, 16] finding understanding the farmers' perceptions, knowledge, and pest management strategies for the control of pest is critically important for setting a research agenda, designing extension strategies. There are no systematic studies carried out on the farmers' perceptions, knowledge, and pest management strategies in Koga irrigation, Ethiopia. Therefore, the objective of the present study was to assess farmers' perceptions, knowledge, current management practices, and potential constraints in management practices of the major pests among vegetable farmers in Koga Irrigation, Ethiopia.

## 2. Material and Method

In West Gojam, Ethiopia, at the Koga irrigation schemes, experiments were carried out. The production seasons of November 2020 to March 2021 were used for it. The Koga irrigation system is located in the South Mecha district at an elevation of 1960 meters above sea level in latitude 11°25'20" N and longitude 37°10'20" E. Farmers in this district were surveyed regarding vegetable pests, pesticide use and types of methods employed, pesticide application frequency, pesticide selection, storage, mixing, and spraying techniques, and the mechanism for disposing of empty pesticide containers.

*Sampling Procedure and Data Collection (Sampling Technique and Data Collection)*

The knowledge and perception of smallholder vegetable farmers about the use of pesticides and pest management was obtained using a semi-structured questionnaire created by entomologists. In order to improve it, the questionnaire was first created, pretested, and then translated into the local tongue to facilitate communication between interviewers and farmers. The study's respondents were chosen using a multistage sampling procedure. Eleven possible kebele were included in this district selection process, and five to thirteen homes were randomly chosen for in-person interviews using the transect method outlined by [5]. 63 irrigated vegetable farmers in all, who have more than interviewees had one year of experience with pest management and vegetable production. There were twenty-eight main questions in the questionnaire. In order to collect data within the cultural context of farmers, open-ended questions concerning farmers' perceptions, knowledge, and use of pesticides in relation to vegetable pests were employed.

The socioeconomic and lifestyle variables (age, sex, education, and land tenure) were the subjects of the data collection.

Farmers also enquired about vegetable pests, their methods of control, where to find information on managing vegetable pests, and how effective pesticides are as a means of pest management. Additional information gathered included the sources of pesticides, their properties, stores, locations, and methods of mixing, as well as the frequency, dosages, and application of pesticides, protective gear, and pesticide container disposal.

