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Prevalence of Agrochemicals Use on Irrigated Vegetables Farms along River Moiben, Uasin-Gishu County

Teresa Akenga[1], Vincent Sudoi[2], Emmy Kerich[2,*], Gladys Cherono[3], Ayabei Kiplagat[4], Cyrus Kuya[1]

[1]Office of the Vice Chancellor, University of Eldoret, P.O BOX 1125, Eldoret, Kenya
[2]Directorate of Research and Innovation, University of Eldoret, P.O BOX 1125, Eldoret, Kenya
[3]School of Natural Resources, University of Eldoret, P.O BOX 1125, Eldoret, Kenya
[4]Department of Chemistry and Biochemistry, University of Eldoret, P.O BOX 1125, Eldoret, Kenya
*Corresponding author: emmycheptoo@gmail.com

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Abstract The purpose of this study was to carry out a survey on farming practices and agrochemical application along River Moiben in Moiben, Uasin Gishu County where intense agricultural practices are done especially during the dry season. As many other areas near water places, irrigated farming is done along Moiben River during dry season. Structured questionnaires were randomly administered through personal interviews and focused group discussion among farmers who practiced irrigated farming along River Moiben and a total of 136 respondents were interviewed. Data were collected in the month of March, 2019 and entered into the Statistical Package of Social sciences (SPSS) after which it were analyzed using descriptive statistics. Results showed that eight villages practiced crop irrigation in Moiben Sub County and they include; Koisagat, Kapsurur, Kaptik, Sasitwo, Kapsoni, Kabomoi, Meibeki and Kapsiliot. From each of these villages, 17 farmers were interviewed. It was also indicated from the results that 94 % of the farmers obtain irrigation water from River Moiben. The main crop grown under irrigation was tomatoes with 91.7 %, others were collard greens, black night shade, cabbage, maize, beans, spinach, coriander and black pepper. The most applied fertilizer was Di-ammonium Phosphate (DAP) with 99.2 % followed by Calcium Ammonium Nitrate (CAN) with 73.3 %, others were urea, Mono-Ammonium Phosphate, farm yard manure and ammonia. The study further recorded the most applied pesticides to be insecticides at 72.5 % of the respondents to be applying them. Labda Cyhalothrin active ingredient was the most applied chemical under insecticide with 31.9 % of the farmers applying it on tomatoes, cabbages and kales. It was noted that some farmers applied fertilizers and pesticides above the recommended level. The study recommends farmers training on appropriate agrochemicals application to reduce the possibility of detrimental effects and on the adverse effects of agrochemicals use on environment and human health.

Keywords: *irrigation, agrochemicals, human health, survey, crop farming*

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1. Introduction

The earth inhabitants is estimated to attain nine billion by the year 2050 [1,2,3] which necessitate an expansion of food production of about 40-45 %. However, food production is continuously susceptible by crop losses due to pests' invasion and soil infertility [4,5,6]. So as to enhance food productivity and increased food security, utilization of agrochemicals such as pesticides and fertilizers is necessary to lessen or eradicate pest infestation and improve soil fertility [7,8,9,10]. Fertilizers are either natural or synthetic material applied to soil or to plant tissues to supply plants nutrients indispensable to plant growth and development. Fertilizers include; synthetic fertilizers, hormones and growth agents and animal manure [11,12,13]. Food with high nitrate contents has led to nitrosation, which causes thyroid defect, cancers, teratogenic effects and diabetes. Pesticides are chemical compounds that are used to kill pests, including insects, rodents, fungi and unwanted plants (weeds). They are grouped into carbamates, pyrethroids, organophosphorous and pyrethrin and organochlorines [14,15,16,17]. Pesticides can have many unfavorable environmental impacts such as persistence in soil bioaccumulation and water contamination [18,19,20]. In humans, pesticides are known to cause carcinogenic, teratogenic neurologic and genotoxic effects [21,22,23,24]. Many of these unintended negative consequences are not yet fully understood [25].

