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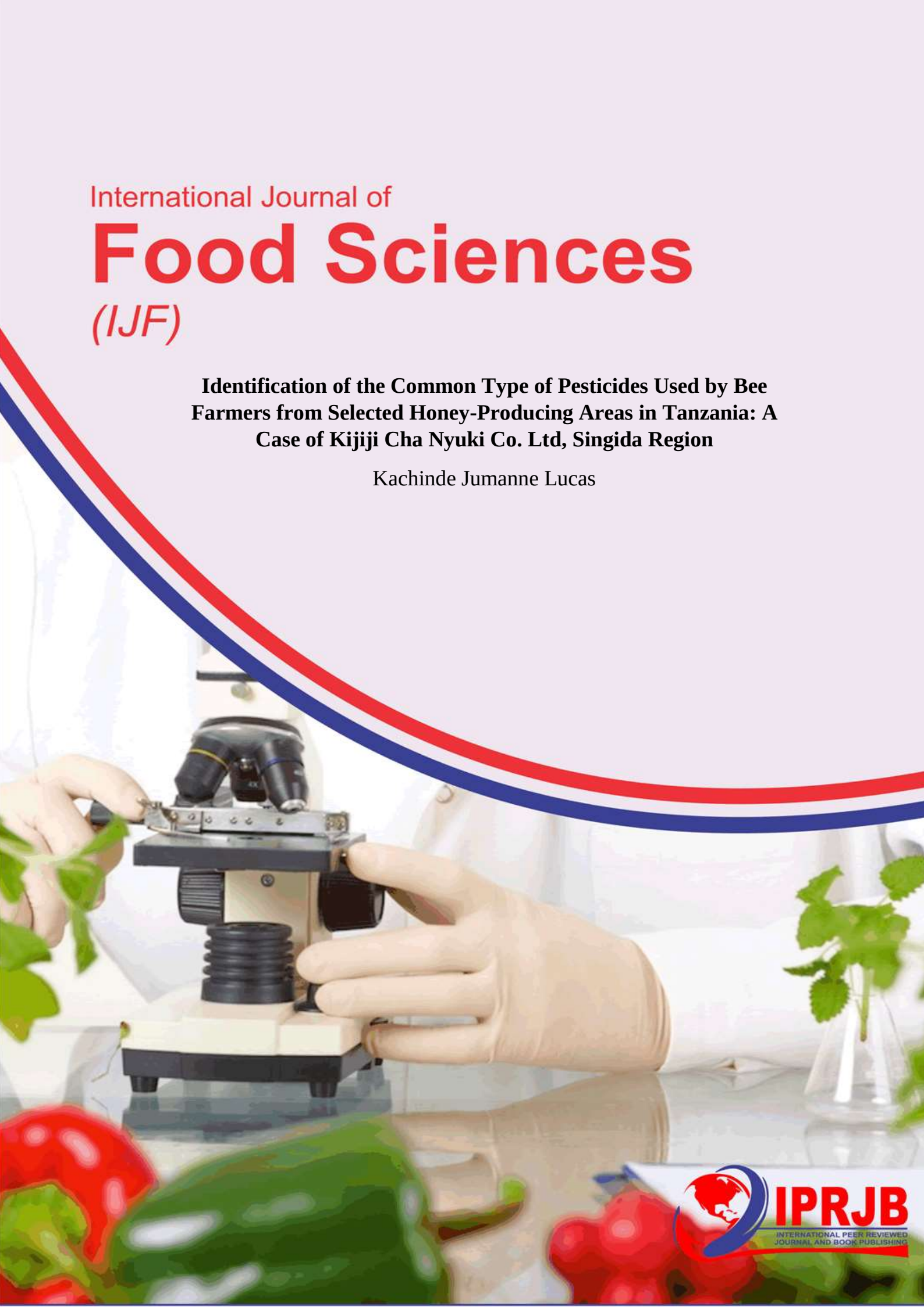

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Identification of the Common Type of Pesticides Used by Bee Farmers from Selected Honey-Producing Areas in Tanzania: A Case of Kijiji Cha Nyuki Co. Ltd, Singida Region

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Abstract

Purpose: The main purpose of this study was to identify the common type of pesticides used by bee farmers. Specifically, the study presents preliminary findings of an inquiry that examined pesticides used by bee farmers and evaluates the awareness among farmers on the negative effects of pesticides in bee products from Kijiji cha Nyuki located in Tanzania.

Methodology: A mixed methods approach was adopted for this study and collected data both primary and secondary data were collected using physical observation and survey, interviews, and questionnaires, purposive and random sampling techniques were used in this study to select a total of 104 participants who was taken as a sample from universal populations. Qualitative and quantitative data were analyzed using IBM Statistical Package for Social Sciences (SPSS) Computer Programme version 25, where the statistics aspect was determined from the results obtained from both questionnaires and laboratory experiments. A preliminary investigation from Africa's most renewed bee village in Tanzania; collected samples were analyzed at TBS & SGS laboratories.

