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THE PhD RESEARCH PROPOSAL

THE ANALYSES OF PESTICIDES LEVEL EXPOSURE RESIDUES IN EDIBLE LEAF VEGETABLES GROWN IN NORTHERN TANZANIA

(Conference ID: CFP/291/2017)

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ABSTRACTS

This PhD analytical research proposal details on extent of the level of exposure of pesticides residues in edible leaf vegetables found in northern Tanzania. Despite of the Stockholm Conventional control of POPs there is a noted high use pesticides application in field control of pests and fishing preferably, Lake Zone in Tanzania. Examples of the pesticides are fenitrothion, DDT, endosulfan, organophosphorus, carbamate and pyrethroid. The use of these organic compounds is widely & illegally extended to fishing the action of which results into high residue of such chemicals among tilapia in big lakes of Tanzania. The proposed specific objectives includes: Characterization of existing number of pesticides available in vegetables; Examining the levels of pesticides available in different type of vegetables such as Brassica oleracea var. capitata (Cabbage), Brassica oleracea var. acephala (Kale), Brassica rapa subsp. narinosa (Chinese Savoy) Manihot esculenta subsp. Esculenta (Cassava), Amaranta (Mchicha), lettuce, spinach (Amaranthaceas), kunde, Mchicha, Pea leaves and Wild amarantus; and determining the geographical locations being affected by selected study districts. After analytical cross-sectional explanatory design, subsequent chemicals (Pesticides) analysis by Gas Chromatography (GC - FID) technical procedures will be processed at Chemistry Department Laboratories of the University of Dar-Es-Salaam. However, this will be finalized by statistical manipulation through EPI Info 7 of the WHO (2013) Version or alternatively Excel packages of the Microsoft, 2010. Expected types of statistical analysis are frequencies, standard deviation, TWO ways and THREE ways ANOVA.

Table of Contents

ISSN: 3471-7102

1.0. INTRODUCTION

1.1. Background Information

As defined by BC Environment (1990), *"Pesticides are the toxic substances released purposely into our environment to kill living things. Substances in this category are designed to kill weeds (herbicides), insects (insecticides), fungus (fungicides), rodents (rodenticides), and others*". The use of these pesticides are distributed everywhere in the world, preferably agricultural fields, homes, parks, schools, buildings, forests, and roads. It is very important that the availability of these chemicals can be found in the breathed air, kitchen sinks, soil, woodlots and airplane sprayed farms. Also they may be found in the food and drinks commonly consumed (Kasozi *et al,* 2006; TPRI, 1979).

Pesticides dependence on human health, animal and livestock production in Tanzania is a major practice preferably in agriculture for crop protection. The estimated 18% of pesticide is used in public sector, 81% for livestock and agricultural sectors and 1% other areas including protecting buildings from damage by insect pests. Both registered and unregistered pesticides are used to tackle of pests and vectors (TPRI, 1979). The more exposures of farmers and farm workers to agrochemical have a vulnerable effect upon their health (TPRI, 1979).

More than 80% of the population live in the rural area and depend entirely on agriculture for food and cash earning. The key primary food crops cultivated in the country include cassava, maize, rice, banana, coconut and potatoes. The cash crops include coffee, cotton, tobacco, sugar cane, cashew nuts, sisal and tea. Farmers use pesticides to protect these crops. Pesticides are mostly traded and used in Arusha, Kilimanjaro, Mbeya, Ruvuma, Iringa, Manyara**,** Morogoro, Tanga, Mwanza, Kagera and Shinyanga mainly to control pests and disease in farms. Among all regions Arusha is the leading region in pesticide trading (TPRI, 1979).

The average rate of fertilizer use in Tanzania is significantly below consumption rates (about 10 kg ha-1) as opposed to 18 kg in Africa and 94 kg in the world. Fertilizer consumption rate in Tanzania increased significantly from 83,392 metric tons in 2003/2004 to 146,000 in 2006/2007 while the supply increased from 112,000 metric tons in 2003/04 to 287,763 metric tonnes in 2006/2007. Of particular concern, the use of commercial fertilizer is done without proper advice from agricultural officers.

ISSN: 3471-7102

Misuse of dosing, mixing of different fertilizers may have impacts to the crop production and environment at large (Nonga *et al*., 2011).

Africa makes up only 4% with a rough estimate of 75,000-100,000 tonnes of active ingredient used per year in Africa versus 350,000 tonnes in Europe. Relative to other developing countries comparison, average pesticide use per hectare of cultivated land in Africa is very low: only 1.23kg/ha, compared with 7.17kg and 3.12kg for Latin America and Asia, respectively. These figures lead some policy makers to conclude that since the volume of pesticides used in Africa is estimated lower than elsewhere, the risks and effects must also be respectively inferior (PAN Africa, 2006).

Different countries in Africa have approved to have potential use of pesticides. Despite of selective use as for agricultural purpose in Senegal, study have shown the increasingly use of pesticides as for suicides tendency whereby 16 suicide cases were detected in 11 villages during 2002-2006 (PAN Africa, 2006). The annual poisoning incidence rates revealed a frequency estimate of 21.3/100,000 population with serious poisoning in 2000-01 (high level seasonal incidence) and 11.9 per100,000 in 1999-2000 (the lowest). The annual deaths incidence ranged from 0.8 to 1.9/100,000 deaths of people (Cole *et al*, 2002).