Agricultural sector is the main driver of Kenya's economy as it provides employment to majority of Kenyans [26,27]. According to the Kenya Big Four Agenda, to achieve food security and proper nutrition for

all Kenyans, the government targets to increase production of maize, rice and potatoes by 2022. In addition, increase irrigation projects countrywide with a view to transforming agriculture from subsistence who farm less than 2 hacters of land to productive commercial farming [28,29]. It has been reported that subsistence farming in the Country is depicted by poor agricultural practices, poor infrastructure and insufficiency of extension officers among others [30].

According to Ministry of Environment, Water and Natural Resources, [10] approximately 54,516 tones of pesticides were imported to Kenya between 2008 and 2013. These pesticides are an assortment of insecticides, fungicides, herbicides fumigants, rodenticides, growth regulators, defoliators, proteins, surfactants and wetting agents [31]. Agrochemicals abuse and misuse in the country has been reported [32,33,34] and its accredited low level of education and low or no training on how to apply and environmental and health consequences of pesticides use. Cases of sale of unregistered and banned products, use of counterfeit labels, smuggled products among others have been reported in Kenya [31].

River Moiben in Uasin Gishu County is one of the water sources in Kenya providing irrigation water to people irrigating their crops along it. Most people living along the River practice irrigation of crops including kales, spinach, tomatoes, black night shade, cabbages among other vegetables. The farmers are using various agrochemicals and the use of the agrochemicals and possible environmental pollution from irrigation has not been investigated. Therefore, this study was necessary to identify areas where irrigation is done along the river, the sources of water used for irrigation and the commonly used agrochemicals and inorganic fertilizers Moiben River along. The results will provide useful baseline information for sustainable agriculture and safeguard the public health and conservation of fragile River Moiben.

2. Methodology

2.1. Study Area

The study was done along Moiben River in Moiben Sub-county of Uasin Gishu County. The county lies between Longitudes 34^0 50'' East and 35^0 37' West and latitudes 0^0 03'' South and 0^0 55' North [35]. The County have common boundary with Kericho County to the South, Trans Nzoia County to the North, Elgeyo Marakwet County to the East, Nandi County to the South West, Kakamega County to the North West and Baringo County to the South East. The County is mainly a crop farming zone of maize and wheat. Other crops grown in the area are beans, potatoes, various vegetables [36] including kales, cabbages, black night shade and spinach and tomatoes. The county has been subdivided into six Sub Counties: Ainapkoi, Moiben, Soy, Kesses, Kapseret and Turbo. Moiben River is situated in Moiben Sub County.