Findings: Based on the findings from informants comprises of two forest officers and two district agricultural officers showed despite a variety of pesticides that can contaminate bee and honey products, the widely observed are Insecticides (cynahalotrine, chlorpyrifos, clothianid), Fungicides (boscalid), and Herbicide (pendimethohele, and cyfluthrin). To mitigate the challenge posed by these pesticides, farmers always work hard to comply with pesticide regulations NBPIS, NBP, 1998, Beekeeping Act No. 15/2002; Beekeeping Regulations, 2005; NBP 2001-2010 and GCBP 2007.

Unique Contribution to the Theory and Policy: the study suggests that participants should be guided to produce the expected outcome, and it has to start with the issue of power. In terms of the policy implementation process, the way policy regulating pesticides and policies activities are communicated should set the right tone that will encourage collaboration to ensure all participants will fully contribute. So, by paying attention to the effect of power, the fundamental principles of openness and inclusiveness can be upheld during the policy design and implementation process. It also recommends further study that will examine the perceptions of decision-makers, consumers, beekeepers, and academicians about the extended use of pesticides in Tanzania, bearing in mind the health implication of the unauthorized use of pesticides.

Keywords: *Pesticides, Honey & Kijiji cha Nyuki*

INTRODUCTION

Bee products such as honey, bee pollen, beeswax, royal jelly, bee venom, bee propolis, and bee brood have had significant usage by human being for centuries in every civilization, it has been used for certain purposes like the promotion of immunization to several infectious diseases and enhancement of health nourishment (Darko, Tabi, Adjaloo, & Borquaye, 2017). It is noted that bee products can be contaminated by two common means, first through direct contamination which occurs due to handling and substances used by beekeepers; and second is indirect contamination which occurs due to the transportation of unwanted and toxic substances during the collection of pollen, nectar, water, and propolis and transferred to beehives. And one of the toxic substances is the high concentration of pesticides that are mostly caused by socioeconomic activities like agriculture (Muli, et al., 2018).

It has been noted that there is a decline of honeybee colonies currently which become a big concern globally not only for the handling of pollination activities which is vital for plant and food production but also for several colonies that are important to the volume of honey which has several significant benefits to human. The quality of bee colonies has been negatively affected by multiple factors such as poor nutrition, pests, diseases, and loss of natural bee habitat, the widespread use of pesticides in agricultural activities was described as major socioeconomic activity that affects the health of bee colonies (Gill et al. 2012; Inguru et al., 2016). József, (2013) indicated that millions tone of pesticides is utilized annually but only a small fraction estimated at less than 1% effectively reaches the target organisms, and the remainder is deposited either in the soil, atmosphere, or water, contaminating the environment and non-target organisms.

Honey production in Africa increased by 47.7% from 78,873 tonnes in 1971 to 150,911 tonnes in 2020 with an approximate growth rate of 1.65% annually, Ethiopia and Tanzania are leading producers of honey estimated to produce 45,300 and 30,393 tone of honey per annum respectively with Tanzania being among top African country in producing beeswax estimated to produce 1,843 tonnes annually behind leader country Ethiopia with 4,914 tonnes per year (Dutch & Agri 2016). Kenya, Uganda, and Rwanda are other East African countries that are producing honey for exporting to Middle East Countries and the United Arab Emirates and also for domestic consumption producing above 4000 tons of honey (Ahmida et., 2017).

In Africa, pesticide use represents less than 5% of the total amount of pesticides used worldwide but many developing countries have large stockpiles of obsolete pesticides, usually scattered over various sites (PAN UK, 2007, World Bank, 2013). These pesticides are in a deplorable state and are hazardous to both human and environmental health (World Bank, 2013). Moreover, the rapid increase in human population in African countries requires more food supply putting a strain on agricultural land available for crop production (Naidoo, 2010; Williamson, 2008).

According to World Bank (2013), in Africa, pesticide use is usually lower when compared to other areas; this means bees are less exposed to pesticides per food visit. However, South Africa is the highest food-producing country on the continent and is also the major consumer of pesticides in sub-Saharan Africa. The use of pesticides poses serious issues to the country to develop satisfactory techniques, which can combine optimal agricultural productivity and environmental safety (Musa et al., 2011).

