ASSESSING PESTICIDE USE AND SAFE HANDLING AMONG SMALLHOLDER TOMATO FARMERS IN LANGO SUB-REGION, NORTHERN UGANDA

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DECLARATION

I Apita Tonny hereby declare that this dissertation is my original work and has never been submitted to any University or Tertiary Institution by any person.

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APPROVAL

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DEDICATION

I dedicate this research work to my mum Florence Ocen and my late dad Cyprian Ocen, my wife Mrs. Christine Apita and children; Ocen Ian Smith, Apita Noella Hope and Apita Ebenezer, my brothers and sister, and my friends for standing with me throughout this study.

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LIST OF ACRONYMS

FAO	Food and Agricultural Organization for the United Nations
FGD	Focus group discussion
FHH	Female-headed household
GUREC	Gulu University Research Ethics Committee
Ha	Hectare
KAP	Knowledge, attitude and practice
KII	Key informant interview
Km	Kilometer
Km^2	Square Kilometer
NPHC	National Population and Housing Census
PPE	Personal protective equipment
WHO	World Health Organization

ABSTRACT

This study assessed pesticide use practices, attitudes, and knowledge among smallholder tomato farmers in Northern Uganda. Specifically, the study: (i) documented pesticide use knowledge, attitudes and practices among smallholder tomato farmers; and (ii) determined factors that influenced the adoption of safe pesticide handling by smallholder tomato farmers. A cross-sectional research design was employed to collect data using structured individual questionnaires. Data was collected from 255 tomato farmers selected from Lira and Kole districts, and Lira City using a simple random sampling technique. Data was analysed using descriptive statistics such as percentages, frequencies, means, minimum and maximum values, and standard deviation to assess the socio-demographic characteristics (age, gender, educational level, income, and years of experience) of the study sample. Meanwhile, cross-tabulation was used to document the existing knowledge, practices, and attitude towards pesticide use among smallholder tomato farmers. Furthermore, a binary logistic regression model was employed to examine the factors influencing smallholder tomato farmers' decision to use or not to use a range of good pesticide handling practices (PPE). Results indicated that 97% of tomato farmers were aware of the routes through which pesticides enter the body, and 87% have ever experienced poisoning by pesticides in their lifetime. The study revealed that tomato farmers stored pesticides and spray equipment in the general stores within their residential houses, didn't check the defect on the spraying equipment and PPE, whistled, received visitors, sprayed close to harvest, disposed pesticide containers and unwanted pesticide that remained mainly through burning, throwing in the toilet, and dumping in the farm. Results further indicated that about 44% of farmers didn't use PPE to apply pesticides due to high cost and lack of PPE items. Education and training had a positive and significant influence on the adoption of PPE by tomato farmers. Therefore, there is a need to improve training and education of farmers on the use of PPE to improve practices of safe use and handling of pesticides during preparation and application.

Keywords: *Pesticides, tomato, pesticide use knowledge, attitude and practice, personal protective equipment (PPE), Uganda.*

CHAPTER ONE: INTRODUCTION

1.1 Background

In Africa, tomato (Solanum lycopersicum L.) is one of the most extensively grown vegetables. Production climbed from 1,968,812 tonnes in 1961 to 14,918,554 tonnes in 2007, with the total area under cultivation rising from 159,593 hectares (ha) in 1961 to 660,215 ha in 2007 (FAO, 2009) . Tomatoes are the major vegetable crop grown in Uganda, mostly for the fresh market in peri-urban areas. Early and late blights damage the fruits, leaves, and stems, and if the blights are not controlled, crop losses surpass 75% (Akemn et al., 1999).

Pesticides are highly relied upon by smallholder farmers to prevent crop losses (FAO, 2019; Yonas, Ashenafi, Kidane, & Welegerima, 2021). Unfortunately, there are instances of pesticide abuse and misuse, as well as unsafe practices like using products that are not advised, applying pesticides incorrectly, and using them frequently (Williamson, Ball, & Pretty, 2008; Mengistie, Mol, & Oosterveer, 2017). Pest resistance is continuously growing in the field and storage as a result of the unsafe and frequent use of pesticides (Hiruy & Getu, 2020; Abrol & Shankar, 2014).

Several factors contribute to this issue, such as small farms that force farmers to interact directly with agrochemicals and smallholder farmers' normalizing of agrochemical use because they lack awareness of safety precautions (Sicchia & Demi, 2021). In addition, a lot of farmers use pesticides without wearing the proper Personal Protective Equipment (PPE), such as goggles, gloves, Wellington boots, nasal masks, or overall jackets, which puts them at greater risk of chemical poisoning with dire health and environmental implications (Ndayambaje et al., 2019). According to a research conducted in Ugandan, for example, 99.5% of smallholder farmers used pesticides without wearing personal protective equipment, and 92.7% mixed chemicals with their bare hands (Ndayambaje et al., 2019). Besides, the lack of knowledge or training in safe pesticide-handling practices exposes both the environment and farmers to the negative effects of pesticides (Okonya & Kroschel, 2015).

There are several initiatives in Uganda, including the Pesticides Initiative Program, that support the safe use of pesticides, particularly on fresh export produce. However, there isn't a scheme like this for crops like tomatoes (Schiffers, 2007). Nonetheless, the factors influencing Ugandans' use of pesticides and safe handling have not been extensively studied. Thus, this study looked into the farmers' perspectives, attitudes, and behaviors both during

and after applying pesticides, as well as their understanding of where to get and how to use them.

1.2 Problem Statement

Every year, pests destroy between 30% and 48% of the world's food supplies (Tano, 2011). To fulfil the growing demand for food, an increasing amount of pesticides is used in agriculture at every phase of the value chain, starting with production to postharvest (Chow, 2016). However, when pesticides are used indiscriminately, it may lower food quality, reduce yields, raise the cost of production, impact pricing, jeopardize the health of farmers and consumers, and contaminate the environment (Majeed, 2018; Ngabirano & Birungi, 2020).

In terms of pesticide safety procedures, farmers in underdeveloped nations lack a basic understanding of safe and appropriate pesticide-handling practices (Lana, 2021). Besides, lack of awareness of the negative effects of pesticide usage and user behavior may be the cause of careless pesticide use practices (Bondori et al., 2018).

Although several studies describe pesticide use practices and handling in several countries (Salameh, Baldi, Brochard, & Abi, 2004; Jors et al., 2006), there is a gap of scarce information about how tomato farmers in Uganda use and handle pesticides. Besides, there is fairly limited and inconsistent information on factors affecting the adoption of proper practices of pesticide use and safe handling.

1.3 Objectives

1.3.1 Main objective

To assess the pesticide use practices, attitudes, and knowledge among smallholder tomato farmers in Lango Sub-region, Northern Uganda

1.3.2 Specific objectives

i. To document knowledge, attitudes, and practices of pesticide application among smallholder tomato farmers in Lango sub-region, Northern Uganda

ii. To determine factors that influence the adoption of safe pesticide handling by smallholder tomato farmers in Lango sub-region, Northern Uganda

1.4 Research Questions

1. What is the current knowledge, attitude, and practice of pesticide use among smallholder tomato farmers?
2. What factors influence the adoption of safe pesticide-handling practices among smallholder tomato farmers?

1.5 Theoretical and conceptual framework

Since pesticide use is a practice, this study will adopt Shove et al.'s (Shove et al., 2012) idea of practices to provide insights into (i) smallholder farmers' practices related to purchasing and using pesticides, detailing how resources, skills, and meanings shape the conditions that either enable or constrain these practices; and (ii) how pesticide use practices may ultimately contribute to (un)sustainable practices.

To overcome the drawbacks of individualistic and reductive methods (Hargreaves, 2008), The theory of practice developed as a helpful theoretical framework that emphasizes practices rather than personal beliefs, actions, and decisions. As a result, social practice theory has gained traction in several fields of study and has been applied to a wide range of academic fields (Welch & Warde, 2015). The most recent studies on pesticide use practices in Africa show this (Mengistie, Mol, & Oosterveer, 2017; Aniah et al., 2021). Social practice theorists contend that a focus on practices that is, what people do, how they change over time, and how institutions, standards, technology, and laws affect those changes—is necessary for intervention and policymaking toward sustainability (Shove et al., 2012; Welch & Warde, 2015).

Expanding upon Bourdieu's theoretical observations (Bourdieu, 1977) and Giddens (Giddens, 1984), there are several interpretations on what defines a practice. According to Schatzki (1996), a practice is a coordinated nexus of doings and sayings. According to Schatzki (2012), the term ' routinized behaviour' does not simply show individuals' habits but a nexus of actions produced by activities with relevant knowledge and skills. Following these interpretations, a succinct and practically useful framework that highlights three essential components of practice has been put forth by (Shove et al., 2012). The interconnected, integrated, and coordinated materials, competencies, and meanings are the essential components of practices.

Objects, tools, technologies, and infrastructures required to carry out a profession are referred to as materials. (Shove et al., 2012). Materials can influence, mold, or restrict practices. (Kadibadiba et al., 2018). Unless they are incorporated into competencies and meanings, materials by themselves are irrelevant (Shove & Pantzar, 2005).

Thus, competencies highlight the skills, methods, prior knowledge, and comprehension required to carry out a practice (Shove et al., 2012). Reckwitz, (2002) defines competence as having a "practical understanding" that allows one to carry out a practice. By engaging in daily practice, one can acquire competencies (Shove et al., 2012), via training, experience, taking advice from family and friends, and doing (Shove et al., 2012; Schatzki, 1996; Røpke, 2009)

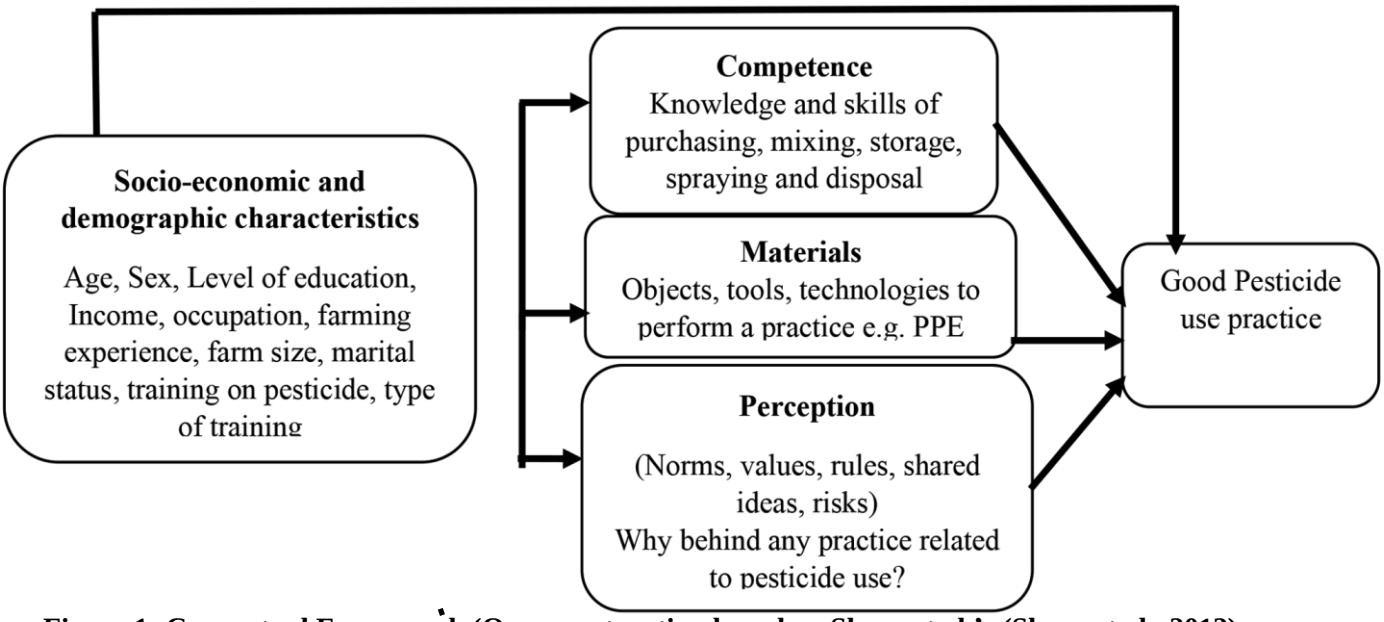


Figure 1: Conceptual Framework (Own construction based on Shove et al.'s (Shove et al., 2012)

Norms, values, regulations, and common understandings are what constitute meaning (Shove et al., 2012). Røpke, (2009) defined meaning as interpreting actions. While the material components describe what permits or restricts a practice, competence describes how a practice is carried out, and meaning describes the purpose of a practice (Nelson, Beckie, & Krogman, 2017).

1.6 Justification of the Study

A complete understanding of related knowledge, attitudes, and practice in various cultural and socioeconomic situations is necessary to develop effective mitigation strategies for the environmental and health impacts linked to pesticide usage (Launiala, 2009).

The results of this study will thus offer a conclusive, evidence-based understanding that will raise the effectiveness of preventative measures and encourage appropriate handling and application of practice. Moreover, the results may aid in the development of regulations that support food safety and environmental health for both farmers and the broader public.

1.7 Scope of the Study

The study was conducted in Lira City, Kole, and Lira districts. In Kole district, the study was conducted in Okwerodot and Alito sub counties which are in the northern part of Kole district headquarters. In Lira district, the study was conducted in Barr and Itek sub-counties in the eastern part of the district and Agali sub-county located in the south eastern part of the district. Meanwhile, in Lira city, the study took place in Lira city east division. The time scope of the study covered all the activities starting from the preparation of the proposal up to the submission of the final dissertation which was anticipated to run from May 2023 to August 2024. The target population for the study was 255 smallholder tomato farmers drawn from the population of tomato farmers in the three districts. In terms of content, the study focused mainly on documenting the existing farmers' knowledge, attitudes, and practices about pesticide use and handling. Furthermore, it also determined the factors that influence the adoption of safe pesticide handling practices during preparation and spraying.

CHAPTER TWO: LITERATURE REVIEW

2.1 Pesticide use knowledge

Inadequate knowledge of pesticide side effects and disregard for usage guidelines are blamed for poor pesticide use practices. Therefore, everyone and the environment benefit from better pesticide practices and decreased pesticide use (Bon et al., 2014). A study conducted by Oesterlund et al., (2014) exposed the level of pesticide use among Uganda's small-scale farmers and looked at attitudes, knowledge, and application of preventive measures as well as pesticide storage and attitudes. According to this study, farmers had little understanding of the danger of pesticides, and the most often used pesticides belonged to World Health Organization (WHO) class II.