Official figures from Amhara Regional Bureau of Health in Ethiopia reported 1.1/100,000 populations poisoning cases to people attended at clinics and hospitals. Incidence figures in Ethiopian farmers were obtained to population of 14,000 which roused concerns about the possible scale of serious poisoning (PAN Africa, 2006). Cotton and cowpea farmers in Ghana estimated that 33-60% of economically active were badly subjected each farming season following pesticides spray. For this case there is clear scientific evidence that, normal exposure to neurotoxic and other pesticides can lead to chronic impairment of the nervous, immune, and reproductive and hormone systems in humans. Children are particularly vulnerable as their organs are still developing (PAN Africa, 2006).

In one study based on epidemiological evidence on use of organochlorine pesticides on food crops & poisoning cases in the district hospitals, Kenya and Tanzania reported 455 and 736 cases of pesticide poisoning respectively. Though uncertain, more than 40% of the health care professionals interviewed, they didn't recall pesticide poisoning cases. Therefore, to prevent pesticide linked illness and deaths in the region, pesticide regulatory bodies require reinforcements. All pesticide users, the general public and health care providers should clearly be oriented on pesticides (Mbakaya *et al*, 1994).

Studies done in India in 2012 evidenced the exposure of urban populations to different classes of organophosphate pesticides due to the consumption of different types of vegetables. Liquid chromatography–mass spectrometry was used for quantification, concentrations μg/kg. This method was accurate (≥ 99.5%) and possessed a limit of detection and quantification in the range of 0.002–0.099 and 0.009–0.337 μg/kg respectively (Sinha ***et al***, 2012). Similarly, by pesticides use, studies done in China reported a significant positive linear correlation between annual food production and chemical fertilizer nitrogen consumption for a consecutive period of 50 years most commonly used fertilizers include different nitrogen and phosphate fertilizers (Agenda, 2006). Globally, the use of fertilizers has increased tremendously and is generally responsible for the green "revolution" i.e. the massive increase in production obtained from the same surface area of land with the help of inorganic fertilizers and intense irrigation (Agenda, 2006).

In USA, due to increased usage of pesticides, farmworkers and farmers have experienced chronic, long-term health problems from exposure to agricultural chemicals, and there have been numerous cases of acute or emergency health problems resulting from pesticide exposure (Kasozi *et al*, 2006).

Fresh vegetables, fruits and pulses are the important part of a healthy diet as the amount of nutrients and minerals present are very significant to human health. Similarly, they can also turn out to be source of toxic substances such accrued from pesticides (Dipakshi *et al*, 2010). The use of pesticides in agriculture has increased after World War II that was used to increase the world food production. Since then there had been marked development of different types of pesticides belonging to various groups. The use of pesticides and additional environmental pollution emitted by industries during pesticides production have resulted in occurrence of vestiges of these chemicals and their metabolites in every component of environment, i.e. air, water and soil along with that in the crops, vegetables and fruits (Timofeeva *et al*, 2008).

By conclusion, pesticides have been widely used in agriculture to fight against insects, pests, weeds and molds for many years, thereby, increasing crop productivity. Besides their positive effects, they also

ISSN: 3471-7102

have been posing various health risks to consumers. Therefore, the concentration of pesticide residues must be monitored not only in various food commodities including fruits, vegetables, pulses and cereals but also in all the three components of environment, viz., soil, air and water in order to check the current status.

1.2. Problem Statement

Pesticides pose a big threat among the public and environments as a result of its legal or illegal application to fields and water bodies. Its use is widely distributed among developing and developed nations. The groups mostly affected are pregnant mothers, children and all other groups of adult people inflicted by massive doses consumption. People employed in fields for crop harvest and spraying for control of pests as well as consumers of such food may greatly suffer from pesticides derived diseases.

Pesticides have been linked to a wide range of human health hazards, ranging from short-term impacts such as headaches and nausea to chronic impacts like cancer, reproductive harm, and endocrine disorder (Kasozi *et al*, 2006).. Acute risks associated with nerve, skin, and eye irritation and damage, headaches, dizziness, nausea, fatigue and systemic poisoning sometimes become theatrical, and even occasionally fatal. Prolonged and chronic health outcomes may occur for years after even minimal exposure to pesticides in the environment, or result from the pesticide residues which we ingest through our food and water. Researchers at the California Public Health Institute, and the UC Berkeley School of Public Health in July, 2007 found a six-fold increase in risk factor for autism spectrum disorders (ASD) for children born by mothers exposed to organochlorine pesticides

Despite of the Stockholm Conventional control of POPs there is a noted high usage of pesticides in field control of pests and un illegal fishing and suicide, meanwhile such pesticides are not yet monitored its residue and toxicity in food. Examples of the pesticides are fenitrothion, DDT, endosulfan, organophosphorus, carbamate, pyrethroid etc (Henry & Kishimba, 2006). There is however, increased residue of such chemicals among tilapia in big lakes of Tanzania (Kasozi *et al*, 2006).