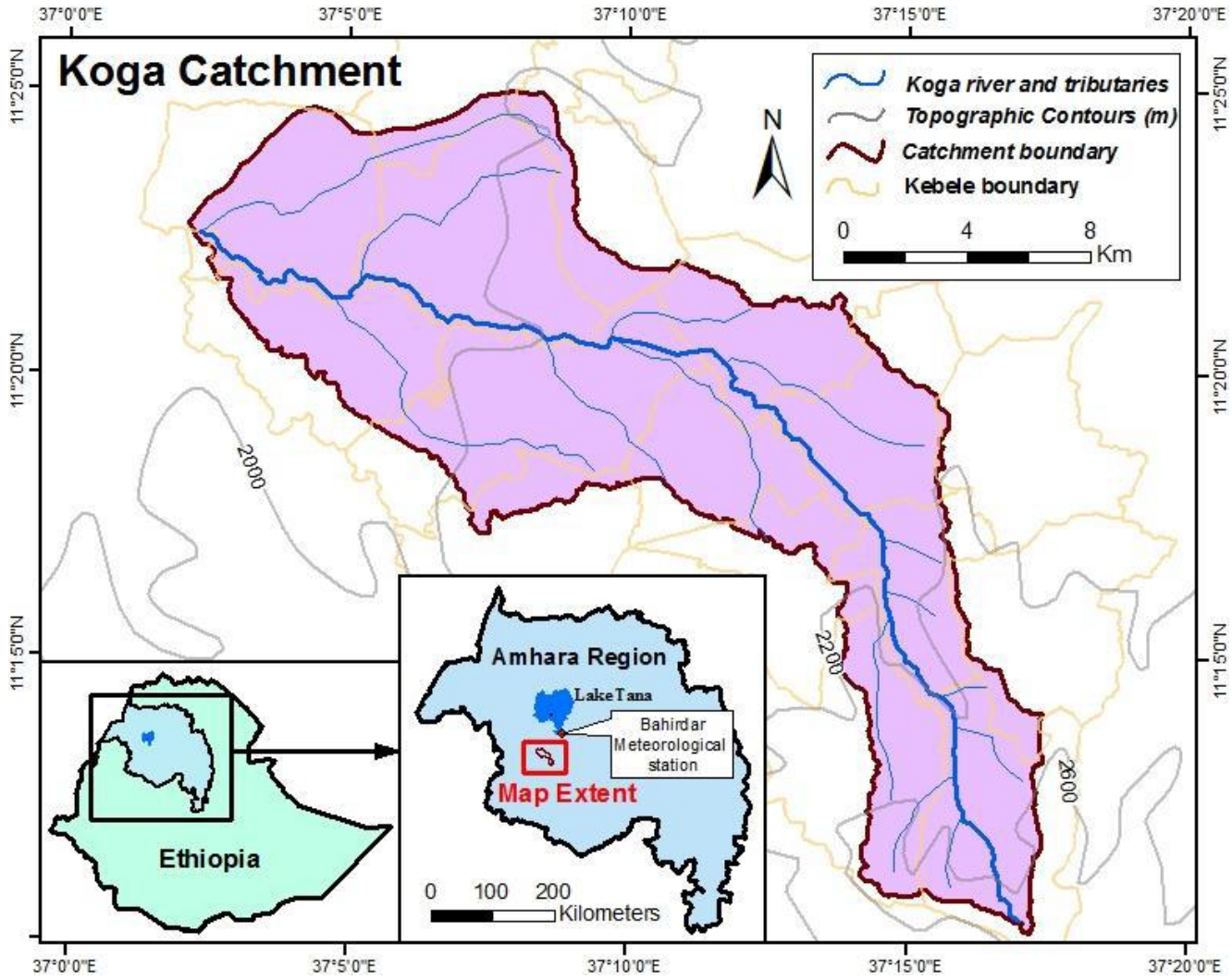


***Figure 1.*** *Map of Koga irrigation scheme and vegetable growing areas covered by the survey.*

*Data Analysis*

The statistical package for social sciences (SPSS) software version 20.0 and Excel Microsoft were used to determine descriptive statistics and percentage.

## 3. Result and Discussion

### 3.1. Socio-Economic Profile

Table 1 represents the socio-economic profile of the smallholder vegetable growers.

According to [4], education enhances one's ability to receive, decode and understand information. This survey result showed that 35.06% of the respondents were didn't receive any formal education at all, whereas 55.84% of respondents had primary school education. The remaining 10% of respondents were secondary school graduates, while only one respondent attained a college diploma.

Regarding respondents' age, a previous survey result examined and implied that age is an important variable in the decision process because younger farmers tend to be more flexible in their decisions to adopt new ideas and adopt proper and safe handling methods. According to the results of the current survey, 36.36% of the respondents were between the ages of 19 and 48, and more than half (58.44%) were between the ages of 40 and 66. 9.32% of the household members were older than 49. In terms of respondents' sex, 88.3% of smallholder farmers in the current survey were men, and the remaining 12.7% were women this result is in line with [11].

We also enquired about their experience with vegetable farming, and based on their response, the farmers reported having 0–10 years of experience with irrigated vegetable production. Given that phone numbers are expected to be among the most important sources of information for rural farmers in countries like Ethiopia, we asked them if they had them or not. In this regard, more than 72% of the respondents to the current survey indicated that they had a mobile phone for communication.-communication (Table 1).

***Table 1.*** *Showed that the socio-economic characteristics of the farmers.*

| Characteristics | Respondents (%) (n=63) |
|---|---|
| Sex | |
| Female | 12.7 |
| Male | 88.3 |
| Age (year/s) | |
| 19-40 | 36.36 |
| 41-66 | 58.44 |
| Farm size | |
| <1 hectare | 67.5 |
| >1 hectare | 32.46 |
| Mobile owner | 72.73 |
| Vegetable farm experience | |
| 2-6 | 53.25 |
| 7-10 | 37.66 |

*Places where pesticides purchase, storage, and mixing carried out and fate of empty pesticide container.*

## 3.2. Pesticide Storage

A previous study in respect to pesticide handling and storage stated that educational status, knowledge, and attitude as factors have a strong association with pesticide handling and storage practice among farmers working in irrigation [14].