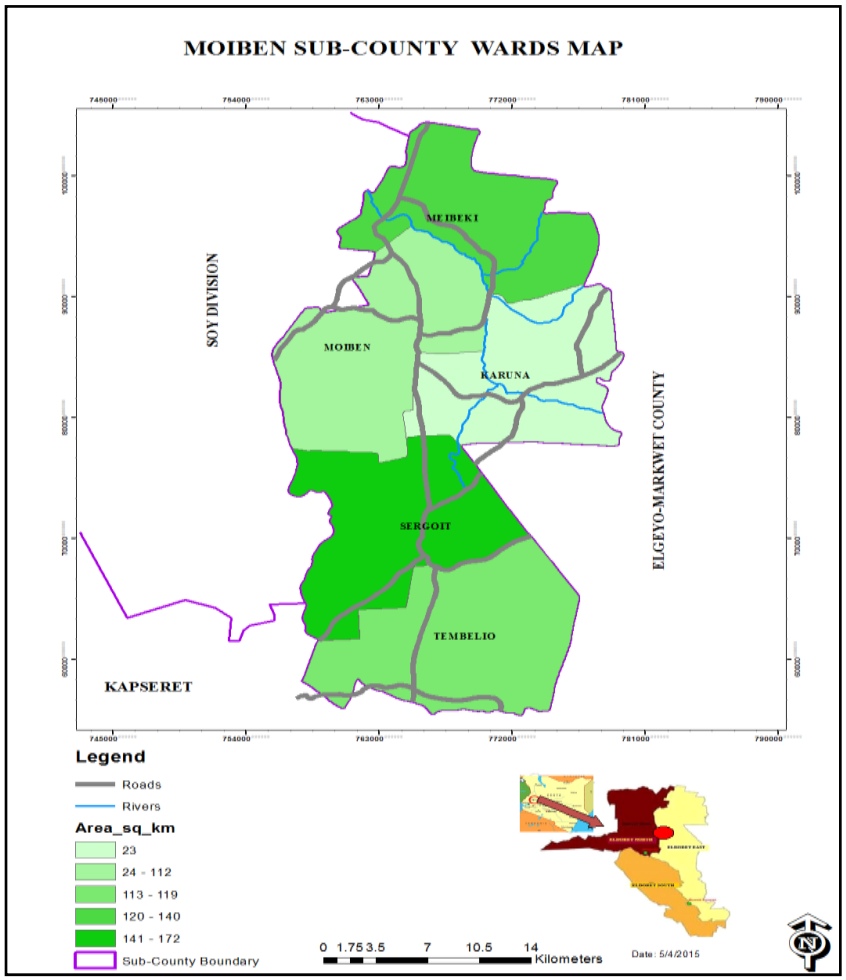

Figure 1. Moiben Sub-county map [37]

2.2. Research Design

2.2.1. Data Collection Methods

Both primary and secondary data collection methods were used in collecting data for this study. Primary data were obtained from structured questionnaires and secondary data were obtained from online and offline published data relating to the area of study.

2.2.2. Sampling Design

Purposive sampling design was used whereby people farming along and around Moiben River most of which are irrigating their farms were interviewed. First, the area around River Moiben was purposively selected because they are practicing irrigation and the researchers were targeting irrigated farms. Secondly, farmers along River Moiben were purposively selected and the researchers were basing their selection on those practicing irrigated farming.

2.2.3. Sample Size Determination

A total of 136 respondents (household heads) out of 210 practicing irrigation were involved in filling questionnaires for the study. This sample size was developed based on Slovin's formula $n = N/1+N(e)^2$ [38].

2.3. Data Analysis

The data was cleaned and entered into Statistical Package of Social Scientist (SPSS Version 16). The data was then subjected to descriptive statistical analysis technique.

3. Results and Discussions

Majority of the people living in Moiben Sub County, Uasin Gishu County practice both crop farming and livestock keeping. Crop farming is done in large scale especially for maize during wet seasons. During dry seasons, most of those who practice crop farming undertake irrigated farming near rivers and streams. This study focused on irrigated farming since they use agrochemicals intensively. One hundred and thirty six respondents were selected from people doing irrigation along River Moiben. The irrigation system is uncontrolled and uses rudimentary technology of abstracting and distributing irrigation water to the farm plots mostly by motorized water pumps.

3.1. Areas Where Irrigated Farming Is Done along Moiben County

Meibeki location chief showed that eight villages practiced crop irrigation in Moiben Sub County. These include Koisagat, Kapsurur, Kaptik, Sasitwo, Kapsoni, Kabomoi, Meibeki and Kapsiliot. 17 farmers were interviewed from each of these villages.

3.2. The Period of Farming

Most farmers in the study area have practiced farming for 5 years and below (44 %), followed by those who have done farming for six to ten years (34 %). Very few have practiced farming for over 20 years (5 %). Results are presented in Figure 2 below.