The most reasons as to why pesticides are extensively applied to fields are for instance, **herbicides** are used in home, farm or garden for controlling weeds to ensure that crops are grown. In order to affect the growth of crops the herbicides works by destroying cells and tissue; preventing cells from dividing, thus keeping the plant from growing; promoting uncontrolled growth, thus killing the plant; or disrupting vital enzyme systems within the plant e.g. **glyphosates** which has relatively low toxicity to mammals, insects, and fish (Food for Thought, 2014). Insecticides are used to controlling pests by applying directly to insects or as systemic translocation through the host plant. There is little toxicity that remains on a surface after spraying to a contact insecticide especially during Mosquito spray. Here the classified insecticides are organophosphates, carbamates, miticides, pyrethoids, and neonicotinoids (Food for Thought, 2014). **Fungicides** are used to prevent or cure diseases that cause crop damage but the cure for this case cannot be helpful ever since the damaged crops cannot produce. Fungicide can only protect new, uninfected growth from disease; fungicides play an important role in crop protection (Food for Thought, 2014).

Attempts of different strategies as alternative methods to control and prevent pests were tried among several developing and developed countries. For instance, in minimizing Malaria epidemics associated with rice lands irrigation, this was done by introducing intermittent irrigation to control breeding sites as has been seen in **Sri Lanka**, **Kenya** and **China** in order to minimize the use of DDT (PAN Germany, 2010). Following detection of numerous cases of acute or emergency health problems associated with pesticides in USA, strategies were developed to use chemicals and storage methods that reduce environmental impacts; Use soil quality indicators, conservation tillage, and crop rotation to build soil health as a means of preventing soil born pestilence; using low toxicity and risks associated with pesticides; allow natural pest control (use of predators); select appropriate pest control measures; and eliminate any use of high toxicity pesticides found on the Food Alliance Prohibited Pesticide List (Food Allience, n.d).

What is important in order to safeguard the community with harmful pesticides are first to monitor pesticide residues in food and the environment and secondly to monitor the levels of toxicity available in vegetable at the proposed study area..

1.3. Justification of the Study

This research proposal is very important that benefits the target environment and population. It shows that both male and female; children and adults; All age groups; and both developing and developed world; and field workers and food consumers are critically affected by pesticides. As longer as this situation continues the majority of the public will be more at-risk pesticides derived effects. The findings from this study will assist in generating a new knowledge on alternative profile of non-toxic pesticides application, knowing the sustainability and food security, and subsequently help to design the appropriate interventions for addressing environmental and population free from harmful pesticides.

1.4. Study Objectives

The main objective of this research is to analyze the level pesticides residues in edible leaf vegetables in northern Tanzania by 2017. This will further determine the level of food safety and dietary exposure among the public.

1.4.1. Specific Objectives

i). Characterization of existing number of pesticides available in vegetables

ii). Examining the levels of fenitrothion, DDT, endosulfan, organophosphorus, carbamate, pyrethroid available in different type of vegetables.

iii). Determining the geographical locations being affected by selected study districts.

1.4.2. Hypotheses

i). H_O: There are no existing pesticides in vegetables

$H_{A:}$ There are number of pesticides available in vegetables

II). H_O: The levels of different examined pesticides in different vegetables are negligible

H_A: There are high levels of pesticides in different examined vegetables

iii). H_O: The levels of existing pesticides in different vegetables relative to geographical locations are not similar

H_A: The levels of existing pesticides in different vegetables relative to geographical locations are not similar

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2.0. LITERATURE REVIEW

2.1. Introduction

This chapter describes in details of literature search on pesticides use at study area, Tanzania, Africa and worldwide contexts. Different theoretical search of information such as journal, internet, library etc were performed by researcher. Envisaged pesticides utilization, toxicity and effects to environment, animal, people are critically documented.

2.2. Pesticides use in Tanzania

As defined by BC Environment (1990), *"Pesticides are the toxic substances released purposely into our environment to kill living things. Substances in this category are designed to kill weeds (herbicides), insects (insecticides), fungus (fungicides), rodents (rodenticides), and others*". The use of these pesticides is distributed everywhere in the world, preferably agricultural fields, homes, parks, schools, buildings, forests, and roads. It is very important that the availability of these chemicals can be found in the breathed air, kitchen sinks, soil, woodlots and airplane sprayed farms. Also, they may be found in the food and drinks commonly consumed (TPRI, 1979).

Many pesticides in Tanzania have been applied for field control of pests. The pesticides used are those debarred by the convention of Stockholm treaty of POPs control. Examples of the pesticides are fenitrothion, DDT, endosulfan, organophosphorus, carbamate, pyrethroid etc (Henry & Kishimba, 2006). The use of these organic compounds is widely & illegally extended to fishing and as a result of this; there is high residue of such chemicals among tilapia in big lakes of Tanzania (Kasozi *et al*, 2006).

In Tanzania pesticides are still dependent commodities to be used for human and animal health care, improvement of livestock production and mainly in agriculture for crop protection. It is estimated that 18% of pesticides is used in the public health sector while 81% is used in livestock and agricultural sectors and 1% is used in other areas including protecting buildings from damage caused by insect pests. The country therefore has many registered and unregistered pesticides of different forms in order to tackle the problems of pest and vectors in the country. The current study mainly focuses agricultural pesticides due to the fact that many of the imported pesticides in Tanzania are agrochemicals. Furthermore farmers and farm workers are the most vulnerable to pesticides exposure (TPRI, 1979).