According to a study by Lana, (2021) in Southern Ethiopia, farmers stated that they are exposed to pesticides through the following routes: inhalation (56.16%), oral (36.99%), ocular (32.88%), and dermal (12.76%). However, 42.47% of farmers were unaware of this method. The farmers also stated that headache (84.93%), skin rash (60.27%), sluggish heartbeats (72.60%), chest wheezing (67.12%), mood swings (71.23%), dizziness (42.46%), and burning in the skin or eyes (61.64%) were the most common symptoms associated with chemical poisoning. Following the poisoning, the following was done: drinking milk (53%), washing the affected region of skin with a clean item of clothing (18%), quitting work (6%), and rinsing the area of skin contaminated with a pesticide with water (34%). But most of them (42%) said they did nothing till their shift was over. When it came to where to purchase pesticides, how to mix pesticides and other related topics, farmers consulted agricultural professionals the most (72%), followed by vendors and neighbors (17%). Meanwhile, according to Asmare, Freyer, & Bingen, (2022) 49.3% of FHHs have access to data from pesticide dealers.

Similarly, Okoffo, Mensah, Yayra, & Mensah, (2016) indicated that cocoa growers knew that the human body can absorb pesticides through the mouth (86.3%), skin (85%), eyes (74.2%), and nose (41.3%). 81.7 percent of respondents knew that pesticides might hurt living things if they are not used appropriately, whereas 18.3 percent said they had no idea how they could affect the environment.

2.2 Pesticide use practices

Pests are still a problem for crop yields, and crop yield losses pose a threat to food security (Munawar & Hameed, 2013). To decrease food loss, pesticide use has increased; yet, most developing nations use pesticides extensively (Ohayo - Mitoko, 1997) where indiscriminate application by certain farmers raises questions regarding food safety (Perez et al., 2015) and health effects of excessive pesticide usage on customers' safety and the environment overall, necessitating revisions to pesticide residue guidelines by national governments (Okello & Swinton, 2011). This increases the risk of pesticide poisoning for farmers at every step of crop production (Damalas & Koutroubas, 2016) because of direct contact, spray, drift, or exposure to pesticide residues on treated crops, soil, and spray equipment (Farmworker, 2013).

Malpractices related to pesticide application include using unregistered pesticides, dousing them incorrectly, disregarding the pre-harvest interval, using prohibited pesticides, applying pesticides incorrectly for example, by applying the wrong amount or combination to a crop and spraying multiple pesticides simultaneously (Ngowi., 2007;Marčić., 2011;Nonga., 2011;WHO and IPCS, 2010).

A study in Mang'ola District, Tanzania reported farmers use excessive amounts of pesticides on vegetables (Mhauka, 2014). Other studies in the Manyara basin and Arumeru District, showed that farmers regularly sprayed pesticides on vegetables as a preventative measure, even in cases when no pests were visible on the plants (Ngowi et al., 2007; Nonga et al., 2011). This may lead to unneeded production expenses and/or undesirable pesticide residues in the vegetables.

Lana, (2021) revealed 64.38% of farmers in Southern Ethiopia repurposed empty pesticide containers for other uses, 10.96% of farmers said they threw away their empty pesticide containers anywhere on the farm, and 12.33% said they burned the containers. Pesticides were maintained in bedrooms, living rooms, and kitchens by the majority of respondents (79.45%, 60.27%, and 63.01%, respectively). Only 50.68% said they kept pesticides in a closed, separate location that is designated specifically for that purpose. Additionally, the survey revealed that 43.8% of farmers never or very rarely checked their spraying equipment before they started applying, 96.72% of farmers seldom used a measurement tool to add the precise amount of pesticide recommended on the label, and 97.25% of farmers never or very

rarely or never checked the PPE, and 54.8% of farmers never or very seldom utilized specialized tools to mix and apply pesticides; instead, they mixed the pesticides with their hands or any stick that was available on the farm.

Ngabirano & Birungi, (2020) conducted a study in Kabale district, Western Uganda on pesticide use practices, and showed that while 58% of farmers do not mix pesticides, 42% of farmers do so before using them. To boost efficacy, some farmers combine two or more pesticides in a single application. Moreover, just 18% of respondents could simply follow the directions on pesticide containers, and over 82% of respondents were unable to understand the labels. None of the farmers who were interviewed had ever participated in official pesticide use training.

Asmare et al., (2022) conducted a study among female-headed households (FHHs) in the Amhara Region, Ethiopia, and discovered that 94.6% of FHHs combined and applied pesticides on the harvested grain inside their homes, compared to 3.1% who did so outside and 2.3% outside of the fields. Pesticides were shielded from the wind by closed doors and windows. This demonstrates a restricted risk perception and ignorance about pesticide dangers. The survey also showed that FHHs reported spraying two or more pesticides on a single crop while combining them and that approximately 55.3% of FHHs used contaminated clothing without cleaning it, compared to 27.7% and 17%, respectively, who washed their garments sometimes.

Atuhaire, Ocan, & Jørs, (2016) conducted a survey of knowledge, attitudes, and practices of tomato farmers and vendors in Wakiso district, Uganda, and found that 45.8% of respondents said they sprayed their tomatoes less than a week before harvest, while 29.2% said they sprayed their tomatoes at or after harvest. The reasons given for spraying were to enhance shelf life (cited by 70% of respondents), draw in customers (cited by 50%), and manage pests and diseases (cited by 46%). In addition, the investigation discovered that advised pesticide usage is not adhered to.

According to Anjum Ali et al., (2020), safe handling procedures and preventative measures must be followed when applying pesticides. These guidelines might make it possible to achieve effective outcomes without endangering people, animals, or the environment. The following are some of the guiding principles: keeping kids away from pesticides; taking precautions or getting guidance on pesticide dosages and application methods; keeping an eye on weather patterns that could have an impact on the pesticide applications; avoid eating,

drinking, or smoking during or right after the application of pesticides; instead, wash your hands and clothes with soap afterward. Use self-defense gear, never leave pesticide and application equipment alone, and only apply pesticides under expert supervision. Properly deposit pesticides after washing them in their assigned regions. Pesticide application is prohibited for minors (those under the age of eighteen). Carefully dispose of or burn cardboard package. It is best to clean and puncture plastic containers.

Okoffo et al., (2016) also reported habits exhibited by cocoa farmers in Ghana which included using one's bare hands to scoop or stir pesticides (67.5%), chewing gum or a stick (17.5%), singing (66.7%), hosting guests (75.8%), talking (89%), clearing blockages in sprayer nozzles with the mouth (40.4%), eating (45%), consuming alcohol or water (55.6%), whistling (25.6%), and smoking tobacco pipes or cigarettes (20.4%). In the meantime, the majority of farmers in the study area (67.5%) did not consider the wind direction when applying pesticides, and 77.1% of farmers in the study area did not wash their used PPE after applying pesticides.

SPSS version 25 was used to code and analyze all the data in order to look at the knowledge, attitudes, and practices surrounding pesticide use. After summarizing frequencies and proportions, descriptive statistics were used, and the outcomes were shown in tables (Lana, 2021). Meanwhile, Asmare et al., (2022) employed semi-structured KII interviews, household surveys, FGDs, and field observations of farms and residences to record spray application procedures, storage, and disposal. Similarly, Okoffo et al., (2016) a semi-structured questionnaire that had been pre-tested was used to obtain primary data. The study examined the demographic traits of farmers, their approaches to using pesticides, their usage of personal protective equipment (PPE), and the operational behaviors they demonstrated both during and after applying pesticides. Version 20.0 of the Statistical Package for Social Sciences (SPSS) software was used in the study to calculate mean responses.

However, few researches have been conducted in Uganda, and none has been conducted among tomato farmers in Northern Uganda, and yet studies about pesticide use are needed to develop strategies aimed at protecting farmers from high risk of pesticide exposure. This study will adopt the use of household survey questionnaires to document their current knowledge, attitude, and practices in tomato production.

2.3 Pesticide use attitude

Atuhaire, Ocan, & Jørs, (2016) conducted a survey of knowledge, attitudes, and practices of tomato farmers and vendors in Wakiso district, Uganda. It found that 53.41% of the farmers knew that spraying tomatoes during or after harvest puts customers' health at risk, 24.5% didn't know, and 22.4% weren't sure. Common misuse behaviors include using pesticides improperly and without wearing enough personal protection. Pesticide use behavior was influenced by community views, financial restrictions, lack of information, and market demand. Farmers' safe use is influenced by education, but producer care for the customer is not guaranteed. Similarly, a study conducted by Lana, (2021) in Ethiopia, the majority of farmers (71.2%) said that the use of pesticides has an impact on the quality of food, whilst 28.8% of the study participants disagreed.

A study by Asmare et al., (2022) demonstrated that one additional obstacle to women's ability to protect themselves from pesticide risks was sociocultural influences. For instance, in certain sociocultural contexts, certain PPE like goggles, caps, and boots are regarded as men's apparel. Additionally, the survey showed that about 49% of the FHHs thought there were no pesticide dangers.

None of the above studies has been conducted in Northern Uganda, and besides, the studies only capture respondents' pesticide knowledge and practices and left out other aspects of attitude/perceptions towards pesticide use such as farmers' perception towards the cost of production, quality of food and use of PPE.

2.4 Pesticide handling practices

Small-scale farmers employ risky pesticide handling techniques and inadequate personal protection equipment in several African nations (Naidoo et al., 2010). Low educational attainment and insufficient professional training in the application of pesticides might result in inadequate pesticide handling techniques and raise the risk of human exposure via food intake and occupational exposure (Ngowi et al., 2007; Nonga et al., 2011; Marčić et al., 2011; WHO and IPCS, 2010; Mdegela et al.,2013).

A study conducted by Oesterlund et al., (2014) in Uganda found that small-scale farmers handled pesticides without following proper hygiene practices or using the proper personal protective equipment. According to the report, it's critical to determine whether things have altered since then. Not only are farmers' health and the health of their families at risk when

pesticides are not handled properly (Macfarlane et al., 2008; Sam et al., 2008; Williamson et al.,2008).

A study by Atuhaire, Ocan, & Jørs, (2016) on knowledge, attitudes, and practices of tomato farmers and vendors in Wakiso district, Uganda showed that using more personal protection during spraying was influenced by a farmer's age, gender, membership in a farmer group, and completion of secondary education. Of the fifty farmers, 38% wore regular clothing when spraying, while 52% wore special long-sleeve shirts or trousers, 14% wore helmets, 72% wore gumboots, 28% used gloves, 10% wore overall, and 2% wore face goggles.

A study by Asmare., (2022) showed that FHHs applied pesticides and performed other agricultural duties while wearing regular clothes rather than donning full personal protective equipment (PPE). Roughly 23.9% of FHHs wore gloves, followed by boots (17%), hats (6.9%), goggles (3.5%), and masks (10.1%). Some of them wore insufficient overalls since they exposed more skin to pesticide contact in the unprotected area. First, reduced risk perception and understanding of pesticide dangers, which were caused by higher levels of illiteracy and limited access to advising services, were barriers to PPE use among FHHs. The second factor preventing PPE adoption was the limited money, time, and labor required to buy it; roughly 78.3% and 74.2% of the respondents, respectively, mentioned this as well as social norms.

Lana, (2021) revealed that 93.15% of farmers handled pesticides without wearing any kind of personal protective equipment. The high cost of PPE (42%), the inconvenient tropical environment (5%), unavailability (22%), and the lack of health risks associated with pesticide use (31%) limited farmers from using PPE. Similarly, results by (Okoffo et al., 2016) showed that while 20% of cocoa farmers in the study area apply pesticides without wearing any protective gear, the majority of farmers (45%) wear partial protective gear. Less than half of the farmers (35%) in the study area wear full protective gear during pesticide application. Overall (47.4%), wellington boots (52.6%), respirators/nose masks (35.4%), caps/hats (29.2%), rubber gloves (34.9%), and goggles (28.8%) were the most often worn personal protective equipment (PPE).

In order to identify the parameters influencing the adoption of PPE among FHHs and the safe use of pesticides, a binary logistic regression model was utilized. Compared to other factors such as family size, wealth, education, understanding of pesticide risks, risk perception, time value, and social norms, the results showed that age and retail information were important

predictors of PPE adoption (Asmare et al., 2022). Similarly, Okoffo et al., (2016) also employed a binary logit regression model to estimate the factors influencing farmers' decisions to wear personal protective equipment (PPE) when handling and applying pesticides. The results showed that farmers' age, years of farming experience, access to extension services, availability of chemical shops, farm size, and educational level all influenced their decision to wear PPE, while their income and membership in Farm-Based Organizations (FBO) had no effect.

The above studies focussed on personal protective equipment (PPE), which is just a subset of pesticide handling and safety practices.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study area

The study was carried out in Lira district in Barr, Itek, and Agali sub-counties, and in Lira City East Division. The distance between Kampala and Lira district is 375 kilometers via Karuma-Kamdini. Lira district is bordered by Pader and Otuke districts in the north and northeast, respectively, Alebtong district in the east, Dokolo district in the south, and Apac district in the west. It's located at 2.2499° N 32.8999° E. About 1,326 km^2 comprise the district's total area; of that, 1,286.22 km^2 are on land, and the remaining square kilometers comprise wetlands, forest reserves, and geomorphic landforms.

The district's extensive wetland region, which encircles the southern portion, modifies the district's continental climate. The district experiences bimodal rainfall, with two peaks occurring in April and May and August and October, respectively. The district experiences 1200–1600 mm of annual rainfall on average, with the amount decreasing northward. 22.5°C is the average minimum temperature and 25.5°C is the average maximum temperature. The district is mostly composed of gently rolling soil that merges into solitary rock outcrops, and it is situated at an estimated elevation of 900 to 1500 mm above sea level. The residents in the Lira area engage in a variety of economic activities as a result of numerous advantageous circumstances and variables. However, because of the rich soils and favorable climate, agriculture is the main economic sector. The majority of retail and wholesale trade takes place in urban and semi-urban areas. Another popular economic activity is rock quarrying (https://www.lira.go.ug/about-us/district-profile). The above conditions favour tomato production.

The study was also carried out in Kole district in Okwerodot and Alito sub-counties. Kole district is 290 km by road, north of Kampala. It's bordered by the districts of Lira to the east, Apac to the south, and Oyam to the west and north. The district headquarters is around 28 kilometers away by car from Lira City. The district is located at 02 24N, 32 48E (https://www.kole.go.ug/lg/location-size).