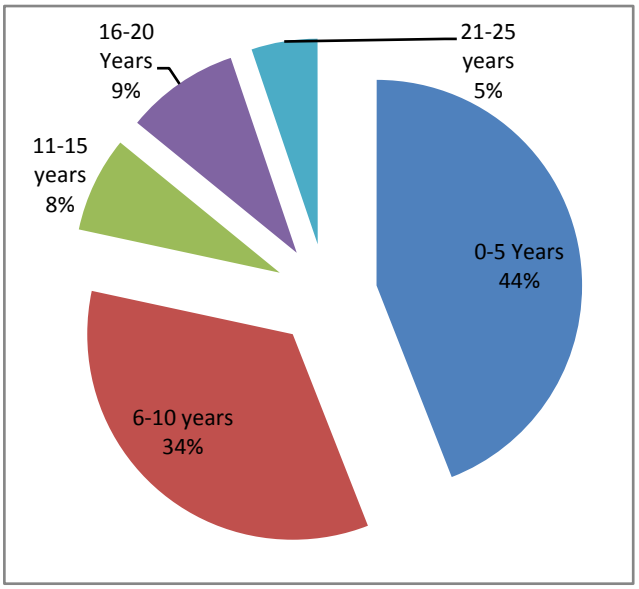

Figure 2. Period that has been taken in farming by the farmers

From results it is apparent that most of the farmers have not yet practiced farming for a long period of time. This may mean that most of them may not have full knowledge on agrochemicals application and they could as well be ignorant on the dangers posed by their use. The high number of farmers with less than 10 years attributed to an increase in number of young people engaging in horticultural production due to lack of formal employment and high illiteracy level. Unemployment rate in the area like in many parts of the country has been high with some of the youths engaging in anti-social behavior and drunkenness hence the community and government leaders have been encouraging the youth to try farming other than waiting for unavailable white collar jobs [39].

3.3. Crops Planted by Farmers along River Moiben

Most farmers living along Rivers and Streams in Moiben Sub County practice farming of tomatoes (91.7 %) during dry seasons. Other crops grown in the region include maize (61.6 %), sukuma wiki (52 %), black night shade (45.9 %), beans (33.1 %), cabbages (33.1 %), spinach (8.3 %), wheat (8.3 %), coriander (3 %), black pepper (2.2 %) and peas (1.5 %). Results are indicated in Figure 3 below.

[40] while evaluating farming practices and uses of agrochemicals in Lake Manyara basin, Tanzania reported that the highest number (95 %) of households grew crops, namely, maize, rice, banana and vegetables. [41] reported that 5 crops grown in the study area included cabbage (*Brassica oleraceae var. capitata*), tomatoes (*Lycopersicumesculentum*), carrots (*Daucascarota*), spinach (*Spinaciaoleracia*) and kales (*Brassica oleraceaevar.acephala*). This study was similar to our study where most of the crops grown were tomatoes, kales and managu.