More than 80% of the population live in the rural area and depend entirely on agriculture for food and cash earning. The key primary food crops cultivated in the country include cassava, maize, rice, banana, coconut and potatoes. The cash crops include coffee, cotton, tobacco, sugar cane, cashew nuts, sisal and tea. Farmers use pesticides to protect these crops. Pesticides are mostly traded and used in Arusha, Kilimanjaro, Mbeya, Ruvuma, Iringa, Manyara, Morogoro, Tanga, Mwanza, Kagera and Shinyanga mainly to control pests and disease in farms. Among all regions Arusha is the leading region in pesticide trading (TPRI, 1979).

The heavily relied pesticides by Tanzanian farmers are organochlorines, carbamates, organophorsphorous, pyrethroids and atrazines (Henry and Kishimba, 2002; Ngowi, 2007; Nonga et al., 2011). Some of the organochlorine pesticides like dichlorodiphenyltrichloroethane (DDT), γ-hexachlorocyclohexane (HCH) and aldrin are reported being persistent in the environment and have been banned in developed countries in Europe and America in accordance with the Stockholm Convention on persistent organic pollutants (POPs) (Vijgen *et al*., 2011). The extensive use of pyrethroids such as cypermethrin, deltamethrin, permethrin and cyhalothrin, organochlorines like endosulfan and chlorothalonil; organophosphorous insecticides (chlorpyrifosdimethoate, profenofos, diazinon and fenitrothion) and carbamates (mancozeb, carbaryl and metalaxy) followed by DDT were banned in agriculture use in the early 1990s by the Tanzania Government. Some of other pesticides like HCH are still used on horticulture crops in Tanzania. Despite the fact that this pesticide is not registered by the Tanzania licensing authority, they are being used because of their low cost and effectiveness in agriculture (Agenda, 2006).

Some of the pesticides are imported and sold under different names (Henry and Kishimba, 2003). Despite the problems of pests and diseases affecting crop productivity, Tanzania like many other Sub-Saharan African (SSA) countries is reported to experience soil fertility decline. Most soils have low nutrient content, particularly in nitrogen and phosphorus). The decline in soil fertility is among the reasons for decline in crop productivity and yields in several SSA countries. The use of fertilizers has been an important input in agriculture to improve soil fertility and consequently increase productivity (Agenda, 2006).

Poor soil fertility as disadvantage to production has also been previously reported in areas with intensive unsustainable agriculture whereby farmers are necessitated to use organic and inorganic fertilizers. However, average rate of fertilizer use in Tanzania is significantly below consumption rates (about 10 kg ha-1) as opposed to 18 kg in Africa and 94 kg in the world. Fertilizer consumption rate in Tanzania increased significantly from 83,392 metric tonnes in 2003/2004 to 146,000 in 2006/2007 while the supply increased from 112,000 metric tonnes in 2003/04 to 287,763 metric tonnes in 2006/2007. Of particular concern, the use of commercial fertilizer is done without proper advice from agricultural officers. Mismanagement including inappropriate dosing, mixing of different fertilizers may have impacts to the crop production and environment at large (Nonga *et al*., 2011).

Suggested Further Research

Research on pesticides use in Tanzania narrated that, pesticides will still be dependent commodities to be used for human and animal health care, improvement of livestock production and mainly in agriculture for crop protection in Tanzania for national desired goals (Agenda, 2006). Also together with other studies it is recommended further research should be conducted to implementation programmes by monitoring pesticide residues in food and the environment (Agenda, 2006); Farmers should be well educated on application of pesticides by traders, CSOs/CBOs, agriculture extensionist etc (Agenda, 2006); Regular monitoring of agrochemicals residues is required in order to control the pollution (Jokha, 2011); and monitoring and modeling pesticide fate and nutrient levels in surface water at the sub-catchment scale (Jokha, 2011).

2.3. Pesticides use in Africa

The global pesticide market, Africa makes up only 4% with a rough estimate of 75,000-100,000 tonnes of active ingredient used per year in Africa versus 350,000 tonnes in Europe. Relative to other developing countries comparison, average pesticide use per hectare of cultivated land in Africa is very low: only 1.23kg/ha, compared with 7.17kg and 3.12kg for Latin America and Asia, respectively. These figures lead some policy makers to conclude that since the volume of pesticides used in Africa is estimated lower than elsewhere, the risks and effects must also be respectively inferior (PAN Africa, 2006).

Research has been done in different Countries in Africa and approved to have potential use of pesticides. Despite of selective use as for agricultural purpose in Senegal, study have shown the increasingly use of pesticides as for suicides tendency due easy availability of such endosulphan pesticides used for cotton growth whereby 16 suicide cases were detected in 11 villages during 2002-2006 (PAN Africa, 2006). The annual poisoning incidence rates revealed a frequency estimate of 21.3/100,000 population with serious poisoning in 2000-01 (high level seasonal incidence) and 11.9 per100,000 in 1999-2000 (the lowest). The annual deaths incidence ranged from 0.8 to 1.9/100,000 deaths of people. Similarly, other involved effects experienced were resulted from comprehensive research done on similar poisoning cases in smallholder farming communities in Ecuador that has stressed to have unrecognizable cases of chronic exposure to hazardous insecticides, from low-level but cumulative effects on the nervous system, motor coordination and behavioral function (Cole *et al*, 2002).

Official figures from Amhara Regional Bureau of Health in Ethiopia reported 1.1/100,000 populations poisoning cases to people attended at clinics and hospitals. Incidence figures in Ethiopian farmers were obtained by recall of six pesticide ingestion suicides and four fatalities from using undiluted insecticides to cure open wounds or treat headlice in three villages with population of 14,000 which roused concerns about the possible scale of serious poisoning (PAN Africa, 2006).