The district has a total area of 2,847 km^2, of which 2,164 km is for arable farming and human settlement and is covered in forest (15%), and 9% is open wetlands and water. The district's primary economic activity is animal husbandry combined with subsistence farming. The bimodal rainfall pattern is usually convectional; however, the current global climate change is

causing the level to vary. With an annual rainfall range of 875 mm to 1500 mm, April to May is thought to be the apex of the short rainy season, while August to September is the longest wet season. The area is located at an average elevation of 900 mm above sea level and lies at an average altitude of 1150mm above sea level (Kole District Hazard Risk and Vulnerability Profile, 2016).

These districts and sub-counties/division were selected because they are homes to the majority of smallholder farmers who are engaged in tomato production, and supply Lira main market with fresh tomatoes. Besides, these districts are surrounded by Olweny and Okole Wetlands which favour tomato production in both wet and dry seasons.

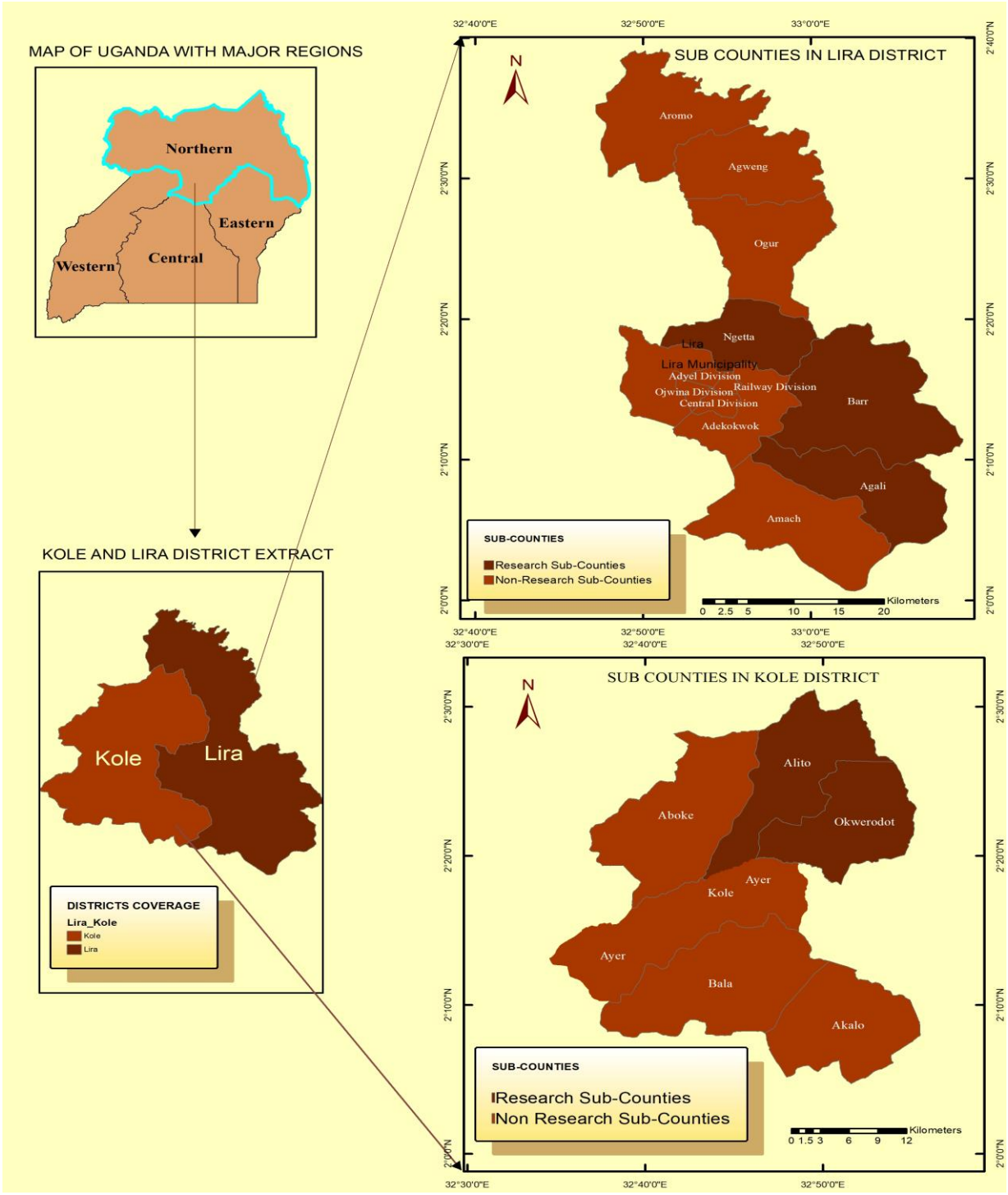


Figure 2: Map showing the study areas

3.1.1 Summary of the population of the study area

Table 1: Disaggregated population of the three study districts

District	Population of Male	Population of Female	Total population
Lira	174,298	185,814	360,112
Lira City	54,102	59,986	114,088
Kole	117,439	124,439	241,878
Total	**345,839**	**370,239**	**716,078**

Source: (NPHC, 2020)

3.2 Research Design

In the study, a cross-sectional research design was used. Time and resources were spared because of the design, which enabled me to measure the study participants' exposures and outcomes simultaneously. Studies with this style may typically be completed more quickly and at a lower cost. With the help of this methodology, quantitative data was gathered to gain a deeper understanding of tomato farmers' current pesticide use practices, attitudes, and knowledge. It also aided in evaluating the elements that impact the adoption of safe handling procedures for pesticides during application and preparation.

3.3 Study Population

Tomato farmers who were involved in tomato production made up the study population for this investigation. This is because tomatoes, which are grown mostly for the fresh market in peri-urban parts of Uganda, are the country's most important vegetable crop (Akemn, et al.,1999). Also, the demand for tomatoes is anticipated to expand in tandem with population growth and urbanization (Dijkxhoorn et al., 2019). Moreover, pesticides are one of the main inputs used in this crop because of the devastation that diseases and pests cause to tomatoes (Karungi.,2011). Furthermore, the majority of smallholder farmers in the study areas are engaged in both small-scale and large-scale tomato production in addition to other crop enterprises.

3.4 Sampling Strategies

The study used a multi-stage sampling technique. Initially, the study districts and sub-counties were specifically chosen due to their closeness to Lira city, high level of tomato

production. Second, the Sub County Agricultural officials of the chosen sub-counties provided the sampling frame, which included a list of tomato farmers in the chosen study locations. Thirdly, a straightforward random sampling methodology was employed to pick study participants. This method reduces sampling error within the population, hence enhancing the accuracy of all estimating techniques employed.

Krejcie and Morgan's table was used to calculate the sample size of farmers who were interviewed (Krejcie & Morgan, 1970). With the necessary level of accuracy, the table enables a researcher to obtain a representative statistical sample from the population. Besides, the data applies to any designated demographic and doesn't require any computations. Therefore, using Krejcie and Morgan's table, since the population (N) was 563, the sample size (S) was 226. However, 10% of the sample size was factored in to cater for attrition and unusable questionnaires, hence, a total of 255 tomato farmers were interviewed.

Table 2: Sampling design and sample size

District	Sub County	Population size of tomato farmers	Sample size
Kole	Okwerodot	214	86
	Alito	56	23
Lira	Barr	68	27
	Agali	102	41
	Itek	53	21
Lira City	Lira City East Division	70	28
Total		**563**	**226**

Source: Sub County Agricultural Production database

3.5 Data Collection Instrument

Pre-tested structured questionnaires that were uploaded to the Kobo tool were used to assist in the collection of primary data through in-person interviews. Question formulation was directed by academic supervisors to ensure the validity and reliability of the instrument. Reliability refers to the ability of measuring instruments to yield results that are similar when employed at different times (Sürücü & Maslakçi, 2020). Meanwhile, validity refers to how well the intended function is performed and whether or not they capture the behavior or quality that the instrument is intended to evaluate (Anastasi & Urbina, 1997). Therefore, the instrument was pre-tested in a location outside the study area to determine the applicability of the tool to obtain the proper data needed to provide answers to the study objectives and research questions. Errors and inconsistencies were fixed before the start of the real data

collection. Following data collection, validity and reliability were confirmed by checking the acquired data.

The tool was administered by research assistants who were recruited based on their ability to read and write English and the local language (lango), experience in conducting a survey as an enumerator, possession of a smartphone, and academic qualification preferably from a Diploma onwards. They were trained on the tool, especially on how to ask the questions in the local and English languages, record the responses in Kobo tool, and how to send a finished form to the server.

3.6 Data Collection Procedures

The list of smallholder tomato farmers in the selected study areas was obtained from the Sub County Agricultural officers. The respondents who participated in the study were selected using a simple random sampling technique, because, it minimizes the sampling error in the population, which in turn increases the precision of any estimation methods used.

The selected respondents were mobilized by research assistants through phone calls and group chairpersons. Respondents were made to sign the consent form after reading it to him /her before the commencement of the interview, and thereafter the questionnaire was administered using the Kobo tool by the research assistants using the local language (lango language) of the area. The responses provided by the respondents were recorded directly into the Kobo tool by the research assistants without compromise. Upon completion of each interview, the finished forms were sent electronically to the server which was downloaded and imported to Excel for cleaning.

3.7 Data Analysis Methods

Before the analysis could begin, the questionnaire items were pre-screened and their missing data checked. The sociodemographic features (age, gender, income, years of experience, and educational attainment) of the study sample were evaluated using descriptive statistics such as cross-tabulations, percentages, means, standard deviations, and minimum and maximum values.

3.7.1 Document pesticide application knowledge, attitude, and practices

Downloaded from the Kobo software, the structured interview data was first cleaned in Excel before being entered into SPSS version 23.0 for analysis, coding, and variable labeling. The

study sample's sociodemographic characteristics (age, gender, income, educational attainment, and years of experience) were evaluated using descriptive statistics like percentages, frequencies, means, minimum and maximum values, and standard deviations. Cross-tabulations were employed to record the smallholder tomato farmers' current knowledge, practices, and attitudes toward the use of pesticides.

3.7.2 Determine factors that influence the adoption of safe pesticide handling

The data was exported from SPPS version 23.0 to STATA version 14.0. The binary logistic regression model was employed to examine the factors influencing smallholder tomato farmers' decision to use or not to use a range of good pesticide handling practices (PPE). The model was chosen due to the nature of the decision variable, whether farmers wear protective equipment during or not. In this dichotomous outcome (1=Yes and 0=No), the most appropriate tool for analysis is the logit model. The Logit model has advantages over other dichotomous models since it's flexible, ease of interpretation and mathematical expression of the model (Okoffo *et al*., 2016). To ensure the assumptions of the model hold, major tests of multicollinearity and linearity tests were conducted using the Variance Inflation Factor (VIF) for the former and scatterplot respectively. The result of the VIF was 1.18 which is far less than the maximum threshold of 10.

The model is given by the formular below;

$$\ln[p/(1-p)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_i X_j \quad \text{..(i)}$$

where;

β_0, β_1, β_2, β_3 are coefficients

X_1, X_2, and X_3 are the predictor variables $\ln[p/(1-p)] = \beta_0 + \beta_1 \text{gender} + \beta_2 \text{age} + \beta_3 \text{education} + \beta_4 \text{experience} + \beta_5 \text{training} + \beta_6 \text{farmsize} + \beta_7 \text{income} + \beta_8 \text{membership} + \beta_9 \text{routes}$ ... (ii)

3.8 Ethical Considerations

The researcher obtained ethical approval from Gulu University Research Ethics Committee (GUREC) before conducting the study. The researcher also received an introductory letter from the Faculty of Agriculture and Environment, Gulu University which was presented to the respondents before data collection. Permission for entry to the study areas sought from

district leaders such as the Chief Administrative Officer, District Production and Marketing Officer, District Agricultural Officer, and sub-county leaders such as Chairperson LCIII, GISO, and Agricultural Officer.

All respondents were adults and their consent was sought before the interview by explaining to them the reason for the study and their permission to participate in the study was obtained through appending their signatures or thumbprint on the consent form. Besides, no information was obtained from children or farmers without sound mind.

Respondents were also informed about their right to refuse participation and to withdraw from the study at any given time. Personal details of respondents like name and phone number were not captured and filled questionnaires were kept under lock and key. The confidentiality of the collected information was kept. Respondents were provided with a modest appreciation to participate in the study by giving half a bar of laundry soap and a sachet of table salt.

CHAPTER FOUR: PRESENTATION OF RESULTS

4.1 Socio-Demographic Characteristics

The study findings revealed that males (82%) dominated tomato farming. Meanwhile, majority of tomato farmers (92%) were married and attended primary education (65%).

Table 3: Socio-demographic characteristics of tomato farmers (N=255)

Variable	Description	Frequency	Percent (%)	Percent of cases (%)
Gender	Male	210	82.4	
	Female	45	17.6	
Marital status	Married	235	92.2	
	Single	13	5.1	
	Widowed	5	2.0	
	Divorced	2	0.8	
Education level	None	3	1.2	
	Primary	165	64.7	
	Secondary	58	22.7	
	Tertiary	27	10.6	
	University	2	0.8	
Main occupation	Business	4	1.6	
	Farming	246	96.5	
	Formal employment	1	0.4	
	Hair dressing	1	0.4	
	Masion	1	0.4	
	Mechanic	1	0.4	
	Welding	1	0.4	
Attended training on pesticide use and application	No	181	71.0	
	Yes	74	29.0	
Agency that offered the training	Private entity	2	21.1	27.4
	NGO	48	50.5	65.8
	Local government	1	1.1	1.4
	Pesticide dealers	17	17.9	23.3
	Extension officers	8	8.4	11.0
	Makerere University	1	1.1	1.4

	Minimum	Maximum	Mean	Standard deviation
Age	18	85	39.8	12.2
Farm size (acres)	0.1	7.5	0.7	0.6
Farming experience	1	39	8	7
Average monthly income	50,000	5,000,000	446,960.78	522,393.928

Membership of a farmer group	No	95	37.3
	Yes	160	62.7

Most tomato farmers (97%) were engaged in farming and earned an average income of UGX 466,000 per month. Only 29% of the tomato farmers reported that they have ever attended training on pesticide use and application with the majority (66%) trained by NGO. The mean age of the tomato farmers was about 40 years with the mean farming experience and farm size being 8 years and 0.7 acres respectively.

4.2 Pesticide application knowledge, attitude, and practices

The study documented the existing knowledge, attitude towards pesticide use, and pesticide use practices that are exhibited by tomato farmers throughout production up to harvesting of tomatoes.