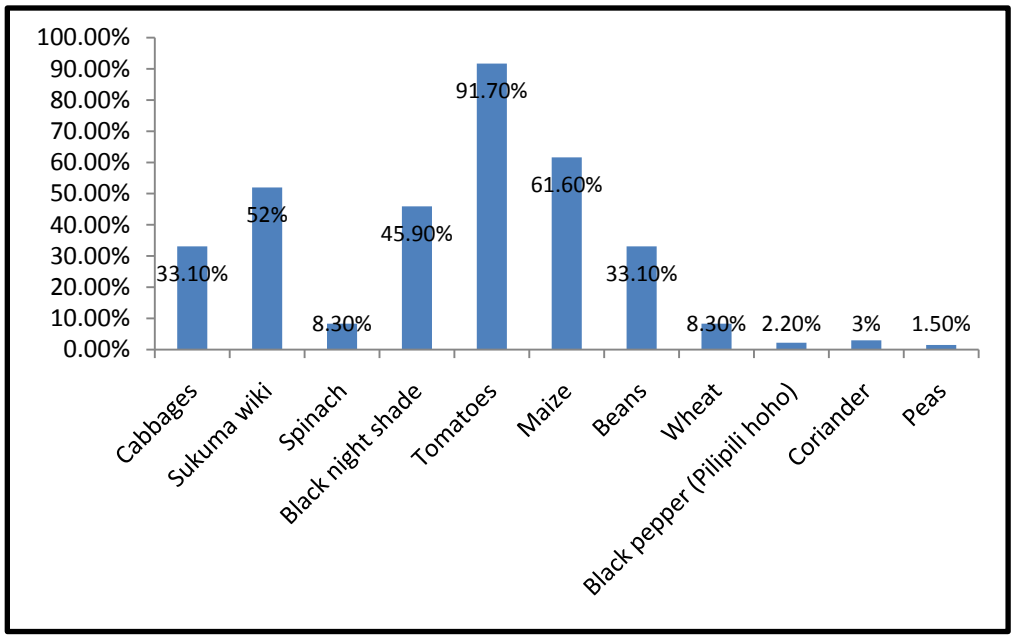

Figure 3. Crops planted along Moiben River

3.4. Irrigation Water Sources

Most of the farmers irrigating farms in Moiben Sub County obtained irrigation water from River Moiben (94 %). The rest obtained the water from Tangasir River (3.4 %), River Cheborорwa (1.7 %) and Koibeiyot stream (0.9 %).

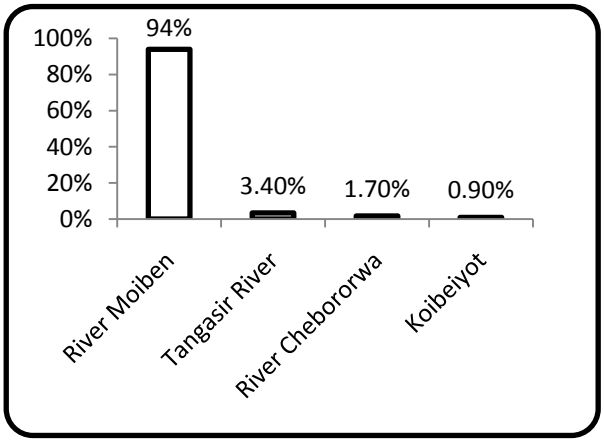

Figure 4. River sources constantly used by farmers for irrigation

It's apparent from results that most of the farmers sourced their water for irrigation from River Moiben, this is because it's not seasonal and relatively large volume of water flows during dry season as compared to the other rivers.

3.5. Types of Crops under Irrigation

All the farmers interviewed practiced irrigated farming. Crops irrigated by farmers along Moiben River include tomatoes (90.8 %), collard greens 'sukuma wiki' (41.7 %), black night shade (30 %), cabbage (21.7 %), maize (11.7 %), beans (6.7 %), spinach (5 %), coriander or 'dania' (2.5 %) and black pepper (1.7 %) as indicated in Figure 5 below.

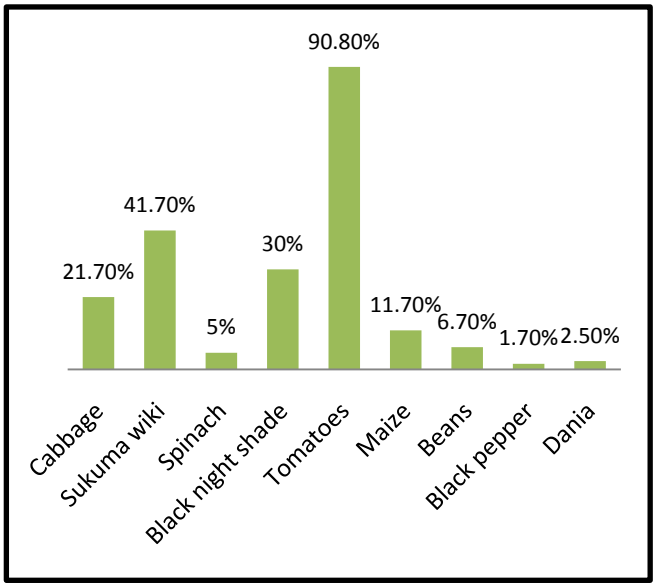

Figure 5. Crops that are irrigated in along Moiben River

Majority of farmers planted tomatoes under irrigation, this was attributed to the fact that tomatoes takes short time to mature and moreover the proceeds from its sales is high as compared to other crops planted.