On the contrary to the aforementioned literature, the current finding showed that 28.73% of farmers stored the pesticide with the bulk of other household materials or hanging from the roof in the house, while 37.66% of respondents stored the pesticide outside the house, a small house constructed for domestic animal or cooking (Table 2). Furthermore, 14.29% of participants put the purchased pesticide in the field (farm). The current result in conformity with [15] finding which states that the storage of pesticides in unguarded sites in residences is common in developing countries. Storing pesticides within the house with the bulk of other household materials by 28.73 % of farmers, which is a cause of a high risk of pesticide exposure through either direct inhalation or contamination with other food.

This mishandling of pesticides may due to a lack of formal training concerning the pesticide health (chronic and acute) negative effect.

## 3.3. Place of the Pesticide Market

Regarding farmers' pesticide purchasing in the surveyed area majority of the farmers (87.4%) bought the pesticide from chemical dealers. Apart from buying the pesticide from chemical dealers, 2.6% of respondents bought the pesticide from a cooperative (Table 2). The rest of them bought the pesticide both from chemical dealers and operatives. When the farmers buy the pesticide, 29.87% of them read pesticide labels before buying pesticides, whereas most of the participants (68.83%) did not read pesticide labels. Their reason why did not read the pesticide label before buying was most of the pesticide label written in a foreign language (e. g. English), and the rest of respondents reason were inability to write and read even with their own Mather tongue. This situation implied that most of the farmers' pesticide selection depends on whether it is an approved pesticide for approved pest or could be that most of the farmers in the current study area. This result is in line with previous studies conducted in developing countries [22].

## 3.4. The Fate of Empty Pesticide Container

According to [23] study, an empty container contains 2% pesticide left in the packaging material. The other study stated and advised that the empty pesticide containers destroy system should be in a licensed incinerator or dumped in an approved landfill site, and in countries, where there are no licensed facilities, on-farm burial or burning, is a possible option [12]. It was found that an approximately equal proportion of participants (44.78% and 38.81%) replayed that they throw the empty pesticide container into an irrigation canal and on-farm respectively, while 2.99% reuse the empty pesticide containers for drinking, and to store solids for pouring (e. g., sugar, flour, and grains). The empty pesticide containers in the study area made from glass, plastic, or metal flasks, bottles, plastic bags, or paper bags. Most fungicide containers are paper bags whereas the insecticide containers are glass, plastic, or metal flasks, bottles.

The respondents who experienced collect and bury in the ground on-farm were 16.41%. Moreover, farmers also respond that currently their son or daughter collect and store empty pesticide container which made from glass and related material and then they sell those collected empty container for buyer locally named as 'QURALEW'. Good practice (collect and burn) of empty pesticide container handling in the current study was implemented by only 7.99% of farmers.

In general, the improper practice of empty pesticide container handling of the current study is inconsistent with [20] report, which conducted in central Rift valley, Ethiopia. This similarity may due to a lack of training on empty pesticide container handling in both previous and current study areas. This misuse of pesticide container in the study area may affect the human health and natural environment such as water, soil, wildlife, fish, and other non-target organisms may be affected [17]. Hence, the government and other non-government organization should focuses on changing farmers' awareness regarding to pest and pesticide container handling.

*Table 2. Represents the places where pesticides purchase, and storage carried out and fate of empty pesticide container (multiple answers possible).*

| Variables | Respondents (%) (N=63) |
|---|---|
| Place of pesticide storage | |
| Stored within their house | 28.73 |
| Stores outside their house | 37.66 |
| Stores within the field | 14.29 |
| Store in room | 0 |
| Fate of empty pesticide container | |
| Throw in to irrigation cannel or river | 44.78 |
| Keep for domestic use | 2.99 |
| Collect and burn | 7.99 |
| Throw away on farm | 38.81 |
| collect and bury in ground on farm | 16.14 |
| Place of purchasing pesticide | |
| From chemical dealers | 87.4 |
| From cooperatives | 2.6 |
| From both dealer and cooperatives | 10.0 |
| Source of information for farmers | |

Pest and pest management advisory services for the farmers in the study area were from different sources (Figure 2).