Cotton and cowpea farmers in Ghana estimated that 33-60% of economically active people in their villages who were badly exaggerated each farming season following pesticides spray. Symptoms were observed as minor poisoning in favors of their day-off loss reservation. For this case there is clear scientific evidence that, normal exposure to neurotoxic and other pesticides can lead to chronic impairment of the nervous, immune, and reproductive and hormone systems in humans. Children are particularly vulnerable as their organs are still developing (PAN Africa, 2006).

In one study based on epidemiological evidence on use of organochlorine pesticides on food crops & poisoning cases in the district hospitals, Kenya and Tanzania reported 455 and 736 cases of pesticide poisoning respectively. Though uncertain, more than 40% of the health care professionals interviewed, they didn't recall pesticide poisoning cases. Therefore, to prevent pesticide linked illness and deaths in the region, pesticide regulatory bodies require reinforcements. All pesticide users, the general public and health care providers should clearly be oriented on pesticides (Mbakaya *et al*, 1994)

The effects of pesticide toxicity and the body's ability to cope with this are influenced by general levels of health and nutrition. For many African smallholder families, malnutrition, poor sanitation and widespread infectious diseases, including malaria and HIV/AIDS, will make them less able to recover from pesticide poisoning (PAN Africa, 2006).

In South Africa, studies have linked pesticide exposure to acute poisoning (Bennett *et al*., 2003), acetylcholine esterase inhibition (Dalvie & London, 2006), possible occurrence of Guillain–Barré syndrome in a rural farming community, birth defects and endocrine disruption in human communities. Moreover, studies done in South Africa have associated pesticide contamination with toxic effects in aquatic and terrestrial ecosystems. These effects are based to environmental and human health focus, particularly in the human health case, considering that many communities in South Africa use groundwater for drinking purposes or do not have access to, or reliable access to, treated water and often drink untreated water (Dabrowski, 2014). However, in SSA countries as well, the low productivity of crops has been linked to poor resource endowments, minimal use of inputs (fertilizer, improved seeds, and irrigation), and adverse policies (Agenda, 2006).

The risk of pesticide posed to human health or the environment is dependent on several factors, including the quantity of the pesticide applied, the toxic mode of action and the physico-chemical properties of the pesticide, such as half-life and solubility (Dabrowski, 2014). Pesticides are important to crop management because they contribute to increased crop yields and improve the quality of crops. However, pesticides tend to move from the point of application into non-target environments, which can result in serious acute and chronic human health and environmental effects (Dabrowski, 2014).

2.4. Worldwide Distribution & Use of Pesticides

Studies done in India in 2012 evidenced the exposure of urban populations to different classes of organophosphate pesticides due to the consumption of different types of vegetables. Liquid chromatography–mass spectrometry was used for quantification, concentrations μg/kg. This method was accurate (≥ 99.5%) and possessed a limit of detection and quantification in the range of 0.002–0.099 and 0.009–0.337 µg/kg respectively (Sinha ***et al***, 2012). Similarly, by pesticides use, studies done in China reported a significant positive linear correlation between annual food production and chemical fertilizer nitrogen consumption for a consecutive period of 50 years most commonly used fertilizers include different nitrogen and phosphate fertilizers (Agenda, 2006). Globally, the use of fertilizers has increased tremendously and is generally responsible for the green "revolution" i.e. the massive increase in production obtained from the same surface area of land with the help of inorganic fertilizers and intense irrigation (Agenda, 2006).

Attempts of different strategies as alternative methods to control and prevent pests were tried among several developing and developed countries. For instance, in minimizing Malaria epidemics associated with rice lands irrigation, this was done by introducing intermittent irrigation to control breeding sites as has been seen in **Sri Lanka**, **Kenya** and **China** in order to minimize the use of DDT (PAN Germany, 2010).

In USA, due to increased usage of pesticides, farmworkers and farmers have experienced chronic, long-term health problems from exposure to agricultural chemicals, and there have been numerous cases of acute or emergency health problems resulting from pesticide exposure. As a result, strategies have been developed to minimize the risk from pesticides. Some of developed strategies were to use chemicals and storage methods that reduce environmental impacts; Use soil quality indicators, conservation tillage, and crop rotation to build soil health as a means of preventing soil born pestilence; using low toxicity and risks associated with pesticides; allow natural pest control (use of predators); select appropriate pest control measures; and eliminate any use of high toxicity pesticides found on the Food Alliance Prohibited Pesticide List (Food Allience, n.d).

2.5. Agricultural Pests and Pesticides Effects

From the point of view of agriculture, pests are "organisms that diminish the value of resources in which man is interested as they interfere with the production and utilization of crops and live-stock" used for food and fiber (NRC, 1975). The term pest includes insects, mites, nematodes, plant pathogens, weeds, and vertebrates. Pests can reduce crop yields or quality of production, while costs of managing pests increase production costs. The term pesticide includes the substances used to control pests. It includes herbicides (to control weeds and other plants), insecticides (to control insects), fungicides (to control fungi or other plant pathogens), nematicides (to control parasitic worms), and rodenticides (to control rodents).