4.2.1 Knowledge of pesticide application

The study sought to understand the extent to which tomato farmers are knowledgeable about the routes of pesticide contamination and poisoning, where they get information regarding the use of pesticides, and their knowledge of how they use pesticides such as their ability to buy the right pesticide, reading and interpretation of labels on pesticide containers.

4.2.1.1 Knowledge of route of pesticide contamination and poisoning

The majority (97%) of tomato farmers were aware of the routes through which pesticides enter the body. The skin (97%) was the main route of pesticide entry into the body and only 3.6% reported that the wound was a route of exposure to pesticides. About 87% reported that they have ever experienced poisoning by pesticides in their lifetime, and skin irritation (93%) was the major sign experienced due to pesticide poisoning. During a field visit to observe farmers' pesticide use practices, the effects of pesticide poisoning were testified by some farmers. A farmer was quoted saying 'One time, pesticide entered my eyes when I was spraying, and right now, I don't see well*'*. Washing the affected part of the body (63%) and bathing (53%) were the major actions taken after pesticide poisoning (table 4).

Table 4: Farmer's knowledge of pesticide contamination and poisoning

Variable	Description	Frequency	Percent (%)	Percent of cases (%)
Knowledge of pesticide contamination routes	No	8	3.1	
	Yes	247	96.9	
Routes of pesticide entry in the body	Skin	244	30.0	98.8
	Nose	208	25.6	84.2
	Mouth	182	22.4	73.7
	Eyes	171	21.0	69.2
	Wounds	9	1.1	3.6
Knowledge of pesticide poisoning	No	35	13.7	
	Yes	220	86.3	
Signs experienced during pesticide poisoning	Skin irritation	205	48.1	93.2
	Chest pain	12	2.8	5.5
	Coughing	32	7.5	14.5
	Flu	89	20.9	40.5
	Wheezing	5	1.2	2.3
	Nose bleeding	4	0.9	1.8
	Diarrhoea	3	0.7	1.4
	Breathing with difficulty	4	0.9	1.8
	Throat irritation	19	4.5	8.6
	Vomiting	3	0.7	1.4
	Headache	50	11.7	22.7
Actions taken after pesticide poisoning	Washing affected part of the body	137	36.5	62.6
	Bathing	116	30.9	53.0
	Drinking water	24	6.4	11.0
	Cleaning the nose with water	21	5.6	9.6
	Seek for help	42	11.2	19.2
	Sit down	2	0.5	0.9
	Didn't take any action	4	1.1	1.8
	Drinking pounded charcoal soaked in lemon juice and water	2	0.5	0.9
	Eating lemon	1	0.3	0.5
	Left the garden	1	0.3	0.5
	Seek for medical attention	18	4.8	8.2
	Smearing affected part with smearing oil	6	1.6	2.7
	Taking milk	1	0.3	0.5
				N=255

4.2.1.2 Source of information on pesticides

The majority (88%) of tomato farmers got information from input dealers whenever they wanted to buy/apply a particular pesticide. However, 0.8% of the farmers did not know the source of information. On how to mix pesticides, 87% of tomato farmers got the information from the input dealers. Meanwhile, about 91% of farmers also reported that they got the information on where to buy pesticides from the input dealers, and a minority (5.9%) got the information from Extension officers (table 5).

Table 5: Farmers' source of information on buying and mixing pesticides

Variable	Description	Frequency	Percent (%)	Percent of cases (%)
Farmer's source of Information on pesticide to buy/apply	Pesticide labels	15	3.7	5.9
	Extension officers	22	5.4	8.6
	Input dealers	224	54.8	87.8
	Past experience	38	9.3	14.9
	Friends or family	108	26.4	42.4
	Unknown	2	0.5	0.8
Farmers' source of information on how to mix pesticide	Pesticide labels	41	9.9	16.1
	Extension officers	11	2.6	4.3
	Input dealers	222	53.4	87.1
	Past experience	40	9.6	15.7
	Friends or family	97	23.3	38.0
	Farmer's best guess	5	1.2	2.0
Farmers' source of information on where to buy pesticides	Pesticide labels	28	6.8	11.0
	Extension officers	15	3.6	5.9
	Input dealers	231	56.1	90.6
	Past experience	51	12.4	20.0
	Friends or family	87	21.1	34.1
				N=255

4.2.1.3 Knowledge of pesticides

Results showed that 27% of tomato farmers couldn't differentiate between a fungicide and an insecticide.

Table 6: Pesticide use knowledge

Constructs	Mean (SD)	Never		Rarely		Sometimes		Often		Always	
		F	%	F	%	F	%	F	%	F	%
I can differentiate a fungicide and an insecticide	2.72(1.427)	69	27.1	52	20.4	60	23.5	29	11.4	45	17.6
I can buy the right pesticide for specific pests	3.16(1.469)	50	19.6	38	14.9	57	22.4	41	16.1	69	27.1
I can read the instructions on pesticide container labels	3.65(1.428)	34	13.3	21	8.2	53	20.8	40	15.7	107	42.0
I can interpret the instructions on the pesticide container labels	3.43(1.483)	43	16.9	30	11.8	45	17.6	48	18.8	89	34.9
I can follow the mixing rates described on the pesticide container	4.02(1.221)	16	6.3	18	7.1	37	14.5	58	22.7	126	49.4
I know that side effects of pesticide use	4.44(1.017)	10	3.9	6	2.4	22	8.6	41	16.1	176	69.0

Source: Field survey 2024, N=255, F= Frequency, SD=Standard deviation. The values in the parenthesis represents SD

Results further revealed that about 27% were able to buy the right pesticide for a specific pest, while, 20% couldn't. 42% of tomato farmers could read the instructions on the pesticide container labels, and about 35% could interpret the instructions on the pesticide container labels. However, 13% and about 17% couldn't read and interpret the instructions respectively.

4.2.2 Practices before, during, and after spraying

In order to understand pesticide, use practices, the study documented existing practices exhibited by farmers before, during and after pesticide application. The findings are presented in the subsequent sections.

4.2.2.1 Practices before pesticide application

The results showed that 39% of tomato farmers never stored pesticides in a locked and separate place specified for pesticides, while 33% also never stored pesticide equipment in a locked and separate place specified for equipment (table 7). This implies that farmers are highly exposed to pesticides.



Figure 3: Storage of pesticides in general house; Source: Field Survey

They instead stored pesticides and spray equipment in the general stores within their residential houses (67%).

Meanwhile, about 24% of tomato farmers rarely use special tools to mix and apply pesticides, which increase high risk of pesticide contamination through the skin. Observation from the field revealed that farmers use the nozzle of the knapsack sprayer to stir/mix the pesticide with water.



Figure 4: Mixing pesticide with a nozzle of the knapsack pump; Source: Field Survey

However, 11% of farmers rarely followed the mixing rates described on the pesticide container. Additionally, 32% of tomato farmers sometimes mixed more than one pesticide in the spray tank when preparing to spray.

On the likelihood of checking the inadequacy of the spraying equipment (knapsack sprayer) and PPE before using it to apply pesticides, 24% of tomato farmers reported that they always don't check the defect on the spraying equipment, while 33% reported that they sometimes don't check defect on their PPE before dealing with pesticides.

Table 7: Practices before pesticide application

Constructs	Mean (SD)	Never		Rarely		Sometimes		Often		Always	
Practices before spraying		**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Store pesticides in a locked and separate place specified for pesticides	2.53(1.577)	100	39.2	45	17.6	42	16.5	10	3.9	58	22.7
Store pesticide equipment in a locked and separate place specified for equipment	2.65(1.550)	85	33.3	50	19.6	51	20	8	3.1	61	23.9
Don't check the defect (inadequacy) of the knapsack sprayer before use ®	3.16(1.397)	46	18	32	12.5	74	29	42	16.5	61	23.9
Don't check the defect (inadequacy) of the PPE before dealing with pesticides ®	3.07(1.325)	44	17.3	35	13.7	84	32.9	44	17.3	48	18.8
Use a measuring cup or measuring tool to add the exact amount of pesticide mentioned on the label	4.45(0.916)	1	0.4	15	5.9	24	9.4	43	16.9	172	67.5
Use special tools (only for pesticide usage) to mix and apply pesticides	3.42(1.403)	23	9	60	23.5	48	18.8	34	13.3	90	35.3
Stir chemicals with bear hands ®	4.79(0.843)	238	93.3	2	0.8	3	1.2	2	0.8	10	3.9
Follow the mixing rates described on the pesticide container	3.88(1.185)	10	3.9	29	11.4	48	18.8	62	24.3	106	41.6
Mix more than one pesticides in the spray tank when preparing to spray ®	2.47(1.386)	93	36.5	32	12.5	81	31.8	14	5.5	35	13.7
Keep pesticides out of reach from children	4.89(0.490)	2	0.8	-	-	6	2.4	8	3.1	239	93.7

Source: Field survey 2024, N=255, F= Frequency, SD=Standard deviation. The values in the parenthesis represent the SD

Statistically, it is observed from the results in table 7 above that the mean score of the participants' responses 2.53, 2.65, and 2.47 regarding storage of pesticides, storage of pesticide equipment, and mixing more than one pesticide in the spray tank respectively is

below the average Likert scale 3. This implies that farmers are still exposed to pesticide risks and continue to inefficiently apply pesticides.

4.2.2.2 Practices during pesticide application

Table 8 below presents farmers' habits during pesticide application in the study area. About 5% of farmers reported that they sometimes drunk water during pesticide application, 7% sometimes blew the nozzle blockage, and 6% often sung during spray application.

Table 8: Practices during pesticide application

Constructs	Mean (SD)	Never		Rarely		Sometimes		Often		Always	
Practices during spraying		**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Observe weather conditions that may affect pesticide application	4.61 (0.825)	4	1.6	1	0.4	29	11.4	23	9	198	77.6
Keep food on my body when handling pesticides ®	4.96 (0.299)	250	98	3	1.2	1	0.4	0	0	1	0.4
Eat when handling pesticides®	4.95 (0.322)	246	96.5	7	2.7	1	0.4	0	0	1	0.4
Drink water when handling pesticides ®	4.75 (0.785)	224	87.8	11	4.3	12	4.7	2	0.8	6	2.4
Blow sprayer nozzle blockage with mouth ®	4.69 (0.842)	222	87.1	9	3.5	18	7.1	3	1.2	3	1.2
Chew gum when spraying ®	4.95 (0.346)	248	97.3	-	-	3	1.2	3	1.2	1	0.4
Sing when spraying ®	4.81 (0.585)	226	88.6	2	0.8	12	4.7	14	5.5	1	0.4
Don't usually whistle when spraying	2.58 (1.842)	137	53.7	12	4.7	13	5.1	8	3.1	85	33.3
Don't usually receive visitors when spraying	2.93 (1.538)	76	29.8	22	8.6	61	23.9	36	14.1	60	23.5
Spray close to harvest ®	2.88 (1.575)	58	22.7	28	11	41	16.1	46	18	82	32.2

Source: Field survey 2024, N=255, F= Frequency, SD=Standard deviation. The values in the parenthesis represents SD

On whether they whistle during pesticide application, results showed that 33% of tomato farmers always whistled during spray application, and 24% always received visitors when spraying. Majority (32%) of the farmers reported that they always sprayed tomatoes close to harvest. During field visits to observe farmers' pesticide use practices, a tomato farmer stated

that ‘I spray close to harvest because my customers like tomatoes that are sprayed close to harvest because it extends its shelf life’.

Results in table 8 above indicated that the mean score of participants’ responses 2.58, 2.93, and 2.88 regarding habits during pesticide application is below the average Likert scale 3. This implies that farmers are still exposed to the risk of drinking or inhaling pesticides during spraying and further contaminates the tomatoes, hence endangering the health of the consumers.

4.2.2.3 Practices after pesticide application

The survey revealed that 91% of tomato farmers washed their hands before eating after spray application. This indicates farmers awareness of the health risks associated with pesticides. However, 30% rarely washed their hands before using a toilet, 35% didn’t always wash their clothes and 54% didn’t always change their clothes after spray application. These practices further expose farmers to pesticide contamination and poisoning such as skin irritation when the unwashed cloth /PPE is again reused in the subsequent spray application.

Table 9: Practices after pesticide application

Constructs	Mean (SD)	Never		Rarely		Sometimes		Often		Always	
Practices after spraying		**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Wash my hands before eating after spray application	4.87 (0.508)	2	0.8	-	-	6	2.4	14	5.5	233	91.4
Wash my hands before using a toilet after spray application	3.33 (1.403)	20	7.8	76	29.8	45	17.6	28	11	86	33.7
Don’t always change my clothes after spray application ®	3.7 (1.667)	61	23.9	5	2	22	8.6	29	11.4	138	54.1
Don’t always wash my clothes after spray application ®	3.57 (1.426)	42	16.5	11	4.3	51	20	61	23.9	90	35.3
Bathe after spray application	4.91 (0.435)	2	0.8	-	-	2	0.8	10	3.9	241	94.5
Spray after harvest ®	4.42 (1.191)	189	74.1	7	2.7	8	3.1	31	12.2	20	7.8

Source: Field survey 2024, N=255, F= Frequency, SD=Standard deviation. The values in the parenthesis represents SD

The disposal methods reported by the respondents were mainly burn (57%), throw in the toilet (40%), dump in the farm (39%), and dump in a hole (29%) (table 10). A few others (11 %) both buried in the ground and re-sprayed remaining solution, whilst 0.4 % sold the

containers as scrap. Field observation indicated that farmers dispose of pesticide containers in the farm by hanging them on the poles used for staking tomatoes. Other farmers throw them near homestead, and others hide it on the roof of the grass thatched houses.



Figure 5: Disposal on the roof and anywhere near home; Source: Field Survey

Table 10: Disposal methods of pesticides, containers and waste water (N=255)

Variable	Description	Frequency	Percent (%)	Percent of cases (%)
Disposal of unwanted pesticides, pesticide containers, and waste water from spray equipment	Burn	145	26.8	56.9
	Burry in the ground	28	5.2	11.0
	Dump in a hole	74	13.7	29.0
	Dump in the farm	99	18.3	38.8
	Re-spray remaining solution	28	5.2	11.0
	Dump in the bush	30	5.5	11.8
	Throw in the toilet	101	18.7	39.6
	Metallic containers sold as scrap	1	0.2	0.4
	I wash the container for other use	35	6.5	13.7



Figure 6: Pesticide containers in the farm; Source: Field Survey

4.2.3 Farmers' attitude towards pesticide use

Majority (53%) of tomato farmers strongly agreed that pesticide is risky to someone's health, while 55% also strongly agreed that following proper guidelines can reduce the risk of pesticide poisoning on their health.