Regarding to pesticide purchasing, availability and cost of pesticides was a major concern for many interviewed farmers. For effective pest management, farmers need to have good knowledge of selection of correct pesticide for target pest. Though, this is important precondition, farmers' pesticide selection in our study area relay on the basis of availability and accessibility. Thus, nearly half of (46.75%) respondents' pesticide selection and decision influenced by pesticide dealer, while 14.29% farmers select the pesticide based on their neighbors information. The rest, 25.92% them buy the pesticide based on their own experience whereas, 12.99% of respondents were perceived they got enough understanding from extension worker.

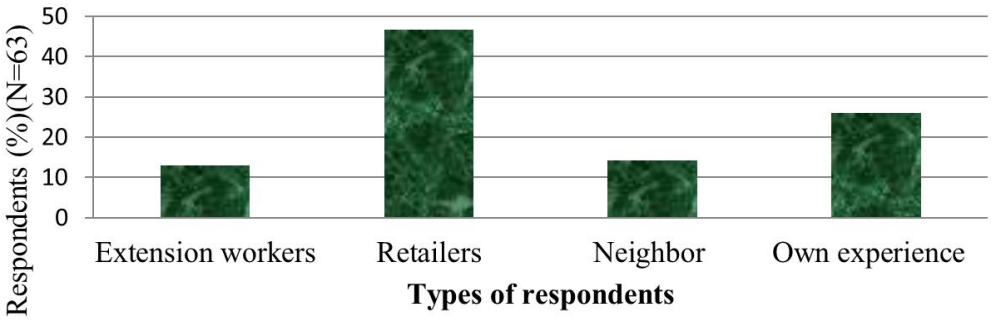


*Figure 2. Summarized that the source of information for farmers.*

*Farmers' knowledge and perceptions of vegetable pests and pest management*

Table 3 Summarized that major pests and management practice identified by growers as major pests of vegetable crops.

Almost all of the interview participants indicate that the attack of their vegetable was by a disease and insect pests. Though, they identified limited number of diseases, insect pests, as major constraints to vegetable production.

In total, respondents identified around 15 major pests that attacked their irrigated vegetables. Of 63 interviewed farmers 46.58%, 42.72%, and 9.27%, respondents identified, onion thrips, downy mildew, and purple blotch as major pests of onion respectively. Furthermore, 28.3% and 7.14% of participants recognized aphid and diamondback moths as cabbage pests. Irrigated tomato pests identified by the farmers were a blight, aphid, whitefly, and fruit borer which is known by 21.7%, 14.29%, 12.5%, and 42% of farmers respectively. Major pests (blight, aphid, and whitefly) of irrigated potato or symptoms they cause, recognized by 20.3%, 7.4%, and 12.1% of farmers during the interview respectively.

All listed pests in the table have been observed and confirmed during this survey and considered as an important pest of vegetables for the study area.

*Table 3. Pests identified by growers as major pests of vegetable crops.*

| Crop | Pests | Respondents (%) |
|---|---|---|
| Onion | Onion thrips | 46.58 |
| Onion | Downy mildew | 42.72 |
| Onion | Purple blotch | 9.27 |
| Potato | Late Blight | 20.3 |
| Potato | Aphid | 7.4 |
| Potato | white fly | 12.1 |
| Tomato | Late Blights | 21.7 |
| Tomato | Aphids | 14.29 |
| Tomato | White fly | 12.50 |
| Tomato | Fruit borer | 42.00 |
| Head Cabbage | Diamondback moth | 7.14 |
| Head Cabbage | Aphids | 28.3 |

*Pest management practice experienced by farmers*

*Figure 3 summarize that the farmers different pest management practice being used currently*

A previous study investigates and showed that cultural practices include scheduling planting time, use of early maturing cultivars, and timely harvesting used to reduce vegetable pests [6]. In spite of the fact that the above-mentioned literature implied the importance of cultural practice and resistance variety to reduce vegetable pests, farmers in our study overwhelmingly depend (100%) on pesticide to prevent pest activities and reduce vegetable losses during growing seasons. Very few farmers (6%) used cultural practice for only tomato insect mitigation in addition to pesticides; this cultural practice being used by the farmer namely removal of infested tomato fruit. None of the respondents used both biological and resistance variety as a vegetable pest management option. The farmers were also asked about their need to use resistance variety, in this regard; the majority of (85.7%) interview participants had an interest or need resistant vegetable verity as an alternative pest control.