The term pesticide also encompasses soil fumigants, plant growth regulators, defoliants, and desiccants. Pesticides can be synthetic (developed in laboratories and manufactured) or natural. According to a study conducted using 1996 data (Fernandez-Cornejo and Jans, 1999), weeds are by far the most important pests in U.S. agriculture in terms of the share of treatments used to control them.

The active chemicals used to control pests (the biologically active part of the pesticide) are called pesticide active ingredients. Pesticides are sold as mixtures of these active ingredients with inert materials used to improve safety and facilitate storage, handling, or application.

The term pesticide used in this report includes what EPA defines as "conventional pesticides" (EPA, 2011). This means pesticides that are chemicals or other substances developed and produced primarily or only for use as pesticides. It excludes sulfur, petroleum oil and other chemicals used as pesticides (for example, sulfuric acid, hydrated lime, and insect repellents).

2.6. General Harmful Effects of Pesticides

Rachel Carson (1962), "Silent Spring", she kept emphasize on the public awareness about the effects of pesticide use on our health and our environment. However, almost forty years after Carson drew attention to the health and environmental impacts of DDT the use of equally hazardous pesticides has only increased. There is still evidence budding that human exposure to pesticides is interrelated to health problems. Taking an example in May, 2010, scientists from the University of Montreal and Harvard University released a study that found that exposure to pesticide residues on vegetables and fruit may double a child's risk of attention deficit hyperactivity disorder (ADHD), a condition that can cause inattention, hyperactivity, and impulsivity in children.

Pesticides have been linked to a wide range of human health hazards, ranging from short-term impacts such as headaches and nausea to chronic impacts like cancer, reproductive harm, and endocrine disruption. Acute dangers - such as nerve, skin, and eye irritation and damage, headaches, dizziness, nausea, fatigue and systemic poisoning - can sometimes be dramatic, and even occasionally fatal. Chronic health effects may occur for years after even minimal exposure to pesticides in the environment, or result from the pesticide residues which we ingest through our food and water. A study done July 2007 by researchers at the California Public Health Institute, and the UC Berkeley School of Public Health found a six-fold increase in risk factor for autism spectrum disorders (ASD) for children born by women who were exposed to organochlorine pesticides (Kasozi *et al*, 2006).

Pesticides can cause many types of cancer in humans. Some of the most prevalent forms include leukemia, non-Hodgkin's lymphoma, brain, bone, breast, ovarian, prostate, testicular and liver cancers. In February 2009, the Agency for Toxic Substances and Disease Registry published a study that found that children who live in homes where their parents use pesticides are twice as likely to develop brain cancer versus those that live in residences in which no pesticides are used.

Studies by the National Cancer Institute found that American farmers, who in most respects are healthier than the population at large, had startling incidences of leukemia, Hodgkin's disease, non-Hodgkin's lymphoma, and many other forms of cancer. There is also increasing evidence that exposure to pesticides disrupts the endocrine system, wreaking havoc with the complex regulation of hormones, the

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reproductive system, and embryonic development. Endocrine disruption can produce infertility and a variety of birth defects and developmental defects in offspring, including hormonal imbalance and incomplete sexual development, impaired brain development, behavioral disorders, and many others. Examples of known endocrine disrupting chemicals which are present in large quantities in our environment include DDT (which still persists in abundance more than 20 years after being banned in the U.S.), lindane, atrazine, carbaryl, parathion, and many others.

Multiple Chemical Sensitivity (MCS) is a medical condition characterized by the body's inability to tolerate relatively low exposure to chemicals. This condition, also referred to as Environmental Illness, is triggered by exposure to certain chemicals and/or environmental pollutants. Exposure to pesticides is a common way for individuals to develop MCS, and once the condition is present, pesticides are often a potent trigger for symptoms of the condition. The variety of these symptoms can be dizzying, including everything from cardiovascular problems to depression to muscle and joint pains. Over time, individuals suffering from MCS will begin to react adversely to substances that formerly did not affect them. For individuals suffering from MCS, the only way to relieve their symptoms is to avoid those substances that trigger adverse reactions. For some individuals, this can mean almost complete isolation from the outside world.

2.7. Pesticides and Children

Children are particularly susceptible to the hazards associated with pesticide use. There is now considerable scientific evidence that the human brain is not fully formed until the age of 12, and childhood exposure to some of the most common pesticides on the market may greatly impact the development of the central nervous system. Children have more skin surface for their size than adults, absorb proportionally greater amounts of many substances through their lungs and intestinal tracts, and take in more air, food and water per pound than adults. Children have not developed their immune systems, nervous systems, or detoxifying mechanisms completely, leaving them less capable of fighting the introduction of toxic pesticides into their systems.

Many of the activities that children engage in - playing in the grass, putting objects into their mouth and even playing on carpet - increase their exposure to toxic pesticides. The combination of likely increased exposure to pesticides and lack of bodily development to combat the toxic effects of pesticides means that children are suffering disproportionately from their impacts.

2.8. Pesticides and the Environment

"The United States government estimates that levels of trace minerals in fruit and vegetables fell by up to 76% between 1940 and 1991" says Cleeton. This change is tied directly to the widespread increased exposure to pesticides.

Since the publication of Rachel Carson's landmark 1962 book Silent Spring, the impacts of pesticides on the environment have been well known. Pesticides are toxic to living organisms. Some can accumulate in water systems, pollute the air, and in some cases, have other dramatic environmental effects. Scientists are discovering new threats to the environment that are equally disturbing. Pesticide use can damage agricultural land by harming beneficial insect species, soil microorganisms, and worms which naturally limit pest populations and maintain soil health; Weakening plant root systems and immune systems; Reducing concentrations of essential plant nutrients in the soil such nitrogen and phosphorous.