However, 27% of tomato farmers agreed that indiscriminate pesticide use does not lower food quality, while 21% strongly disagreed that indiscriminate pesticide use reduces crop yields. Similarly, 38% strongly agreed that indiscriminate pesticide use does not raise the cost of production.

On whether use of PPE is not comfortable, 32 % of tomato farmers strongly agreed that use of PPE during spray application is not comfortable, while majority (49%) of tomato farmers strongly agreed that PPE use among women is not good.

Table 11: Attitude

Constructs	Mean (SD)	Strongly disagree		Disagree		Uncertain		Agree		Strongly agree	
		F	%	F	%	F	%	F	%	F	%
I perceive that pesticide is risky to my health	4.44 (0.684)	1	0.4	2	0.8	16	6.3	102	40	134	52.5
In my opinion, following proper guidelines can reduce the risks of pesticide poisoning to my health	3.96 (0.924)	3	1.2	26	10.2	17	6.7	140	54.9	69	27.1
In my opinion, spraying at/after harvest pose health risks to consumers	4.23 (0.934)	4	1.6	16	6.3	16	6.3	100	39.2	119	46.7
Indiscriminate pesticide use does not lower food quality®	3.14 (1.386)	45	17.6	44	17.3	47	18.4	69	27.1	50	19.6
Indiscriminate pesticide use reduces crop yields	2.89 (1.351)	53	20.8	62	24.3	28	11	85	33.3	27	10.6
Indiscriminate pesticide use does not raise the cost of production®	3.63 (1.368)	20	7.8	50	19.6	32	12.5	55	21.6	98	38.4
Use of PPE is not comfortable®	3.85 (1.143)	15	5.9	23	9	28	11	107	42	82	32.2
In my opinion, PPE is not affordable	2.88 (1.188)	25	9.8	98	38.4	37	14.5	72	28.2	23	9
In my opinion, PPE use among women is not good®	4.16 (1.068)	9	3.5	17	6.7	23	9	82	32.2	124	48.6

Source: Field survey 2024, N=255, F= Frequency, SD=Standard deviation. The values in the parenthesis represents SD

4.3 Factors influencing adoption of safe pesticide handling by tomato farmers

The study investigated how tomato farmers handle pesticides before and after spray application. This specifically was concerned with use of PPE by farmers during and after pesticide application. It further investigated factors that influenced use of PPE by farmers.

4.3.1 Use of personal protective equipment (PPE)

Results show that up to 57% of tomato farmers used some form of PPE during pesticide application. Of these PPEs used, respirator (70%), gumboots (69%), gloves (49%), and overall (47%) were the most commonly used PPEs (table 12). However, during field visits, it was observed that the status of the overalls that some tomato farmers wore during pesticide application were damaged and dirty, and therefore didn't cover the whole body; which exposes the body to contact with pesticides.

Table 12: Use of PPE items by farmers

Variable	Description	Frequency	Percent (%)	Percent of cases (%)
Use Personal protective equipment (PPE) when applying Pesticides	No	111	43.5	
	Yes	144	56.5	
PPE items used during preparation, handling and spraying pesticides	Gloves	70	17.3	48.6
	A face shield/full-face respirator	29	7.2	20.1
	Mask/Respirator	101	24.9	70.1
	Protective eyewear	21	5.2	14.6
	Chemical resistant special shoes	100	24.7	69.4
	Overall	68	16.8	47.2
	Washable hat	16	4.0	11.1
Factors for not using all the PPE items	High cost	105	65.6	94.6
	Unavailability in the market	5	3.1	4.5
	Discomfort in usage	2	1.3	1.8
	See no need to use	4	2.5	3.6
	Do not have PPE	43	26.9	38.7
	Neighbors or society at large do not expect that I wear PPE	1	0.6	0.9

N=255

Besides, during field visits, it was noted that some tomato farmers borrow masks from their friends and do not have separate water containers. They instead carried jerricans with water from home to the field and are never washed after spray application. This contaminates the

jerricans and raises health risks when these same jerricans are used to fetch water. The major reasons for not using all the forms of PPE items included high cost (95%) and lack of PPE items (39%).



Figure 7: Farmers spraying without full PPE; Source: Field Survey

4.3.1.1 Factors influencing famers' decision to wear personal protective equipment

Results show that education and training had positive significant ($p < 0.01$) influence on the use of PPE amongst tomato farmers. Meanwhile, farmers income levels and membership of a farmer group also had an influence ($p < 0.05$) on using PPE during pesticide application (table 13). Education and training equip farmers with skills and knowledge of the dangers of pesticides and how to protect oneself, hence their positive influence on the use of PPE. The influence of income and group membership implies that with more income, farmers are able to afford PPEs for their own protection. Additionally, farmers groups usually facilitate access to PPEs for all members.

Table 13: Logit results on factors influencing smallholder farmers to wear personal protective equipment (PPE)

Variable	Coef.	Std. Err.	Z	P Values	95% Conf. Interval	
Gender	1.389	0.503	0.91	0.365	0.683	2.823
Age	1.000	0.013	-0.01	0.993	0.974	1.026
Education	1.880	0.403	2.95	0.003**	1.235	2.861
Experience	1.012	0.022	0.56	0.574	0.970	1.056
Training on pesticide application	3.288	1.137	3.44	0.001**	1.670	6.474
Farm size	0.830	0.196	-0.79	0.431	0.522	1.320
Income	1.000	3.791	2.28	0.022*	1.000	1.000
FO Membership	0.541	0.170	-1.96	0.050*	0.293	1.001
Routes	2.770	2.255	1.25	0.211	0.562	13.662
Log likelihood	-157.052					
Pseudo R2	0.101					
LR chi2(9)	35.120					
Prob > chi2	0.0001					

*, ** 5 and 1% significance levels respectively; N=255

CHAPTER FIVE: DISCUSSIONS

5.1 Socio-demographic characteristics of tomato farmers

The study findings revealed that males (82%) dominated tomato farming. Meanwhile, 65% attended primary education. This could be due to high labour intensity required in tomato production. This finding is consistent with that of Selestine, Msollo, & Fundikira, (2023) They discovered that most tomato producers who took part in the survey were men (75%) with only a primary education (73.3%). Similarly, the study done by Nguetti et al., (2018) in Mwea region, Kenya also found that 38.5% of the tomato growers who took part in the study had completed primary education, and 90% of them were men. Additionally, according to a study by Gauli, Sah, Rajbhandari, & Ghimire, (2020) in Kathmandu and Bhaktapur districts, males made up 61.11% of tomato farmers, and most had only completed primary school.

5.2 Pesticide application knowledge, attitude, and practices

5.2.1 Knowledge of pesticide application

On the knowledge of pesticide application, the study revealed that the majority of smallholder tomato farmers were aware of the routes through which pesticides enter the body. The skin was the main route of pesticide entry into the body. They have ever experienced poisoning by pesticides in their lifetime, and skin irritation was the major sign experienced due to pesticide poisoning. This finding implies that smallholder tomato farmers were knowledgeable about the pesticide routes of poisoning, actions to be taken after poisoning, which protects them against any future poisoning. This corresponds to a study by Lekei, et al., (2014) on assessing knowledge, practices, and injuries associated with pesticide exposure among vegetable and coffee farmers in Arumeru district, Tanzania which reported that the majority of farmers' knowledge of the routes of absorption was inhalational (72.7%) and dermal (75.2%). Approximately 93% of farmers reported having experienced pesticide poisoning at some point in their lives. Following poisoning, the actions taken included washing the affected part of the body (3%), applying cream to the affected area (6%), and drinking milk (25%). But after the poisoning, the majority of farmers (60%) said they did nothing.

Hussen Ahmed, Astatike, Fekadu, & Mekonen, (2024) conducted a study to analyse the factors affecting farmers' safe pesticide handling in Southwest Ethiopia. The study revealed that 75% of participants in the study reported having at least one acute symptom, including nausea, headaches, diarrhoea, breathing difficulties, or sleeplessness. A study by Bandanaa et

al., (2024) also showed 50.6% of the 72% of tomato producers who wore protective clothing knew the risks. The most often reported risks and side effects included itching of the body, weakness, and lightheadedness, and the belief that it is the cause of infertility in both men and women.

Furthermore, smallholder tomato farmers received knowledge or sources of information about the type of pesticide to buy, how to mix pesticides, and where to buy pesticides from input dealers whenever they wanted to buy/apply a particular pesticide, to mix pesticides, and where to buy pesticides respectively from the input dealers, and minority got the information from Extension officers. This is true because there are many input dealers in the study areas and some input dealers move to the community during market days. Lekei et al., (2014) revealed that pesticide labels (70.8%), pesticide dealers (48.2%), and agricultural extension officials (38.6%) were the main sources of information on how to handle pesticides. A study by Marete et al., (2021) in Meru County, Kenya showed that a higher percentage of horticultural farmers in Imenti South (49%) relied on pesticide labels, while farmers in Imenti North (72%), Buuri (56%), and Imenti South (47%), utilized agricultural extension workers (AEW). Retailers of pesticides were also a valuable source of knowledge for farmers in Buuri (37%), Imenti North (38%), and Imenti South (45%).

However, according to a study by Selestine, Msollo, & Fundikira, (2023), 62% of farmers obtained information about mixing pesticides from agro-input stores and their peers. Meanwhile, Nguetti et al., (2018) 63.5% of tomato growers who took part in the study stated that they get their pesticide usage knowledge from input dealers, and 36.5% from other farmers. But the extension officers were disregarded by the farmers.

In terms of farmers' awareness of using pesticides, their average score for distinguishing between a fungicide and a pesticide was 2.72, which is less than the 3-point midpoint on a 5-point Likert scale. Because tomato farmers are ignorant of the appropriate timing for applying fungicides and pesticides based on the mechanism of infection, they may apply them incorrectly, leading to the development of resistance to both pests and diseases. Ngabirano & Birungi, (2020) conducted a study in Kabale district, Southwestern Uganda to assess pesticide use in vegetable production in rural. The study showed that only 18% of respondents could readily follow the directions on pesticide container labels, while approximately 82% of respondents could not interpret the instructions on the labels. Similarly, according to a study by Bhandari, Paneru, Pandit, & Rijal, (2020), 46% of

vegetable farmers in Dhading district, Nepal could read the instructions and label while buying the pesticides. Meanwhile, a study by Selestine, Msollo, & Fundikira, (2023) in Mvomero District, Morogoro showed that 85% of tomato farmers read the label instructions before applying.

5.2.2 Pesticide Use Practices

According to the survey, farmers' mean scores for how to store pesticides and pesticide equipment were 2.65 and 2.53, respectively, before the application of pesticides. On the 5-point Likert scale, these are below the midpoint of 3. The fact that farmers and their families don't keep pesticides and spray equipment in specialized stores but rather in normal stores within their homes suggests that they are exposed to health dangers and pesticides. This allows farmers to inhale pesticides when they leak and irritate skin that comes into contact with the pesticide. A study by Okoffo et al., (2016) on pesticide exposure and the use of personal protective equipment by cocoa farmers in Ghana, findings showed that 22.5% of farmers kept pesticides in bedrooms that were utilized by several family members. A similar study by Lekei et al., (2014) also showed that 81% of farmers of cocoa and vegetables stored pesticides in their residential houses, frequently in areas occupied by multiple family members. Only 9% said they kept their insecticides in a store specifically for that purpose. Similarly, a study by Asmare et al., (2022) among female-headed households (FHH) in Ethiopia discovered that 47.2% of FHH kept pesticides and related equipment inside their houses, putting kids and other household members at risk for contamination. Lana, (2021) also reported that in Southern Ethiopia, after working in the field, 98.63% of farmers usually bring their spraying equipment home, where 79.45% store pesticides in their bedrooms, 60.27% in their living room, and 63.01% in their kitchen.

Meanwhile, on the 5-point Likert scale, the farmers' responses to mixing more than one pesticide in the spray tank had an average score of 2.47, which is less than the middle point of 3. This suggests that when getting ready to spray, tomato farmers occasionally combine several pesticides in the spray tank. It also indicates that tomato farmers consistently use ineffective pesticides. Pest resistance is a result of this practice, which poses a major health danger (Schreinemachers et al., 2017). A similar finding was reported by Ngabirano & Birungi, (2020) which showed that 42% of vegetable farmers combined pesticides before using them. According to Dari, Addo, & Dzisi, (2015), about 50% of tomato farmers in some

areas of northern Ghana frequently combine two or more agrochemicals in the belief that doing so will guarantee great efficacy.

Comparably, 14% of respondents always sprayed using the cocktail method, while 27% of farmers sprayed occasionally using a mixed strategy (Bhandari et al., 2020). Furthermore, the study showed that 33% of tomato farmers did not always check for defects on their protective equipment (PPE) before handling pesticides, while 24% of tomato farmers said they never checked for defects in the spraying equipment. This is worrisome since it puts the farmer at significant risk of pesticide poisoning by dermal absorption if the spraying equipment's tank has any holes, cracks, or breaks. This corresponds to a study by Lana, (2021) in Southern Ethiopia which revealed that roughly 43.8% of farmers never or sporadically checked their PPE and spraying equipment (97.72%) before applying pesticides.

Regarding pesticide use practices during pesticide application, findings of the study showed that smallholder tomato farmers usually sprayed tomatoes close to harvest, always whistled, and got visitors during spray application. When it came to whistling and singing during spraying and spraying tomatoes in preparation for harvest, farmers' reactions had mean scores of 2.58, 2.93, and 2.88, respectively. This is below the 5-point Likert scale's midpoint of 3. This suggests that producers continue to be at risk of consuming pesticides by ingestion or inhalation when spraying, further contaminating the tomatoes and putting customers' health at risk. Similar habits were reported by Okoffo et al., (2016) who showed that, of the cocoa farmers surveyed, 75.8% received guests, and 25.8% of them whistled while spraying. A study conducted by Atuhaire et al., (2016) to assess the knowledge, attitude, and practices of tomato producers and vendors in Uganda disclosed that tomato producers sprayed their produce just before harvesting in order to increase the tomatoes' shelf life and draw in consumers.