A previous study recommended an integrated approach using a combination of disease management options as a plausible strategy to effectively manage blight on potato [6]. In contrast to aforementioned scientific study, our study found that nearly all of the farmers were aware of the IMP, biological and few farmers use cultural practices used as pest control. Therefore, awareness creation on those situations and correct pesticide utilization should be indispensable pre-condition to ensure that sustainable and effective vegetable pest management techniques. Considering, health and environmental risks totally depend on pesticide, the government has to formulate and enforce policies on use of integrated pest management approach.

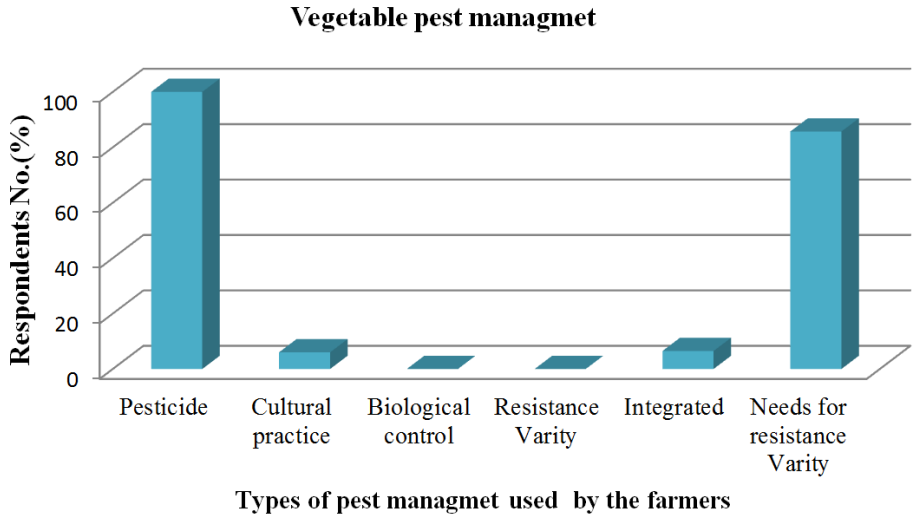


*Figure 3. Pest management option used by the smallholder farmers (multiple answers possible).*

*Pesticide type and application frequency by small holder farmers*

All surveyed irrigated vegetable growers control the pest by using synthetic pesticides. The types of pesticides used by the vegetable growers were insecticides and fungicides. Pesticides were bought from pesticides shops (60%), general shops (30%), and cooperative shops (10%). The pesticides were supplied in containers ranging from 0.5 to 5 l or in packets ranging from 0.5 to 25 kg.

The most frequently used insecticides were Profenofos with different trade names for more than two vegetable crops; mostly for the onion to control onion thrips, for head

cabbage to control aphids, and Dimethoate and Lambda-cyhalothrin were also commonly used insecticide. Regarding disease control, there are two common and widely used fungicides named Metalaxyl-M 68 %WG and Mancozeb.

Almost all farmers applied Ajanta and/or Dimethoate (locally called 'Coby' at the earlier crop growth stage of the vegetable, even without a significant amount of pests on their vegetables. We asked them why they spray that insecticide at the earlier crop growth stage of the vegetable, even no insect infestation, their reason was, they considered those insecticides as a crop vegetative growth stimulator. Most vegetable growers did not know the name of the pesticides; this makes farmers' and pesticide dealers' communication difficult, but they asked the dealer simply by calling the name of the vegetable. This Vegetable being attacked by different types of pests, hence calling the name of the crop is not good enough to effectively communicate with pesticide sellers and difficult to get the correct pesticide for desired crops. Most of the farmers used pesticides that were not labeled and unapproved for use on vegetables.