2.9. 1. DDT

DDT was one of the first chemicals to be used worldwide as a pesticide which was promoted as a wonder chemical after a World War II. It is a simple solution which does not occur in natural environment and debarred by US except in cases of a public health emergency 40 years ago and it has got long-lasting effects to cause us live long due to its prolonged possessions. However, this is still used only to some other areas of the world, most notably for controlling malaria. The use of DDD to kill pests has (Centers for Disease Control and Prevention, 2015).

DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl) ethane) is a pesticide that was once widely used to control insects on agricultural crops and insects that carry diseases like malaria and typhus, but is now used in only a few countries to control malaria. Technical-grade DDT is a mixture of three forms, p,p'-DDT (85%), o,p'-DDT (15%), and o,o'-DDT (trace amounts). All of these are white, crystalline, tasteless, and almost odorless solids. Technical grade DDT may also contain DDE (1,1-dichloro-2,2-bis (p-chlorophenyl) ethylene) and DDD (1,1-dichloro-2,2-bis (p-chlorophenyl) ethane) as contaminants. DDD was also used to kill pests, but to a far lesser extent than DDT. One form of DDD (o,p'-DDD) has been used medically to treat cancer of the adrenal gland. Both DDE and DDD are breakdown products of DDT (Centers for Disease Control and Prevention, 2015).

2.10.1.1. Health Impacts of DDT

Persistent Organic Pollutants are banned for agricultural uses worldwide by the 2001 Stockholm Convention. The use of DDT is still permitted in small quantities in countries that need it, with support mobilized for the transition to safer and more effective alternatives. The treatment of DDT under the Stockholm Convention is strongly supported by PAN and the international partners. One of the new EPA's first acts was to ban DDT, due to both concerns about harm to the environment and the potential for harm to human health. There was also evidence linking DDT with severe declines in bald eagle populations due to thinning eggshells. Since DDT was banned in the U.S., bald eagles have made a dramatic recovery.

The science on DDT's human health impacts has continued to mount over the years, with recent studies showing harm at very low levels of exposure. Studies show a range of human health effects linked to DDT and its breakdown product, DDE: Breast & other cancer; Male infertility; Miscarriages & low birth weight; Developmental delay; and nervous system & liver damage

Animal studies show that long-term exposure to moderate amounts of DDT (20-50 mg per kilogram [kg] of body weight every day) may affect the liver. Tests in animals also suggest that short-term exposure to DDT and metabolites in food may have a harmful effect on reproduction. In addition, we know that some breakdown products of DDT can cause harmful effects on the adrenal gland. This gland is situated near the kidney and produces hormones (substances produced by organs and released to the bloodstream to regulate the function of other organs).

As has been studied, liver cancer can occur in animals due to oral exposure to DDT but, there is no evidence that DDT- exposed labor force did not show increases in deaths or cancers. Based on all of the evidence available, the Department of Health and Human Services has determined that DDT is reasonably anticipated to be a human carcinogen. Similarly, the International Agency for Research on Cancer (IARC) has determined that DDT is possibly carcinogenic to humans. EPA has determined that DDT, DDE, and DDD are probable human carcinogens (CDC, 2015)

2.10.2 Fenitrothion

According to CECP (2006), Fenitrothion is carcinogenic at Group E in nature. Following exposure through aerosol inhalation, skin contacts and ingestion routes, several symptoms may develop according to routes of entry. The symptoms associated with inhalation may include cough, headache, pupil's constriction, muscle cramp, excessive salivation, nausea, dizziness, laboured breathing, convulsions, sweating and unconsciousness. When acquired through skin contacts the manifestations are redness and pains. By ingestion route, this may be accompanied by abdominal cramps, confusion, diarrhea, shortness of breath and vomiting.

2.10.3 Endosulfan

Endosulphan is one of the persistent organic pollutants (POP) having possible adverse effects to human health and similarly included in the Stockholm convention (Polder, 2014). Although the use of technical endosulfan is restricted in Tanzania, high levels of endosulfan sulfate were measured in soil from tomato fields in Ngarenanyuki, Arusha district, and indicated recent use of endosulfan (Kihampa et al., 2010). The chemicals are widely applied in Tanzania for agricultural produce such as cotton, tobacco and vegetables. Also, used for vector control through water ponds spray. Their high impulsiveness has a risk of high range travel at global atmosphere (Chikuni and Polder, 2003).

Endosulfan is a toxic chemical substance used for Controls aphids, thrips, beetles, foliar feeding larvae, mites, borers, cutworms, bollworms, bugs, whiteflies, leaf-hoppers, and slugs on deciduous, citrus, and small fruits, vegetables, forage crops, oil crops, fiber crops, grains, tobacco, coffee, tea, forest, ornamentals and controls termites and tsetse fly (Meister *et al*,1984). It has got a molecular formula of $C_9H_6Cl_6O_3S$ (Worthing, 1983).