Tanzania's government recognized the need to increase agricultural investment and production, which led to the establishment of a plan called “Kilimo Kwanza”. A Tanzanian green revolution in the agricultural sector is part of the strategy. As a result, farmers from areas mainly with agricultural activities use different pesticides to prevent their vegetation from harmful insects and diseases. Based on the uniqueness of pesticide properties, most of which are persistent in the environment, and have a great potential to contaminate the plants. Pesticide residues in honey arise when bees search for food, layover crops that have been treated with pesticides, and when beekeepers use chemicals to treat or prevent diseases. The possibility of pesticides causing both short-term and long-term adverse effects on the surroundings as well as public health has become an international concern. If pesticides are left to pollute hive products such as honey, a nutrient-rich food commodity for humans and bees, they result in diseases and the death of pollinators. Therefore, pesticide residues have developed a high concern problem in the field of food safety (MNRT, 2015; Negutu et al. 2021).

Bees are termed to operate in either inside or outside clean, healthy, and safe environments from which pollen, nectar, and water are collected (Bognadov, 2005; Negutu et al. 2021). However, bee products are recently produced in a contaminated environment with bacterial, and fungal spores, specks of dust and chemical residues, industrial pollutants, hydrocarbon emissions, and naturally occurring toxins found in plants (URT, 2007)**.** The extensive use of pesticides in crops is a major factor affecting bee products, thus a need for the preservation of bees as well as the products for best quality(Brikké & Bredero, 2003)**.** To preserve honey bee health which is inextricably integrated with human health and to preserve the quality of bees' by-products especially honey requires regular monitoring using rigorous analytical methods to confirm product quality (Muliet al. 2014).

Statement of the Problem

Unfortunately, only a few types of research have been conducted to display pesticide residues in other hive products such as bee pollen, bee venom, royal jelly, bee wax, bee bread, and propolis, whereby, most of the research concentrated on honey since that is the readily available and mostly consumed bee product. These products are recently used as medical products hence the potential of bioaccumulation in the human body (Eissa*et al*.,2014). Therefore, this research is designed to determine the pesticide contamination in bee products from selected honey-producing areas (Singida) in Tanzania.

Beekeeping in Tanzania is mostly practiced on a large- and small-scale basis as a source of both income and food in several cultivated and forest lands of Singida (Manyoni), Tabora, Mbinga, and Mbeya regions. These areas are also supported by the growing of tobacco crops where the application of various pesticides is inevitable, consequently; there is a high likelihood for the bee products to become contaminated with pesticides because the bees do not have boundaries during the collection of pollen. The availability of pesticides in the surrounding environments could lower the quality of bee products and kill the bees, which consequently pollute the environment, as well as pose potential risks to humans and other organisms. The presence of pesticides in bee products also poses a potential health risk to the consumer of the products.

However, data on the contamination of bee products due to pesticides is so scanty despite of frequent use of pesticides on cultivated and forest crops close to beehive farms, and the development, production, and use of various pesticides with new designs together with the associated harmful effects to human health, it is important to assess their levels in the bee

products. Therefore, the study will focus on determining the pesticide contamination in bee products from honey-producing regions in Tanzania, the Singida region chosen as a case study. Therefore, the main purpose of this study was to identify the common type of pesticides used by bee farmers. Specifically; to identify pesticides used by bee farmers, and to evaluate the awareness among farmers of the negative effects of pesticides.

LITERATURE REVIEW

Theoretical Review

Theory of Planned Behaviour (TPB)

The theory of planned behavior was introduced in the 1980s to predict individual decision-making toward the presence of certain scenarios (Shaw, 2016), The theory argued that human action and behavior depend on individual intention and control ability that is influenced by sociocultural factors and external environment. See figure 1

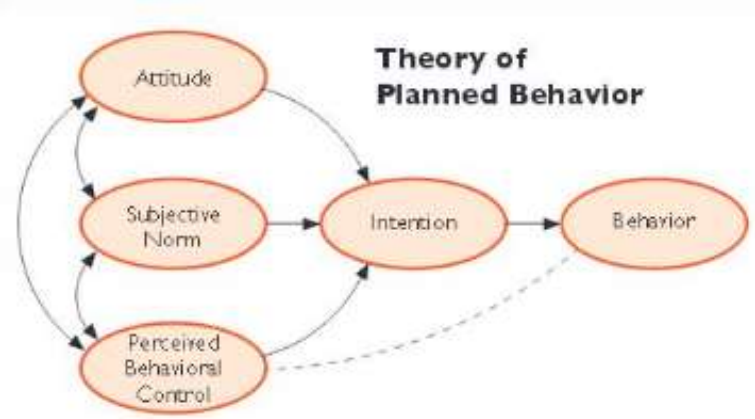

Figure 1: Theory of Planned Behavior

Sourced (LaMorte, 2019)

In this study, the theory of planned behavior has been utilized to explain the relationship between individual use of pesticides in agricultural activities and the intentional to increase food production without considering the impact on the environment, it has been noted that 20% of sickness in Australian has been contributed by the food handling behavior (Mocinhato, et al., 2022).