### 3.5. Frequency of Pesticide Spray Used by the Farmers

Regarding the frequency of pesticide application, most of the farmers applied pesticide more than seven, (10.58 and 7.55) times, throughout their growing season on onion and cabbage respectively. In our study irrigated vegetables that receives less pesticide application frequency (4.72 and 2.55 times) were tomato and potato respectively (Figure 4).

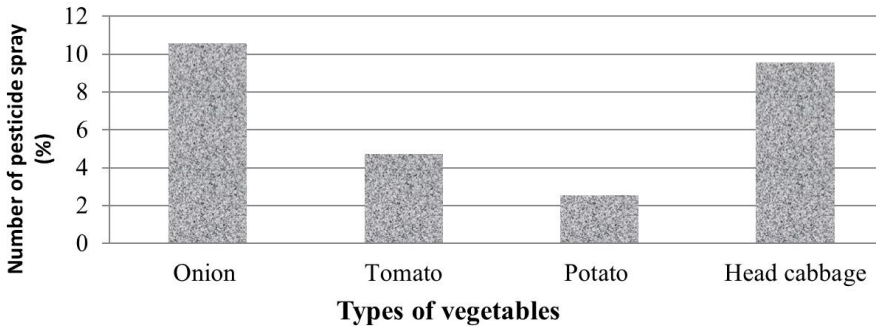


*Figure 4. Represents pesticide application frequency on different irrigated vegetable.*

## 4. Conclusion

In the current study area, the majority of farmers have more than seven years vegetable growing experience through irrigation system and they grew two sequential crops in a year. In this area insect pests and disease are the major vegetable production constraints. Farmers identified different types of diseases, and insect pests. Major pests identified by the farmers were onion thrips, downy mildew on onion, and garlic, whitefly and blight on potato, pea aphid on cabbage, and African bollworm, aphid, whitefly, and blight were recognized as a major vegetable production problem. Almost all formers depend on pesticide for the control of pest of the irrigated vegetables. Furthermore, our study found that vegetable growers having a misperception of pesticide use, and pest control strategy in vegetables. The farmers' unwise pesticide utilization practices are overuse, misuse, abuse and violation of the scientific instruction. These carless practices expose farmers to potential health and environmental contamination with pesticides. Additionally, this the farmers' abuse use of pesticide may lead to insect resistance development to pesticide and also it may eliminate the natural enemy of insect pest, which disturb the nature balance.

Further, farmers in the study area store the pesticide unsafely, they use wrong protective devices during spraying and mixing pesticide and they used wrong disposal system of pesticide containers. Additionally, some farmers in the study area re-used pesticide containers for household items like sugar, salt and water. This could lead to contamination of environment and a possible means of contamination of surrounding water bodies living organism like such as fish.

## 5. Recommendation

Hence, the government must establish policies on the use of pesticides and should promote integrated pest management technology. It is also highly recommended that there is a need for continuous pesticide safety education along with training to the farmers regarding the use of personal protective devices, personal hygiene, and sanitation practices during and after the application of pesticides. In addition, the supervisory mechanism and environmental monitoring systems for pesticides need to be strengthened on the safe use of pesticides regarding the environment and human health.

Furthermore, the farmers should be educated regarding to the use of PPE. The government and nongovernmental organization should provide training for farmers in the use of PPE.

## Abbreviations

| | |
|---|---|
| PPE | Personal Protective Equipment |
| CSA | Central Statistical Agency of Ethiopia |

## Limitation of the Experiment

The study did not include health risks associated with pesticides due to occupational or involuntary exposure, the impact of pesticides on domestic and wild animals, and the extent of environmental (air, water, and soil). The reason was Ethiopia has not yet set or adopted tolerance level (maximum residual limits) for pesticide residues in foods and feeds and the absence of laboratory facilities and trained personnel in the area of pesticide quality and residue analysis.

## Acknowledgments

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## Conflicts of Interest

The authors declare no conflicts of interest.

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## Research Fields

**Geteneh Mitku:** Agricultural entomology, plant science, Agricultural science, Environment science, life science

**Yinebeb Abebaw:** Plant science, biological science, soil science, Agricultural Science, micro biology