3.6. Agrochemical Inputs

3.6.1. Fertilizers Used on Irrigated Farms along River Moiben

On assessing the fertilizers used by farmers on their irrigated farms, a higher percentage of farmers interviewed used Di-ammonium Phosphate –DAP (99.2 %) followed by those using Calcium Ammonium Nitrate – CAN (73.3 %). Others used urea (35.8 %), Mono-Ammonium Phosphate -MAP, farm yard manure and ammonia (1.7 % each) as indicated in Figure 6 below.

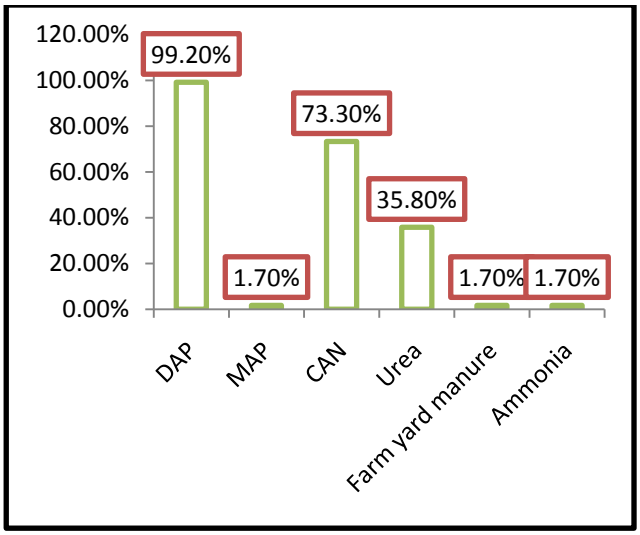

Figure 6. Fertilizers used by farmers along Moiben River in Moiben Sub County

Almost half of the farmers using DAP fertilizers applied 100 kg per acre (48.7 %) on their farm followed by those applying 200 kg per acre (22.7 %). Very few applied 250 kg per acre and 500 kg per acre (0.8 %). The recommended application in Kenya is 100 kg for tomatoes and 150-200 kg for maize [42]. The two farmers (100 %) using MAP applied 150 kg per acre. Over forty per cent of the farmers interviewed (43.2 %) using CAN apply 100 kg per acre followed by those applying 50 kg per acre. The recommended application in Kenya for CAN is 200 kg for tomatoes and 250 kg for maize [42]. Very few applied 250 kg and above. A half of the farmers using CAN (50%) applied 100 kg per acre. Others applied 50 kg per acre (16.7 %), 250 kg per acre (16.7 %), 150 kg per acre (11.1 %) and 200 kg per acre (5.6 %). More than half of the farmers (61 %) using urea fertilizers apply 100 kg per acre. Others applied 50 kg per acre (29.3 %) and 150 kg per acre (9.7 %). The recommended application in Kenya for Urea is 200 kg for tomatoes and 150 kg for maize [42]. It was observed in this study that the majority of farmers do not follow the recommended application method and rates of animal manure. Some farmers overuse and others use lower doses due to either ignorance or lack of transport facilities to enable them ferry enough manure to the fields.

[43] reported that the majority (65 %) of the farmers used organic fertilizer largely animal manure and 12 % of the farmers use artificial fertilizers only, which include CAN, Urea, Sulphate of Ammonia and Triple Super Phosphate. Other farmers who constitute 22 % of the study group apply both animal manure and inorganic fertilizers. Artificial fertilizers are mainly applied in horticultural farming. On fertilizer usage, 92 % applied DAP during planting with only 40 % carrying out subsequent top dressing by use of CAN [41].

Half (50 %) of the farmers interviewed used starter foliar feed, 47.5 % used flower and fruit foliar feed and 41.7 % used vegetative foliar feed.

3.6.2. Pesticides Used on Irrigated Farms along River Moiben

The vastly applied pesticide along Moiben River was insecticide with 72.5 % of farmers applying it, followed by fungicide with 25.7 % and the least applied was herbicide with 1.8 % of them applying it. [44] reported pesticides that were in use in Weruweru sub-catchment were; 40 % organochlorine pesticides, 20 % fungicides, 20 % organophosphorous, 13.3 % carbamates and 6.7 % pyrethroids. Results from this study are presented in Table 1 below.