The behavior beliefs of farmers on the uses of pesticides to boost the fertility of land have caused environmental contamination which results in bees contamination since most of the resources required by honey bees are found on plants and crops, first through direct contamination that occurs due to handling and substances that used by beekeepers; and second is indirect contamination that occurs due to transportation of unwanted and toxic substances during the collection of pollen, nectar, water, and propolis and transferred to beehives; first through direct contamination that occurs due to handling and substances that used by beekeepers; and second is indirect contamination that occurs due to transportation of unwanted and toxic substances during the collection of pollen, nectar, water, and propolis and transferred to beehives (Muli, et al., 2018). Therefore, the attitude and perceived behavior of individuals have a direct contribution to the intention of using pesticides that results in the contamination

of bee products

The theory of planned behavior has been criticized based on the argument that the theory ignored the lack of resources and opportunities for the household to decide using pesticides can be influenced by more factors such as environmental factors and economic factors than the decision-making of an individual, also the theory fails to describe the timeframe of human intension and control action ability of an individual. But with that limitation, the planned behavior theory (PBT) is more accurately been utilized in determining pesticide contamination in bee products from honey-producing areas.

Empirical Review

Kazda (2021) conducted a study in Colombia and Germany to identify common pesticides that have high concertation between bees' products and the surrounding environment. The outcome revealed that Chlorpyrifos was present in high concentrations of up to 0.021 mg/kg in honey and up to 0.1 mg/kg in bee pollen, it was further described that Chlorpyrifos is an organophosphate insecticide and an inhibitor of acetylcholinesterase (AChE) and is potentially toxic to most animals. Chlorpyrifos is used for various purposes including; crop protection, controlling fire ants and mosquitoes, and treating wood fences and utility fences (NPIC, 2006; Williams & Solomon, 2014). Bees are primarily exposed to chlorpyrifos by diet and contact whereas the secondary exposure pathways are through nectar and pollens carried to the hive, thus a great risk of contaminating the bee products (Williams & Solomon, 2014).

Mcfadden, (2019) conducted a study on nutrition and healthcare in Europe to determine health risks associated with the consumption of toxic products, the results indicated that the pyrethroid derivative which is used as an insecticide against many insect pests on a broad range of crops such as corns, vegetables, and fruits are one of the common pesticides that found on farming areas, exposure to etofenprox may be through oral, dermal and inhalation result into vomiting, diarrhea, hypersalivation, exhaustion, tremor, and ataxia. The major target organs include the kidney, liver, thyroid, and hematopoietic system. Also, it was found that Boscalid was the most common fungicide present in bee pollen in Germany with a concentration of 0.021 mg/kg compared to other pesticides and it was revealed that the compound is persistent and mobile, with greater potential to reach groundwater, and transported via runoffs. Furthermore, Picoxystrobin and Pyraclostrobin was also agricultural pesticide product used to kill fungi. It belongs to the group collectively known as strobilurins which inhibit mitochondria respiration. It tends to reduce honeybee longevity.

He et al, (2021) prepared a report that demonstrates the toxicity of the drug in activating oxidative stress that led to high mortality in bee colonies Apis Mellifera, the study adopted statistical analysis using SPSS to the analysis regression model. The results Imidacloprid, Cyfluthrin, Cypermethrin with a predicted LC_{50} of 92.24 µg/ml within the dissipation time, and lambda-cyhalothrin is highly toxic to bees when exposed to direct treatment or residues on blooming crops or weeds.

Darko, Tabi, Adjaloo, and Borquaye (2017) conducted research on pesticides residues in honey from the major honey production forest in Ghana, the study used purposive sampling to select sample size for collection and extracted of information using QuECHERS methods to analyze the research problem. The results found that several pesticide residues were detected in major honey forest belts in Ghana including; diazinon, chlorpyrifos, dimethoate, methoxychlor, malathion, aldrin, cyfluthrin, permethrin, fenvalerate, endosulfan, and DDT.

Fikadu, (2020) investigated the study on pesticides that have potential risks to human beings in America due to effects from some pesticides that have recently been brought to attention and more emphasis is placed on evaluating the impacts of these pesticides on the bees and related bee products. The results revealed that In North-eastern Mexico, chlorpyrifos was highly detected in honey and bee wax due to extensive use of pesticides in agriculture activities.

Muli *et al.*, (2014) conducted in Kenya in 2010 detected four pesticides from beeswax and beebread at very low concentrations. However, the cumulative levels and presence of pesticides in hive products over time can pose health problems for both honeybees and humans. The outcome identifies eleven pesticides diazinon, chlorpyrifos, dimethoate, methoxychlor, malathion, aldrin, cyfluthrin, permethrin, fenvalerate, endosulfan, and DDT was common pesticides that were found on farms in Kenya and East African countries.