Furthermore, the study revealed that after pesticide application, most smallholder tomato farmers cleaned their hands before eating. This shows that farmers are aware of the hazards pesticides pose to their health. Nevertheless, majority of respondents didn't always wash their clothes, change their clothes after applying a spray, and rarely washed their hands before using the restroom. When the soiled cloth or PPE is used again in a subsequent spray application, these practices put farmers at increased risk of chemical contamination and poisoning, including skin irritation. This is in line with a study by Okoffo et al., (2016) that reported that after spray application, 72.1% of people cleaned their hands with water and

soap, whereas 77.1% of people neglected to wash their PPE. A study by Asmare et al., (2022) also revealed that about 55.3% of the FHHs wore infected garments without washing them. The study findings revealed that tomato farmers mostly employed four techniques to get rid of unwanted pesticides and pesticide containers that remained in the spray equipment: burning (57%), tossing in the toilet (40%), dumping in the farm (39%), and dumping in a hole (29%). These actions increase the risk of poisoning for the kids because they might utilize the containers as playthings. This finding is in line with previous study by Asmare et al., (2022) that showed that 35.5% of FHHs burned empty containers, and 9.4% of them threw them away in the field. The residue from these containers contaminates the surrounding area, including grazing areas, soils, and water supplies. Similarly, Lana, (2021) also reported that in Southern Ethiopia, 10.96% of farmers simply discard the containers somewhere on the farm, while 12.33% burn them. When unused pesticide containers are burned outside, harmful vapors are released that could seriously affect both human and animal health (WHO, 2008).

5.2.3 Farmers' attitude towards pesticide use

Most tomato farmers strongly agreed that using pesticides can be harmful to one's health. This is in agreement with the findings of Bhandari et al., (2020) which showed that 84% of Nepalese vegetable growers were aware of the dangers associated with pesticide use. However, despite being aware of the detrimental effects that pesticides have, they disregarded safety precautions when handling, storing, and applying them. This contradicts the findings by Asmare et al., (2022) which indicated that almost 49% of the FHHs said there were no risks associated with pesticides. Additionally, smallholder tomato farmers strongly agreed that adhering to the recommended criteria can lessen the likelihood of health effects from pesticide contamination. However, majority of smallholder tomato farmers agreed that indiscriminate pesticide use does not lower food quality. This corresponds to a study by Lana, (2021) in Ethiopia which showed that 28.8% of farmers disagreed with the claim that food quality is impacted by indiscriminate pesticide use. This contradicts the finding from a study by Ngabirano & Birungi, (2020) which revealed that 8% of vegetable farmers agreed that pesticides could have an impact on food quality.

On whether the use of PPE is not comfortable, smallholder tomato farmers firmly agreed that it is uncomfortable to use PPE when spraying. This belief will continue to expose farmers to dangers of pesticide poisoning, which in turn will disrupt production activities once a farmer

is poisoned. This is in line with a study by Ali et al., (2018) that farmers find it quite uncomfortable to utilize PPE when spraying. While most smallholder tomato farmers strongly agreed that women shouldn't wear personal protective equipment (PPE). This implies that women spray without use of PPE, which continue to expose them pesticide poisoning through skin irritation, inhaling. This corresponds to a study by Asmare et al., (2022) which mentioned that goggles, boots, and hats are examples of PPE that are socio-culturally seen as men's gear.

5.3 Factors influencing the adoption of safe pesticide handling

Findings showed that tomato farmers used some form of PPE during pesticide application. Observation in the garden and home indicated that tomato farmers did not adopt full PPE. This suggests that when preparing, handling, and spraying pesticides, tomato farmers are constantly at danger of contracting pesticide poisoning. A study by Bhandari et al., (2020) in Dhading district, Nepal showed that 83% of vegetable growers utilized masks as their primary piece of PPE, and most of them were ignorant of the proper ways to handle pesticides. This finding is consistent with the previous study in Ethiopia which showed that FFHs did not use full PPE when applying pesticides or performing other agricultural chores; instead, they wore regular clothes (Asmare et al., 2022).

The results indicated that the usage of PPE by tomato farmers was positively significantly ($p<0.01$) influenced by education and training. Meanwhile, income and group membership also had influence ($p<0.05$) on wearing PPE. Education and training give farmers skills and information to protect themselves and understand the risks associated with pesticides. Similarly, the influence of income and group membership means that with more income, farmers are able to afford PPEs for their own protection. Additionally, farmers groups usually facilitate access to PPEs for all members. This is in line with the findings by Okoffo et al., (2016) which showed that farmers' educational attainment significantly influenced their decision to use safety gear when applying pesticides. Similarly, a study by Piya et al., (2024) in Nepal showed that farmers' knowledge of using personal protective equipment (PPE) was correlated with their educational attainment.

A study by Hussen Ahmed et al., (2024) also showed that farmers' educational status had a substantial correlation with using safe pesticide-handling practices. This contradicts the findings reported by Marete et al., (2021) which revealed that, despite farmers' reasonable levels of education and information availability, pesticide use laws continued to be

disregarded and some applicators continued to wear no protective gear at all, putting them at significant risk of pesticide poisoning. Furthermore, the study found that although the farmers had a fair level of education and were aware of the safe use of pesticides, they did not adhere to the regulations on safe use, which included wearing protective clothing, hand gloves, and eye goggles during application. They also did not read the labels or follow the protocols.

However, farmers' income levels and membership in a farmer group also an influence on using PPE during pesticide application. This contradicts a study by Asmare et al., (2022) in the Amhara region, Ethiopia mentioned that one factor limiting FHHs' use of PPE was insufficient income. During individual interviews, some farmers testified that they do not use PPE/all forms of PPE because they don't have money to buy the items.

Additionally, farmer groups usually facilitate access to PPEs for all members. This finding is consistent with the findings of Okoffo et al., (2016) who revealed that farmers' decisions to wear safety gear were determined by their income from cocoa fields or membership in farm-based organizations.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary

Descriptive statistics revealed that while 65% of tomato farmers had completed primary school, men (82%) dominated the tomato farming industry. Regarding pesticide treatment, the vast majority of tomato producers (97%) knew how pesticides enter the body. Moreover, 87% of tomato growers have ever been poisoned by pesticides, and the majority (88%, 87%, and 91%) obtained advice from input dealers about where to acquire pesticides, how to mix pesticides, and which pesticides to buy. In the meantime, 27% of tomato growers were unable to distinguish between an insecticide and a fungicide, 20% were unable to purchase the appropriate pesticide for a given pest, 42% were able to read the labels on pesticide containers, and roughly 35% were able to understand the labels. But 13% and around 17%, respectively, were unable to read and understand the instructions.

On practices before pesticide application, the findings indicated that tomato growers never kept insecticides (39%) or their equipment (33%), in a closed, dedicated space meant just for that purpose. Furthermore, of tomato farmers, 32% occasionally mixed more than one pesticide in the spray tank before starting to spray, 24% neglected to inspect the equipment used for spraying, 33% occasionally neglected to inspect PPE before handling pesticides, and roughly 24% seldom used specialized tools for mixing and applying pesticides.

On practices during pesticide application, 33% of tomato farmers always whistled while spraying, 24% always received visitors while spraying, and 32% always sprayed tomatoes close to harvest. These are the activities related to pesticide application. After pesticide application, results revealed that 91% of tomato farmers cleaned their hands before eating. But 30% rarely washed their hands before using a toilet; 35% didn't always wash their clothes; and 54% of respondents didn't always change their clothes after using a spray. Tomato farmers disposed of pesticide containers and the undesired pesticide that remained in the spray equipment in the following ways: burning (57%), throwing in the toilet (40%), dumping in the farm (39%), and dumping in a hole (29%).

Concerning farmers' attitudes towards pesticide use, results revealed that most tomato farmers (53%) firmly agreed that pesticide use poses a harm to an individual's health. Nonetheless, 27% of respondents concurred that indiscriminate pesticide usage does not

degrade food quality. Meanwhile, 32% of tomato growers strongly agreed that wearing PPE when spraying is uncomfortable, and 49% strongly agreed that women should not wear PPE.

On the factors influencing the adoption of safe pesticide handling practices, the findings indicated that tomato farmers' use of PPE was positively significantly ($p<0.01$) influenced by education and training. Meanwhile, farmers' income levels and affiliation with farmer groups had an adverse effect.

6.2 Conclusion

The study documented pesticide application knowledge, attitudes, and practices among smallholder tomato farmers, and determined factors that influence the adoption of safe pesticide handling. The study concluded that although most farmers reported having experienced pesticide poisoning, the survey found that farmers had a strong understanding of the routes of pesticide toxicity.

The study revealed that smallholder tomato farmers were predominantly exhibiting indiscriminate behaviors before, during and after pesticide application, indicating that farmers are more vulnerable to pesticide toxicity and pollution. The environment and soils may get contaminated due these behaviors. Besides, the study documented poor attitudes towards the use of PPE among women.

Education, training, farmer's income level and membership influenced adoption of safe pesticide handling by smallholder tomato farmers. The significant influence on adoption of safe pesticide handling indicates that membership of a farmer organisation and training of tomato farmers on knowledge, safe pesticide application practices and safe pesticide handling must be emphasised and strengthened by relevant authorities. This will equip farmers with skills and knowledge of the dangers of pesticides and how to protect oneself, hence their positive influence on the use of PPE. It will also contribute to the reduction of health risks associated with consumption of contaminated tomatoes.

6.3 Recommendations

6.3.1 Policy recommendations

- The study revealed that smallholder tomato farmers exhibited improper pesticide handling and application practices before, during and after pesticide application. These practices expose farmers to pesticide contamination and poisoning. The study recommends that government through the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF) should improve on enforcing existing policies that promote proper practices of pesticide use and handling, environmental health and food safety among tomato growers and consumers. MAAIF should develop, produce and circulate to farmers customized good practices to be followed.

- The study recommends that government and development partners should embark on providing PPE items to tomato farmers. Furthermore, majority of farmers indicated that use of PPE among women is not good. There should be sensitisation to reverse this attitude.

- Training had a positive and significant influence on adoption of safe pesticide handling by smallholder tomato farmers. The significant influence of training on adoption of safe pesticide handling indicates that training of tomato farmers on knowledge, safe pesticide application practices and safe pesticide handling must be emphasised and strengthened by government and other relevant authorities.

6.3.2 Recommendations for future study

1. The study was conducted in urban and peri-urban areas of Lira city. These areas receive services from Lira city and does marketing of their products to Lira city. Due to differences the in socio-demographic characteristics that exist between dwellers of urban and rural areas, another study should be conducted in the rural areas in order to document the existing pesticide use knowledge, practices and attitude, and make comparison.

2. The study did not ascertain the type of pesticides farmers in the study areas use in tomato production. Therefore, future studies should focus on this, because there are pesticides which are not recommended by MAAF or have been banned by World Health Organization (WHO).

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APPENDICES

Appendix I: Data collection tool

Assessing pesticide use and safe handling among smallholder tomato farmers in Lango Sub-region, Northern Uganda

Dear Sir/Madam,

My name is **Apita Tonny**, a student from Gulu University, Uganda. I am conducting research on **assessing pesticide use and safe handling among smallholder tomato farmers in Lango Sub-region, Northern Uganda.** This is purely an academic study and information you share will be treated as strictly confidential. Your participation in the study is voluntary and you may choose not to participate if you are not interested or withdraw from the interview at any time. If you choose to participate, the interview will take approximately 20-25 minutes of your time.

GENERAL INFORMATION

Name of Interviewer: ……..... Contact of Interviewer……..

Interview date: ……

District: ……Sub County: ……

Parish: ……Village: ……

Section A: Socio-demographic characteristics

No.	Variables	Responses	
1	Sex of the respondent	1 = Male 0 = Female	
2	Age of the respondent (years)		
3	Marital status	Single ☐ Married ☐ Divorced ☐	Widowed ☐
4	Educational level	None ☐ Primary ☐ Secondary ☐	Tertiary ☐ University ☐
5	Main occupation	Farming ☐ Business ☐ Formal employment ☐ others(specify)….	
6	Farm size	…… in acres	
7	Farming experience (No. years in farming)	……. in years	
8	Average monthly income	……. Shillings	
9	Have you attended any training on pesticide use and application?	1= Yes 0= No	
10	If yes (in 9 above), which type of training did you attend? (Tick all that apply)	a. Types of pesticides b. Pesticide identification c. Mixing rates d. Considerations in buying pesticides	

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		e. Dangers of pesticides f. Pesticide application techniques g. Others(Specify)…..
11	If yes, (in 9 above), who offered the training you attended	Private entity NGO Local government Pesticide dealers Extension officers Others (specify)…
12	Are you a member of a farmer's groups	1= Yes 0= No

Section B: Knowledge, attitude and practice towards pesticide use

1. Knowledge

S/N	Pesticide use knowledge	Response
1	**Knowledge of pesticide contamination routes** Are you aware of the routes through which pesticides can enter your body?	1= Yes 0= No
1 (a)	If yes in 1 (a) above, which routes are those? (Tick all that apply)	☐ Skin ☐ Nose ☐ Mouth ☐ Eyes ☐ Wounds ☐ Don't know
2	**Knowledge of pesticide poisoning** Have you ever experienced pesticide poisoning?	1= Yes 0= No
3	If yes (in 2 above), which signs did you experience (Tick all that apply)	a) Skin irritation b) Chest pain c) Coughing d) Flu e) Wheezing f) Nose bleeding g) Diarrhoea h) Breathing with difficulty i) Throat irritation j) Vomiting k) Headache l) Unconsciousness
4	What actions did you take after the poisoning?	a) Washing affected part of the body b) Bathing c) Drinking water d) Cleaning the nose with water e) Seek for help f) Sit down g) Others (specify)……..

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5	**Farmers' source of information on pesticides to buy/apply** (Tick all that apply) Where do you get information on the pesticide you want to buy/apply?	☐ Pesticide labels ☐ Extension officers ☐ Input dealers ☐ Past experience ☐ Friends/family ☐ Unknown
6	**Farmers' source of information on how to mix pesticides** (Tick all that apply) Where do you get information on how to mix pesticides?	☐ Pesticide labels ☐ Extension officers ☐ Input dealers ☐ Past experience ☐ Friends/family ☐ Farmers best guess
7	**Farmers' knowledge of where to buy pesticides** (Tick all that apply) Where do you get the knowledge to buy pesticides?	☐ Pesticide labels ☐ Extension officers ☐ Input dealers ☐ Past experience ☐ Friends/family

On a scale of 1-5 indicate your level of Agreement with the following statements regarding pesticide use knowledge (1=Never, 2=Rarely, 3= Sometimes, 4= Often, 5= Always)

Pesticide use knowledge	**1**	**2**	**3**	**4**	**5**
I can differentiate a fungicide and an insecticide					
I can buy the right pesticide for specific pests					
I can read the instructions on pesticide container labels					
I can interpret the instructions on the pesticide container labels					
I can follow the mixing rates described on the pesticide container					
I know the side effects of pesticide use					

2. Practice

How often do you do the following before, during and after spraying?