Table 1. Types of pesticides applied by farmers along River Moiben

Types of Pesticides Active ingredient	Frequency (%)
INSECTICIDE	
Lambda-Cyhalothrin	31.9
Neonicotinoids/Pyrethrinoids	3.9
Flubendiamide	17.2
Hydramethylnon	2.0
Imidacloprid	1.0
Bifenthrin, Chlorpyrifos	2.2
Chlorothalonil	1.0
Pirimiphos-Methyl	1.0
Profenophos	1.8
Diazinon	2.5
Chlorantraniliprole	8.0
Total	**72.5**
HERBICIDE	
S-Metolachlor	4.8
Total	**1.8**
FUNGICIDE	
Chloropyriphos +Cypermethrin	1.0
Cymoxanil	1.2
Metalaxyl-M	7.6
Mancozeb	6.5
Thiophanate Methyl + Hexaconazole 1	2.0
Cypermethrin	1.0
Alphacypermethrin	1.8
Evercide	2.8
Acephate	1.8
Total	**25.7**

The most enormously applied pesticide along River Moiben was insecticide with Labda Cyhalothrin leading with 31.9 % of the farmers applying it. Labda Cyhalothrin is meant for killing insects affecting cabbages, kales and tomatoes on farms were applied on irrigated farms along River Moiben and their trade names as given by farmers were; Pentagon, thunder and duduthrin. Flubendiamide followed with 17.2 % of the farmers applying it on irrigated tomatoes and cabbages and the trade name was belt.

Fungicide was the second most applied by farmers with Metalaxyl-M applied by 7.6 % of the farmers followed by Mancozeb with 6.5 % of the farmers. Mancozeb as their active ingredient were used for fungal diseases affecting tomatoes and vegetables and their trade names were: milthane super (40.8 %), ridomil (24.2 %), oshothane (17.5 %), mistress (3.3 %) and tajiri (1.7 %).

S-Metolachlor was the only herbicide by the farmers with 1.8 % of them applying it. This is consistent with a study done in Tanzania where it was found that herbicides are rarely used in vegetable production [30]. This contrasts a study in Ghana, where herbicides were the class of pesticides most used in vegetable farming [45]

with a perception by farmers that herbicides use is able to suppress weeds for a longer time and over a wider area than manual weeding with a hoe.

[31] reported Diazol 60EC to be the most regularly used by farmers, followed by methomex 90sp, which is in the carbamate family. Glyphogan 48 SL was the most popular herbicide, whereas the combination of linurex and touchdown was the most frequently mentioned fungicidal agent. [46] reported that the most frequently used pesticides included profenofos (74 %), mancozeb (72 %), endosulfan (36 %), chlorpyrifos (31 %), carbosulfan (30 %) and pyrethroids (28 %) including cypermethrin, deltamethrin, permethrin and lambda-cyhalothrin. Another commonly used pesticide was abamectin (19 %) in rusha, northern Tanzania.

4. Conclusion and Recommendation

The finding from the study indicated that most farmers in the study area have practiced farming for 5 years and below. The crops that are grown under irrigation were tomatoes collard greens 'sukuma wiki', black night shade, cabbage, maize, beans, spinach, coriander or 'dania' and black pepper with tomatoes being the mostly grown. Di-ammonium Phosphate (DAP) was highly applied fertilizer in irrigated farming as compared to Calcium Ammonium Nitrate (CAN), urea, Mono-Ammonium Phosphate (MAP), farm yard manure and ammonia. The vastly applied pesticide along River Moiben was insecticide with 72.5 % with Labda Cyhalothrin as the mostly applied, followed by fungicide and the least was herbicide. It was noted that some farmers applied fertilizers and pesticides above the recommended level. The study recommends farmers trainings on efficient and appropriate use of agrochemicals is needed so as to minimize the likely agrochemical undesirable effects. Farmers should also be trained on the adverse effects of agrochemicals use on environment and human health.

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