Matowo, et al (2020) prepared the study to explore the types and usage of agricultural pesticides and awareness and management practices among farmers in Morogoro, the study adopted the use of explanatory sequential mixed methods approaches to survey the pesticide stocks using 17 retailers and 30 farmers respondents. The results indicated that Lambda-cyhalothrin, cypermethrin which is fallen under pyrethroids as well as imidacloprid categorized as neonicotinoids the highly common pesticides sold and used by farmers in Morogoro, also it was revealed that herbicides glyphosate (59.0%), acylalanine, fungicides dithiocarbamate (54.5%), and organochlorine (27.3%) was common pesticides that found on agro vet shops and agriculture retails. The study concluded that poor pesticide management control and practices, low knowledge, and lack of awareness of the farmers toward the usage of agricultural pesticides.

Conceptual Framework

The following conceptual framework describes the relationship between variables based on the objectives of the research

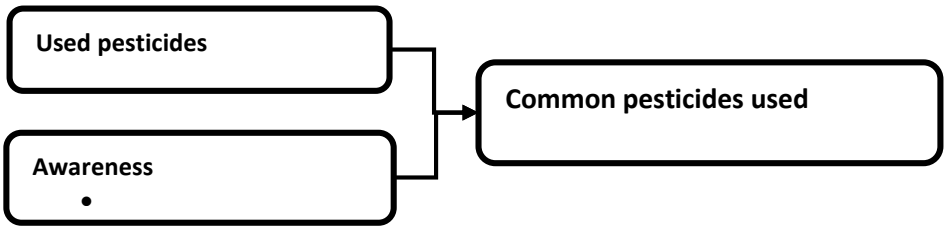

Figure 2: Conceptual Framework

METHODOLOGY

This study implemented a paradigm that concerns the use of quantitative and qualitative approaches; the approach was chosen since it provides accuracy and valid reality on determining the common pesticides used by farmers producing areas in Tanzania, Kijiji cha Nyuki Co. Ltd, located in the Singida region. The areas of the study were selected based on the growing bee farming activities as major Agroecological zones in Tanzania in terms of bee production. Kijiji cha Nyuki is one of the major leading bee farming in Africa and a leader in the use of advanced technology and bee farming practices. The selected apiaries spread apart (<10m from each other).

The study population comprised Kijiji cha Nyuki bee farm workers, beekeepers, farmers, agricultural and forest officers, and honey users who provided relevant information on the phenomenon. **Slovene's formula in Equation (i)** was used to compute an appropriate sample of the human subject for the study, which is optimal. The Slovene formula is given by:

$$\boldsymbol{n = \frac{N}{(1+ Ne^2)}} \text{ ..... Equation} \quad (i)$$

Whereas:

n = number of samples

N = total population

e = Level of precision error, and

The confidence level of 95% for both consumers and farmers

The total was 104 (one hundred and four) respondents. Also, the issues of gender were highly regarded**.** The sample size composition is indicated in Table 1

Table 1: Sampling Composition

Participant	Male	Female	Total
Agriculture officers	1	1	2
Forest Officer	1	1	2
Farmers	27	25	52
Consumers (Users)	26	26	52
Beekeeper	1	-	1
Total	**55**	**54**	**109**

Multiple methods of data collection including focal group discussion, interviews, and questionnaires will be employed. First, questionnaires were administered to obtain data and information related to beekeeping, farming activities, and where bee products from Kijiji Cha Nyuki C. Ltd. And Interview was conducted with both district and regional agricultural and forest officers.

The analysis comprised determining the common pesticides used by farmers producing areas in Tanzania, Kijiji cha Nyuki Co. Ltd, located in the Singida region was analyzed using descriptive statistics and content analysis for quantitative and qualitative data respectively. Also, quantitative data were categorized and presented in tabular form and frequencies such as percentages.

Ethical Issues to be considered

Ethical consideration was observed in the following manners at the university, and abiding with confidentiality from the information provided by various stakeholders. There was no exposing or leaking of the information without the consent of the person who provided them. The researcher was humble about the culture and beliefs of all respondents. There was no bias, exposing, leaking, hyperbolizing, or understatement of the information from the respondents.

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RESULTS

Demographic Characteristics of the Respondents

Table 2 presents respondents' characteristics such as their categories, gender, education qualifications, and age pattern of the school committee members.

Table 2: Frequency and Percentage Distribution of Respondents by Category

	Respondents	Frequency	%
category	Women	47	47.1
	Male	47	47.1
	District Agricultural officers	2	2
	Forest officers	2	2
	Beekeeper	1	1
Gender	Female	49	49
	Male	51	51
Age	18-30	8	9
	31-50	66	66
	51-60	25	25
Education level	None	5	5
	Primary	65	65
	Secondary	25	25
	University	5	5

Table 2 indicates the frequency of the respondents by their categories. Based on the data obtained, the majority n=94 of the respondents consisted of farmworkers and consumers, followed by forest officers n=2 Agriculture district officers n=2, and beekeepers n=1. The variation of respondents by gender, whereby male participants n=51 of the respondents and n=49 of the respondents were female.