Pesticide use practice **Preparation of pesticides before spraying**	Never	Rarely	Sometimes	Often	Always
a) PB1 Store pesticides in a locked and separate place specified for pesticides					
b) PB2 Store pesticide equipment in a locked and separate place specified for equipment					
c) PB3 Don't check the defect (inadequacy) of the knapsack sprayer before use ®					
d) PB4 Don't check the defect (inadequacy) of the PPE before dealing with pesticides ®					
e) Use a measuring cup or measuring tool to add the exact amount of pesticide mentioned on the label					
f) Use special tools (only for pesticide usage) to mix and apply pesticides					
g) Stir chemicals with bear hands ®					

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h) Follow the mixing rates described on the pesticide container						
i) Mix more than one pesticide in the spray tank when preparing to spray ®						
j) Keep pesticides out of reach of children						
During spraying						
a) Observe weather conditions that may affect pesticide application						
b) Keep food on my body when handling pesticides ®						
c) Eat when handling pesticides®						
d) Drink water when handling pesticides ®						
e) Blow sprayer nozzle blockage with mouth ®						
f) Chew gum when spraying ®						
g) Sing when spraying ®						
h) Don't usually whistle when spraying						
i) Don't usually receive visitors when spraying						
j) Spray close to harvest ®						
Farmers habits after spraying						
a) Wash my hands before eating after spray application						
b) Wash my hands before using a toilet after spray application						
c) Don't always change my clothes after spray application ®						
d) Don't always wash my clothes after spray application ®						
e) Bathe after spray application						
f) Spray after harvest ®						
g) Dispose empty pesticides containers away from the farm by burning						

3. Attitude

	Response				
Statements	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree
a) I perceive that pesticide is risky to my health					
b) In my opinion, following proper guidelines can reduce the risks of pesticide poisoning to my health					
c) In my opinion, spraying at/after harvest poses health risks to consumers					
d) Indiscriminate pesticide use does not lower food quality®					
e) Indiscriminate pesticide use reduces crop yields					
f) Indiscriminate pesticide use does not raise the cost of production®					

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g) Use of PPE is not comfortable®					
h) In my opinion, PPE is not affordable					
i) In my opinion, PPE use among women is not good®					

Section C: Pesticide safety practices during and after pesticide handling, storage, and disposal

S/N	Pesticide safety and handling practices	Response				
1	Do you use Personal protective equipment (PPE) when applying Pesticides?	1= Yes 0= No				
2	If yes in (above), which PPE items do you use during the preparation, handling, and spraying of pesticides? (*Tick all that apply*)	a) Gloves b) A face shield/full-face respirator c) Mask/Respirator d) Protective eyewear e) Chemical-resistant special shoes f) Overall g) Washable hat				
3	How often do you use the following PPE during spraying?	Never	Rarely	sometimes	Often	Always
	a) Gloves					
	b) A face shield/full-face respirator					
	c) Mask/Respirator					
	d) Protective eyewear					
	e) Chemical-resistant special shoes					
	f) Overall					
	g) Washable hat					
4	If you do not use all the PPE items above, list the factors that stop you from using all of them	a) High cost b) Unavailability in the market c) Discomfort in usage d) See no need to use e) Do not have PPE f) Neighbours or society at large do not expect that I wear PPE				

Storage

Where do you normally store pesticides? (Tick all that apply)	
General storage within the house	
Dedicated pesticide store	
Elsewhere on the farm	
Toilet	
Kitchen	
Bedroom	
Bathroom	
Where do you normally store spray equipment? (Tick all that apply)	
General store	
Equipment store	
Bedroom	
Elsewhere on the farm	

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Disposal of unwanted pesticides, pesticide containers, and waste water from spray equipment

How do you dispose of unwanted pesticides, containers and waste water from spray equipment?

I wash the container for other use	
Burn	
Burry in the ground	
Dump in a hole	
Dump in the farm	
Re-spray remaining solution	
Dump in the bush	
Throw in the toilet	
Donate/give to neighbour	
Others (Specify)……..	



Appendix II: Ethical clearance from GUREC

GULU UNIVERSITY

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RESEARCH ETHICS COMMITTEE

01/08/2024

To: APITA TONNY

Gulu University
0781452447

Type: Initial Review

Re: GUREC-2024-858: Assessing pesticide use and handling in tomato among smallholder farmers

I am pleased to inform you that at the **113th** convened meeting on **16/05/2024**, the Gulu University REC meeting voted to approve the above referenced application.
Approval of the research is for the period of **01/08/2024** to **01/08/2025.**

As Principal Investigator of the research, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the research.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the REC for re-review and approval **prior** to the activation of the changes.
3. Reports of unanticipated problems involving risks to participants or any new information which could change the risk benefit: ratio must be submitted to the REC.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by participants and/or witnesses should be retained on file. The REC may conduct audits of all study records, and consent documentation may be part of such audits.
5. Continuing review application must be submitted to the REC **eight weeks** prior to the expiration date of **01/08/2025** in order to continue the study beyond the approved period. Failure to submit a continuing review application in a timely fashion may result in suspension or termination of the study.
6. The REC application number assigned to the research should be cited in any correspondence with the REC of record.
7. You are required to register the research protocol with the Uganda National Council for Science and Technology (UNCST) for final clearance to undertake the study in Uganda.

The following is the list of all documents approved in this application by Gulu University REC:

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No.	Document Title	Language	Version Number	Version Date
1	Data collection tools	English	3	2024-06-19
2	Community engagement plan	English	2	2024-06-19
3	covid-19 risk management plan	English	2	2024-06-19
4	Translated consent	Lango	3	2024-06-19
5	Informed Consent forms	English	3	2024-06-19
6	Protocol	English	version 3	2024-06-19

Yours Sincerely

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P. O. Box 166, Gulu

Julaina A. Obika (PhD)
For: Gulu University REC

Appendix III: Community engagement plan

Version 2

COMMUNITY ENGAGEMENT PLAN

STUDY TITLE: Assessing pesticide use and safe handling among smallholder tomato farmers in Lango Sub-region, Northern Uganda

Principle Investigator: Apita Tonny

Rationale of the study

- To provide a definitive evidence-based understanding which will improve the efficiency of preventative efforts and the promotion of proper practices of practice use and handling

General objective and specific objectives to be achieved

General objective

- To assess the pesticide use practices, attitude, and knowledge among smallholder tomato farmers in Northern Uganda

Specific objectives

1. To document pesticide application knowledge, attitude and practices among smallholder tomato farmers
2. To determine factors that influence adoption of safe pesticide handling by smallholder tomato farmers

The objectives of the community engagement are to;

- To sensitize the community and the stakeholders about the nature of the research and receive real time feedback
- Provide clarity on the respective roles and responsibilities of the stakeholders involved in the study before, during and after the study
- Address key ethical concerns of the research. These will include the benefits of the study to the affected community so that the community appreciates the value of the

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research, the consenting processes prior to the research and the rights of the participants

The key community stakeholders to be involved

The stakeholders to be involved in the study are District Agricultural Officer, Sub County Agricultural Officer, Chief Administrative Officer, LCIII Chairperson, Group chairpersons, Research Assistants, Principal investigator and sampled participants. These stakeholders will maintain constant engagement of stakeholders throughout the duration of research.

The research team responsible for managing community engagement activities

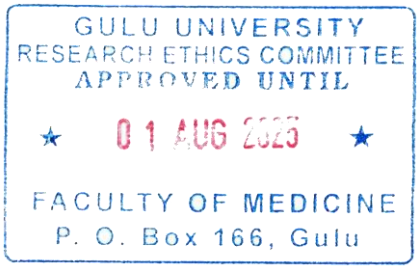
S/N	Research Team	Technical abilities	Tasks/lead roles
1	Research Assistants	Experienced in conducting surveys	• Mobilize tomato farmers to participate in the study • Administer the questionnaire to respondents
2	Principal investigator	Student	Will lead the research team, coordinate and oversee the implementation of the Community engagement plan

Approaches, activities and mode of implementation

The approach to community engagement will involve formative consultations, existing community structures and community events as follows;

We will use formative consultations to understand the geographical nature of the areas, socio-cultural norms and practices, power influences, local perceptions of the target population related to the study. This will be undertaken through field visits to the study areas to gain sufficient familiarity with the geographical characteristics and livelihood activities. We will also visit the local district offices to submit introductory letter from head of department Rural Development and Agribusiness, Faculty of Agriculture and Environment, Gulu University and later get approval letter allowing the study to be conducted in the district.

Community Stakeholders' Partnerships: Gaining community entry will require effective engagement of the community structure and stakeholders as follows;



S/N	Stakeholders	Roles/Involvement
1	Chief Administrative Officer	Grant permission to conduct the study in the selected district
2	District Agricultural Officer	Share the list of tomato farmers
3	Sub county Agricultural Officer	• Share the list of tomato farmers • Help in the mobilization of tomato farmers
4	LCIII Chairperson	Grant permission to conduct the study in the selected sub county
5	Group chairpersons	Help in mobilizing tomato farmers to participate in the study

Community events such as community meetings and conducting interviews will be conducted to sensitize communities and the stakeholders in the study areas about the study and obtain feedback in real time. The investigator and research assistants in the respective study areas will co-chair meetings with the communities. Discussions will Centre around; a) introducing the research team, b) explaining the purpose of the study, c) providing responses to questions asked by the community.

Communication strategy for the engagement

Communication between the research team and the stakeholders will be conducted throughout the study period. Prior, to the consultative meetings, we will contact the LC, Agricultural Officer and group chairpersons of the study area by phone for an appointment for a meeting. During the meeting, the subject matter will be introduced and during the discussion, we will take notes and record the meeting proceedings which will be reviewed later on. Extracts of the meeting will then be used to enrich and improve the research undertaking.

For the workshops and seminar events, we will notify the area LC, Agricultural Officer, group chairpersons of the date of the workshop in their area. They will be requested to mobilize the selected participants to attend the workshop. The workshop venue will be located in a central location so that the participants do not travel long distances for the meeting. The meetings will be conducted in a language that is understood by the participants, and proceedings will be documented for review and appropriate use to improve and enrich the research.

Considering that the engagement will also include sharing the research results, we will produce leaflets and distribute to the participants during the workshops to share results of the research findings, challenges encountered and steps taken to address them, lessons learned and recommendations.

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Plan on mitigation of risks and conflicts

Risks and conflicts might arise before, during or after the conduct of research. The risks and conflicts have the potential to affect the research and the research outcomes. If they occur, they will be addressed as soon as they are detected. GUREC and UNCST will be notified of risks and conflicts of adverse nature. We anticipate the following risks and conflicts;

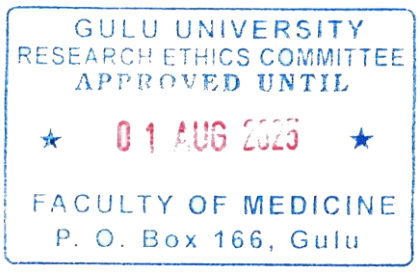
There is the risk of the spread of covid-19 virus which is presently a global and national health concern. We will ensure that prevention measures such use of masks, washing hands is adhered to during the conduct of the study especially during the meetings and workshops both in the community and sub county halls.

We anticipate that there might be participant apathy in participating in research as several researches may have been conducted in the study areas. To minimize this risk, the research team will work with the local leaders to sensitize the community about their wellbeing and benefits of the research.

There is a risk of community and stakeholder misperceptions about the research which might generate conflicts or disagreements.

Evaluation plan

Evaluation will be conducted prior to the conduct of the research, during the research and after the research. Field notes, minutes, documents generated, observations made during the community engagement with the different stakeholders and during the implementation of the research will be comprehensively reviewed and analyzed. Feedback will be considered as value information. Feedbacks that are considered as in disharmony with the study will be comprehensively in order to achieve the objectives of the community engagement and the research.



Appendix IV: Covid-19 risk management plan

Version 2

Measures for the Prevention and control of risk of spread of COVID-19 during the implementation of research

Study Title: Assessing pesticide use and safe handling among smallholder tomato farmers in Lango Sub-region, Northern Uganda

Principal Investigator (s): **Apita Tonny**

Introduction

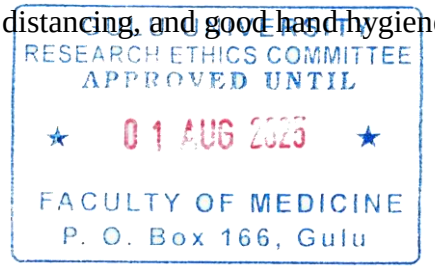
The novel Coronavirus is transmitted from human to human through droplets and direct or close personal contact with an infected individual.

Novel Coronavirus signs of infection include respiratory symptoms, fever, cough, shortness of breath and breathing difficulties. In more severe cases, infection can cause pneumonia, severe acute respiratory syndrome, kidney failure and even death.

World health organization and government of Uganda issued guidelines and imposed restrictions to prevent spread of COVID 19. Much as restrictions such as travel restrictions, crowding and attending functions have been eased/uplifted, they still remain in place. The Uganda National Council for Science & Technology (UNCST) issued guidelines to researchers/investigators on how best research can be conducted in the country in line with the Ministry of Health guidelines on prevention of COVID-19 and without compromising the rights, welfare and safety of bot research participants and research team.

Implementation of the prevention and control measures

In the implementation of the research activities, the investigators are committed to ensuring the safety of its research team, research participants and communities where the study will be conducted. The study team undertakes to comply with the Standard Operating Procedures issued by the Ministry of Health, and presidential directives to mitigate against the risk of infection of COVID-19, rapidly detect and effectively respond to any COVID-19 case that may occur in the process of carrying out the study, screening, face covering, physical distancing, and good hand hygiene.



Procedures to be followed during the implementation of the research.

Prior to data collection and Training

1. **Health guidance:** There will be training sessions dedicated for COVID-19 sensitization and awareness, to equip the research team with knowledge of signs and symptoms of the COVID-19, and preventive measures such as hand hygiene before placing and removing the mask, as well as storage of the mask, social distancing. The research team will circulate notices, posters, charts on common signs and symptoms of COVID-19 as provided by the Ministry of Health, and develop and/or use existing plan for the appropriate referral pathway for identified and/or suspected cases.