The age groups of respondents; the findings reveal n=66 of respondents were aged between 41-50 years of age. This suggests that most of the respondents were aged, followed by n=16 of the respondents who were between 51-60 years of age. Surprisingly, the study uncovered the youth living in the area aren't that much involved in beekeeping activities as compared to the adult community. For example, only n=8 of respondents were aged between 18-30 years old.

As shown in Table 2. the majority of respondents n=65 only attended primary school, and n=25 of respondents attended both primary and high schools. In addition, n=5 participants including a beekeeper, agriculture district officers, and forest officers stated that they hold a university degree. This study also identified n=5 of respondents never been to school. This is an indication that the majority of individuals involved in beekeeping activities within Kijiji cha Nyuki and the surrounding can read and write which supposes that beekeepers can keep up with regulations if they receive the necessary training.

Pesticides Used by Bee Farmers

The three common pesticides that were identified contain some element of chemical that can pose harm to human health, however, participants noted that several pieces of training/workshops have been provided to all beekeepers and farmworkers therefore they do not expect any negative effects as a result of using insecticides, fungicide and herbicide during harvesting and processing to storage period as noted by one of the forest officers:

We do not expect any injury or harm to the consumer resulting from the consumption of bee and honey products produced in Kijiji cha Nyuki. Our office does run ongoing workshop and training on good practice to ensure bee and honey products produced from Kijiji cha Nyuki is safe and does meet international beekeeping standard. This is because we want to maintain the country's position in terms of countries that do produce quality bee and honey products. And this is not only about Kijiji cha Nyuki but all beekeeping across the region – (Respond 3, Forest officer).

I can tell you, if anything goes wrong then it will be the ignorance of farm workers, or the transportation scheme because we have trust in farm owners. He seems to be aware of what he wants, therefore I doubt that he can engage himself in something that can negatively affect his vision. He wants to be the leader in this industry so to do that, I assume he has to respect all regulations – Respond 5, District agriculture officer)

So, building on the above quotes, and on the respondents discussed in figure 3 and figure 4 one can conclude that bee and honey products produced in Singida, particularly from Kijiji cha Nyuki is safe and cause no harm to human being and the environment. These findings are further reinforced by findings from the quantitative evaluation which shows bee and honey products produced by Kijiji cha Nyuki pose no risk to consumers.

Furthermore, to respond to this objective, the study made use of informant interviews. Participants were one beekeeper, two forest officers, and two agricultural officers. One of the participants indicated that despite a larger number of pesticides that can contaminate honey and honey products the common types are insecticides, fungicides, and herbicides, as noted by the respondent:

There is a larger number of pesticides that can contaminate honey and honey products, although in our area the most common types that we have identified on several occasions are insecticides, fungicides, and herbicides - (Respondent 1).

The issue of honey and honey products contamination is real. As such, we are always conscious and always make sure we do not just allow the use of every pesticide. For example, we have identified Insecticides (cynahalotrine, chlorpyrifos, clothianid), Fungicides (boscalid), and Herbicide (pendimethohele, and cyfluthrin) - (Respondent 2).

Awareness of the Negative Effects of Pesticides

Firstly, the study explored the level of awareness among all participants about the negative effect of pesticides, and whether they were aware of the types of pesticides they were using for their farming activities. Figure 2. demonstrates the level of awareness among participants. Based on the data presented in the figure, n=93 of the participant was aware of the negative effect of extensive use of insecticides, and the types of insecticides they were using. Despite the majority of respondents showing that they were aware of the pesticide being used, n=7 noted that they were not aware.

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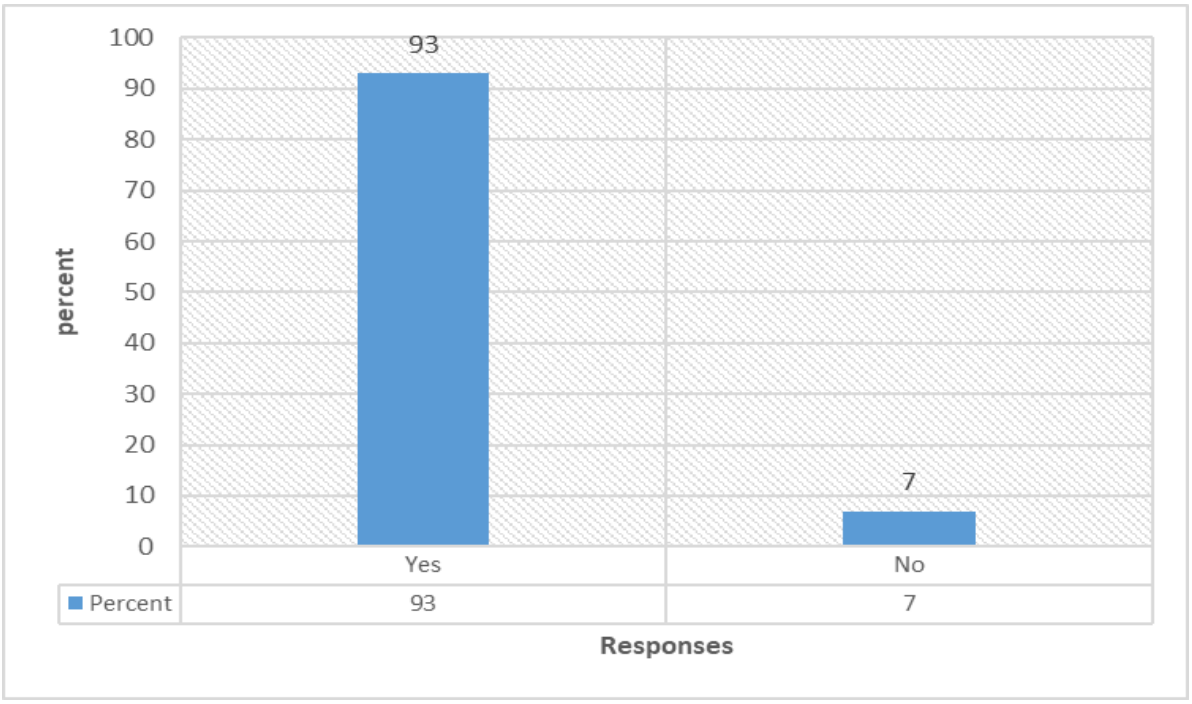
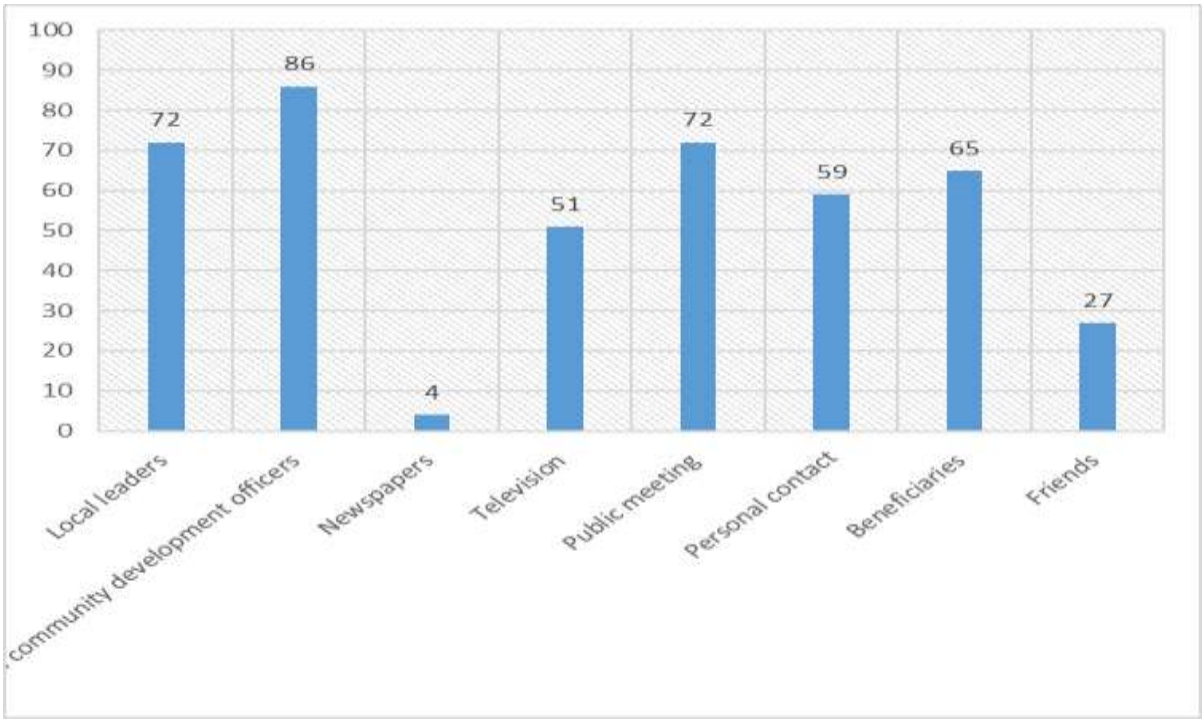


Source: (Field Data, August 2021).