2. **Personal Screening:** All researchers, research assistants, research participants and any other individuals engaged in research activities will undergo temperature screening daily for fever. Screening for temperature will be carried out during planning meetings, trainings, community outreach. Any individual found with COVID 19 symptoms will be withdrawn and referred to the COVID – 19 task force for further assessment and management. The withdrawn individual will be allowed to return only if they present a valid certification of their COVID-19 status showing negative result.

3. **Wearing face coverings:** All researchers and research assistants and any other individuals engaged in research activities that require interaction with fellow researchers or research participants or the community member will have to wear a face mask that fully covers the mouth and nose at all times. The study will provide face masks for individuals who do not have.

4. **Physical Distancing:** There will be social distancing during the enumerators training, meetings, community outreach of at minimum of 2 metres. During breaks, the team will not be allowed to congregate in common areas.

5. **Good hygiene:** All team members will be required to wash their hands or use hand sanitizers before and after entering the training room, and other common areas. Hand washing equipment shall be supplied and made available at all times. All surfaces and equipment shall be sanitised frequently.



During data collection

1. **Personal Protective Equipment (PPE):** All research assistants involved in tracing of respondents and in in-person interviews and research participants will use PPE including a properly fitted face mask. Enumerators/Researchers and research participants will wash hands with soap and water or use hand sanitizer prior to the interview. Handshakes and hugging are prohibited. Physical distancing of at least 2 metres in all research related activities shall be observed.

2. **Consent Process:** The Researcher /Research assistants will observe social distancing when taking consent (while 2 metres apart) upon arrival to the participant. Enumerators/Researchers and research participants will wash hands with soap and water or use hand sanitizer prior to the interview. Participant will then be sensitized on covid-19 and presented with preventive measures.

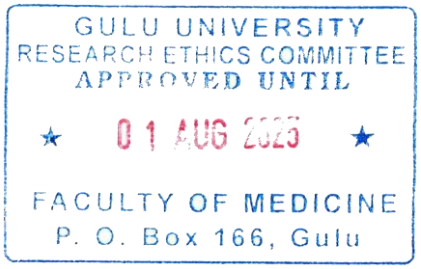
3. **Equipment sanitization:** shared devices used to record or capture data shall be sanitized regularly.

During Dissemination/Community engagement

1. **Community Engagement:** The research team shall carry educational materials on prevention of COVID-19 in a language understood by the participants. These materials shall also have visual images to support understanding. Enumerators/Researchers and research participants will wash hands with soap and water or use hand sanitizer prior to the interview. Screening for temperature will be carried out prior to conducting community engagements.

2. **Equipment sanitization:** shared devices used during community engagements to shall be sanitized regularly.

The preventive and control measures will continuously be reviewed based on new information and guidelines communicated by the Ministry of Health



Appendix V: Informed consent form (English)

Version 3

Informed consent document

Title of the study: Assessing pesticide use and safe handling among smallholder tomato farmers in Lango Sub-region, Northern Uganda

Investigator(s): Apita Tonny

Institution(s): Gulu University

Introduction

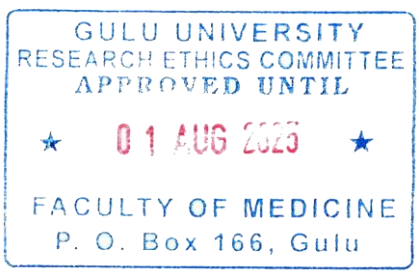
My name is Apita Tonny, a student pursuing Master of Science in Agri-Enterprises Development of Gulu University, Uganda. I am conducting research on the topic 'Assessing pesticide use and handling in tomato among smallholder farmers in Northern Uganda. This informed consent will explain the study to you. After the study has been explained, any questions that you may have will be answered, and you when you decide to participate in this study, you will be requested to sign a consent form which you will be given a copy to keep.

Purpose

The study seeks to assess the pesticide use practices, attitude, and knowledge among smallholder tomato farmers in Northern Uganda. The findings of this study will provide a definitive evidence-based understanding which will improve the efficiency of preventative efforts and the promotion of proper practices of practice use and handling. Furthermore, the findings could help formulate policies to promote environmental health and food safety among growers and the general population.

Procedures

Your participation in this study will involve answering questions in the questionnaire that will be asked by the research assistants.



Who will participate in the study?

You have been chosen to participate in this study because you are a tomato farmer. The interview will last for approximately 20-25 minutes and the estimated sample size is 226 participants.

Risks/discomforts

There is no foreseeable risk of harm or discomfort that will arise from your participation in this study. The only risk or discomfort will be the inconvenience in terms of time spent during the interview.

Benefits

As a participant in the study, you will get feedback on findings and progress of the study, and that any new information that affects the study participants (including incidental findings) will be made available to research participants.

Confidentiality

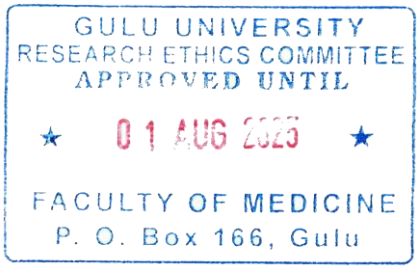
Your identity will not be revealed to any one as we shall only use codes to identify participants. Information obtained will only be accessible by the research team. Soft copies of the data will be protected by password and hard copy files will be kept under lock and key. Confidential information will only be accessed by the principal investigator.

Alternatives

You do not have to participate in this study if you are not interested. You will not lose any benefit in case of no participation.

Cost

There will not be any additional cost incurred as a result of participating in this study. However, you will be provided with a modest appreciation of UGX 5,000 as time compensation to participate in the study which will facilitate you to buy at least half bar of laundry soap and a sachet of table salt.



Questions

If you have any questions related to the study as a research participant, you can contact the principal investigator, Apita Tonny on telephone number 0781452447 or via email on apitatony@gmail.com.

Statement of voluntariness

Participation in the research study is voluntary and you may join on your own free will. You have a right to withdraw from the study at any time without penalty.

If you have any issues pertaining to your rights and participation in the study, please contact the Chairperson, Gulu University Research Ethics Committee, Dr. Julaina A. Obika Tel: No., 0772964491; email: j.obika@gu.ac.ug ; or the Uganda National Council for Science and Technology, on plot 6 Kimera road, Ntinda, Kampala on Tel 0414705500.

Statement of consent

Apita Tonny has described to me what is going to be done, the risks, the benefits involved and my rights as a participant in this study. I understand that my decision to participate in this study will not affect me in any way. In the use of this information, my identity will be concealed. I am aware that I may withdraw at anytime. I understand that by signing this form, I do not waive any of my legal rights but merely indicate that I have been informed about the research study in which I am voluntarily agreeing to participate. A copy of this form will be provided to me.

Name of participant……Signature/thumbprint……Date ……

Name of witness…… Signature…… Date……

Name of interviewer……...…...Signature……. Date……

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Appendix VI: Translated Informed consent form (Local Language-Lango)

Version 3

Informed consent document (Local language-lango)

Title of the study: Assessing pesticide use and safe handling among smallholder tomato farmers in Lango Sub-region, Northern Uganda

Investigator(s): Apita Tonny

Institution(s): Gulu University

Nyute

Apwoyo matek, nyinga obedo Apita Tonny, atin kwan me Master of Science in Agri-Enterprises Development me Gulu University, Uganda. Atye atimo ikweda amaku neno kit ame opur nyanya me tumalo me Uganda tio kede yen me kiro kudi kede two amako nyanya. Dong ka itye kede apenyoro akwaku ikweda ni, abino yeyi penyo eka ate miyi agamere. Ka ibino ye me bedo iyi ikweda man, abino kwayi me keto cingi I papara man eka dang ate miyi copi acel me papara man.

Tyen lok me ikweda man

Tyen lok me ikweda man tye me neno kit ame opur nyanya me tumalo me Uganda tio kede yen me kiro kudi kede twoo amako nyanya. Adwogi me ikweda man bino miyo waa niang aber yore aber me tic kede mako yen me kiro kudi kede two amako nyanya. Bino dang miyo gamente donyo kede cike mogo ame gwoko yot kom dano kede kun orumo waa, kede kite me gwoko aber cem ame jo camo.

Kit ame ikweda man bino bedo kede

Otim ikweda man bino penyi kede apeny ame oyiko eka yin ite miyo agami akwakere kede apeny ame openyo.

Nga ame bino bedo ikweda man?

Yin oyeri me bedo ikweda man pien yin I bedo apur nyanya. Apeny ame obino penyi kede bino tero dakika ame tye iyi akinakina 20-25, kede opur nyanya aromo 226 en abino bedo ikweda man.

Gin araca me romo timere ikweda man

Pe tye gin aromo timere kede adwogi ame lubere kede bedo ni ikweda man. Abino gwoko imung atut ame ibino myia, dang pe abino miyo ngatoro keken ngeyo imiya ngec magi. Gin arac ame romo timere alubere kede bedo ni ikweda man, obedo cawa ni ame ibino bedo kede ikweda man.

Gin ame ibino nwongo

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Acalo ngat ame omio tamere ikweda man, abino miyi adwogi ame bino ya ikweda man, kede ngecoro keken me kony ame bino ya ikweda man.

Ngec ame kwako imung me komi

Ngecoro keken ame kwako komi pe obino miyo bot ngatoro okene, pien obino tic kede nyukuta me ngeyi. Ngec ikomi bino bedo bot akwed ikweda man keken kede kop apire tek bino bedo bot akwed ikweda man keken.

Yore okene

Iromo kwero me bedo ikweda man ka miti ni pee iye. Kwero bedo ikweda man pe bino weki keng ginoro keken.

Garama

Pe ibino rwenyo gi cingi moro keken acalo adwogi me yin ibedo ikweda man. Ento, obino miyi cente aromo tutu mia abic acalo pwoc me miyo tami iyi ikweda man. Cente man bino konyi me wilo cabun aromo nucu bar kede kado.

Apeny

Ka itye kede apenyoro keken akwako ikweda man, iromo goya cim bot akwed ikweda anyinge obedo Apita Tonny, inama cim 0781452447 onyo cwala email: apitatony@gmail.com.

Lok me ye piri keni

Ye me bedo ikweda man tye itwero ni, iromo donyo ikweda man ka imito dang dok twero ni tye me yaa weko ikweda man icawa moro keken, dang pwodoro pe obino keto ikomi. Kubere me niang i kom twero ame itye kede, ka itye kede apenyoro i kom ikweda man, itwero goyo cim bot apwony alo kop ikom woro me ikweda i Gulu University, Dr. Julaina A. Obika Tel:

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No., 0772964491; email: j.obika@gu.ac.ug ; onyo Uganda National Council for Science and Technology, on plot 6 Kimera road, Ntinda, Kampala on Tel 0414705500.

Kop ame moko ni iyee

Apita Tonny okoba gin ame bino timere, ginoro arac ame twero timere, ber me an bedo ikweda man kede twero na alubere kede bedo na ikweda man. Aniang dok aye ni me bedo na ikweda man pe bino timo kit ginoro keken ikoma iyore moro keken. Dong aniang ni tic kede lok komi ikweda pe bino ngutu ngat an abedo. Dok atye iniang ni aromo yaa weko bedo ikweda man icawa moro keken. Dok aniang ni ka aketo cinga I papara man, no dong aye apira kena me bedo ikweda man abongo dicoro keken. Papara man ame an aketo cinga iye ni obino miyo bota dang.

Nying agam apeny ……..….Cinga ……..…..…… Ninodwe……..

Nying caden……. Cing caden ...……. Ninodwe……

Nying apeny-apeny……Cing lapeny ….……..Ninodwe…….……



Appendix VII: Binary Logistic output

```
. logistic PPE_use gender age educ farmsize experience income training routes membership

Logistic regression                             Number of obs     =        255
                                                LR chi2(9)        =      35.12
                                                Prob > chi2       =     0.0001
Log likelihood = -157.05161                     Pseudo R2         =     0.1006
```

PPE_use	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
gender	1.388195	.5027391	0.91	0.365	.6826295	2.823031
age	.9998827	.0132126	-0.01	0.993	.9743189	1.026117
educ	1.879923	.402925	2.95	0.003	1.235098	2.8614
farmsize	.8300196	.1964399	-0.79	0.431	.5219577	1.319901
experience	1.012293	.0219794	0.56	0.574	.9701178	1.056301
income	1.000001	3.79e-07	2.28	0.022	1	1.000002
training	3.288052	1.136616	3.44	0.001	1.669916	6.474149
routes	2.769737	2.255223	1.25	0.211	.5615116	13.66213
membership	.5412515	.1698555	-1.96	0.050	.2926005	1.001205
_cons	.103928	.115575	-2.04	0.042	.0117527	.9190245

Note: _cons estimates baseline odds.

Appendix VIII: Variance Inflation Factor

```
. vif
```

Variable	VIF	1/VIF
age	1.34	0.745079
experience	1.33	0.753195
membership	1.24	0.804983
training	1.22	0.819955
farmsize	1.19	0.839860
income	1.12	0.891243
educ	1.07	0.935933
routes	1.07	0.935959
gender	1.05	0.951473
Mean VIF	1.18	

Appendix IX: Plagiarism Check

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PLAGIARISM CHECK

Declaration for Originality Form
This form must be completed and signed for all scholarly work produced.

Name: _ **APITA TONNY (MR.)**
Personal File No.(staff) Reg. (**student**).___ **Reg. No. 22/U/0938/MAE/PS**____
Faculty/Institute:___ **AGRICULTURE AND ENVIRONMENT, GULU UNIVERSITY**
Department:____ **RURAL DEVELOPMENT AND AGRIBUSINESS**_____
Title and bibliographic description of the work
ASSESSING PESTICIDE USE AND HANDLING IN TOMATO AMONG SMALLHOLDER FARMERS IN NORTHERN UGANDA

Declaration.

1. I understand what plagiarism is and I am aware of the University policy on this regard,
2. I declare that this …, **Dissertation** … (thesis, Proposal, essay, assignment, paper, report etc.) is my original work and has not been submitted elsewhere for examination, award of a degree or
   publication. Where other people's work or my work has been used, this has been properly acknowledged and referenced in accordance with Gulu University requirements,
3. I have not sought or used the services of any professional agency to produce this work,
4. I have not allowed, and shall not allow anyone to copy my work with the intention of passing it off as his/her own,
5. I understand that any false claim of this work shall result in disciplinary action in accordance with University Policy on Plagiarism.

Signature _____ Date 04.9.2024

Originality Report

The article/thesis/document titled above have been subjected to plagiarism check and the level was found to be……**20%** (percent) this is classified as:

- ✓ Minor
- ☐ Moderate
- ☐ Serious

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Yours sincerely,

Manana N Herbert
Ag. University Librarian