Figure 3: Awareness about the Negative Effect of Pesticides and the Types of Pesticides



Source: (Field Data, August 2021)

Figure 4: Ways Beekeepers and Employees Know About the Negative Effect of Extensive Use of Pesticides

Further, the respondents were asked to share their sources of information, or list ways in which they knew about the negative effect of the extensive use of pesticides. The question allowed the participants to select more than one source of information. As per data presented in figure 4 n=77 of respondents indicated they got the information through ward community development officers while n=65 participants were informed by their local leaders. Similarly, n=65 got detailed information about the use of pesticides via public meetings, n=53 said through personal contact, n=59 through beneficiaries, and n=46 said through television while n=24 respondents said through friends and lastly, n=4 said through the newspaper. The findings imply those involved in beekeeping activities in the area have some relevant information regarding the negative effect of the extensive use of insecticides as per figure 4.

According to the district agriculture officers and forest officers, several regulations were put in place to guide farmworkers or beekeepers on the right farming mechanism. The purpose is to ensure beekeepers are aware of the negative effect of honey and honey product contamination. For example, one of the officers noted:

> *Beekeepers must be well equipped with current and relevant knowledge regarding the use of pesticides as there're several negative effects associated with the use of pesticides. The fact that there is an increased demand for bees and honey products should not be the reason for beekeepers neglecting the issue of quality - (Agricultural officer)*

The above findings show that participants are aware of the negative effect associated with the use of pesticides, and revealed the types of pesticides that contaminate honey and honey products with three types of pesticides being prominent which are insecticides, fungicides, and herbicides.

CONCLUSION AND RECOMMENDATION

Conclusion

The study identified the common pesticides used by farmers producing areas in Tanzania, Kijiji cha Nyuki Co. Ltd, located in the Singida region. Based on the findings from informants comprised of two forest officers and two district agricultural officers showed despite a variety of pesticides that can contaminate bee and honey products, the widely observed are Insecticides (cynahalotrine, chlorpyrifos, clothianid), Fungicide (boscalid), and Herbicide (pendimethohele, and cyfluthrin). To mitigate the challenge posed by these pesticides, farmers always work hard to comply with pesticide regulations NBPIS, NBP, 1998, Beekeeping Act No. 15/2002; Beekeeping Regulations, 2005; NBP 2001-2010 and GCBP 2007. According to the district agriculture officers and forest officers, several regulations were put in place to guide farmers and employees on the right application of pesticides. The purpose is to ensure beekeepers are aware of the severe effect of bee and honey products contaminated with insecticides, hence equipping beekeepers in regards to the use of pesticides is critical as noted in (MNRT, 2020).

It has to be concluded that beekeepers indicated that they regularly follow all necessary steps stipulated in regulations outlining the use of pesticides in Tanzania as per Acts regulating the use of pesticides residues such as the Tanzania Food, Drugs and Cosmetics Act No. 1 of 2003, Pesticide Control Regulations, 1984 for pesticides import, Plant Protection Act No. 13, National Environmental Management Act No. 20, Industrial and Consumer Chemicals (Management and Control) Act No. 3 and Occupational Health and Safety Act No. 5, NBP,

1998, Beekeeping Act No. 15/2002; Beekeeping Regulations, 2005; NBP 2001-2010 and GCBP 2007.

Recommendation

Based on this study's findings, it is firstly recommended that, without coordination, policy regulating the use of pesticides will be hard to implement, because actors in policy implementation display different power. To alleviate this challenge, decision-making for pesticide regulation should not be left at the national level alone. Beekeepers as the first affected individuals and other actors should be made aware of their rights to question and receive constant updates about the use of pesticides in Tanzania.

Further, the study suggests that participants should be guided to produce the expected outcome, and it has to start with the issue of power. In terms of the policy implementation process, the way policy regulating pesticides and policies activities are communicated should set the right tone that will encourage collaboration to ensure all participants will fully contribute. So, by paying attention to the effect of power, the fundamental principles of openness and inclusiveness can be upheld during the policy design and implementation process.

It also recommends further study that will examine the perceptions of decision-makers, consumers, beekeepers, and academicians about the extended use of pesticides in Tanzania, bearing in mind the health implication of the unauthorized use of pesticides.

Furthermore, the study has contributed to the understanding of how the regulations outlining the use of insecticides are being implemented, and the current economic condition of studied farms. The identified challenges can be addressed by ensuring that the views of farms are integrated into policy design and implementation. Therefore, policymakers should involve beekeepers and other actors in the process of designing and implementing pesticide management policies. The study shows the need to incorporate into pesticide regulations praxis, modalities that address the roots of beekeeping challenges. This calls on policymakers to rethink ways of engaging the beekeepers and to have an ongoing discussion with beekeepers and concerned stakeholders about a model that could be used to enhance pesticide regulation in Tanzania. To conclude, a well-thought policy outlining the use of pesticides that takes the views of beekeepers and consumers into consideration positions the pesticide Act with good chances of succeeding. When beekeepers' and consumers' views are integrated into the design and the implementation of policy regulating the use of pesticides makes adoption more practical, thus creating hope for sustainability.

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