2.10.4. Organophosphorus (OPC) and Parathion

Among various pesticide classes, organophosphorus pesticide (OPPs) group is the most widely used class of agricultural pesticides [2–8]. In recent years, many studies have proved OPPs to be mutagenic, carcinogenic [5,8–12], cytotoxic [13,14], genotoxic [15–17], teratogenic [18] and immunotoxic [19,20]. Some of the pesticides belonging to OPPs group are also known for their interferences in reproduction especially in males there are reports on the testicular toxic effects of parathion (OPP) in males and mouse and chromosomal aberrations in peripheral lymphocytes of mouse. Few studies reported that the exposure of OPPs had posed a direct potential risk to human health by inhibiting acetyl cholinesterase and modifying cholinergic signaling. OPPs have tendency to bind to the enzyme acetyl cholinesterase and to disrupt nerve functioning which further result in paralysis and death (Dipakshi ***et al***, 2010)

2.10.5. OPC and Carbamate

Pesticide poisoning is the most common cause of OPC and carbamate poisoning as the vast majority of pesticides still contain OPCs and carbamates [Chen *et al*,2011). The illegal application of OPC such as sarin was used during terrorist attack at Tokyo subways in 1995. Despite of such disadvantages encountered, the two chemicals of physostigmine and neostigmine of carbamate group are important agents for treatment glaucoma and myasthenia gravis (Mason, 2011). There is a similarity of OPC and Carbamates in terms clinical features and control, although sometimes differ structurally. If poisoning occurs its outcome always become good and death may occur in large dosage (Nishijima, 2014).

The main difference in the mechanisms of action between OPCs and carbamates is that carbamates spontaneously hydrolyze from the AChE site within 24 hours, whereas OPCs undergo aging. Aging occurs when the phosphorylated AChE nonenzymatically loses an alkyl side chain, becoming irreversibly inactivated. Carbamates, however, reversibly bind to the active site and do not undergo aging (Nishijima, 2014).

The annual rate of Occupational exposure of pesticide linked cases in US has reported 18 cases per 100,000 workers. The reported 7500 cases of OPC and 3700 cases of carbamate in 2003 were those exposured to Poison Control Centers in the United States. Sixteen OPC associated deaths and 2 carbamate associated deaths were reported that year (Nishijima, 2014).

The increased use and availability of pesticides in developing countries as well, this has resulted in high incidence of OPC and carbamate poisoning. This has been reported in China whereby OPC, caused almost 170,000 deaths per year due to cautious self-poisoning by ingestion (Nishijima, 2014).

Children have an increased incidence of unintentional exposure at home. One retrospective study revealed a difference in clinical presentation in children with OPC and carbamate poisoning compared with adults. Pediatric patients had predominately CNS depression and severe hypotonia, whereas muscarinic symptoms were infrequent (Liftshitz *et al*, 1999)

Patients usually have a history of OPCs or carbamates exposure, either suicidal or unintentional. Pesticides can rapidly be absorbed through the skin, lungs, GI tract, and mucous membranes. The rate of absorption depends on the route of absorption and the type of OPC or carbamate. Symptoms usually occur within a few hours after GI ingestion and appear almost immediately after inhalational exposure.

In most cases farming acquaintance is the mutual cause of OPC and carbamate poisoning. As has been classified by the World Health Organization (WHO) class I poisoning is extremely toxic to class III which is slightly hazardous. The WHO advocates banning or strong restrictions on the use of class I pesticides and a reduction in the use of pesticides to a minimal number of compounds that are less hazardous than others (Eddleston *et al*, 2002).

2.10.6. Pyrethroid

The first pyrethroid pesticide, allethrin, was identified in 1949. Allethrin and other pyrethroids with a basic cyclopropane carboxylic ester structure are type I pyrethroids. The insecticidal activity of these synthetic pyrethroids was enhanced further by the addition of a cyano group to give alpha-cyano (type II) pyrethroids, such as cypermethrin. The finding of insecticidal activity in a group of phenylacetic 3-phenoxybenzyl esters, which lacked the cyclopropane ring but contained the alpha-cyano group (and hence were type II pyrethroids) led to the development of fenvalerate and related compounds. All pyrethroids can exist as at least four stereoisomers, each with different biological activities. They are marketed as racemic mixtures or as single isomers. In commercial formulations, the activity of pyrethroids is usually enhanced by the addition of a synergist such as piperonyl butoxide, which inhibits metabolic degradation of the active ingredient. Pyrethroids are used widely as insecticides both in the home and commercially, and in medicine for the topical treatment of scabies and headlice. In tropical countries mosquito nets are commonly soaked in solutions of deltamethrin as part of antimalarial strategies (Bradberry, 2005)

Pyrethroids are some 2250 times more toxic to insects than mammals because insects have increased sodium channel sensitivity, smaller body size and lower body temperature. In addition, mammals are protected by poor dermal absorption and rapid metabolism to non-toxic metabolites. The mechanisms by which pyrethroids alone are toxic are complex and become more complicated when they are co-formulated with either piperonyl butoxide or an organophosphorus insecticide, or both, as these compounds inhibit pyrethroid metabolism. The main effects of pyrethroids are on sodium and chloride channels (Bradberry, 2005)

3.0. MATERIAL AND METHODS

3.1. Description of the Study Location

This study will be conducted among the four districts located in Mwanza and Shinyanga Regions considering the high application of different pesticides in vegetable gardens, cotton fields and pest control and the reviewed deferral of past study findings conducted within the area. The districts lie between 3^{o} and 4^{o} South and, 34^{o} and 35^{o} East. Purposively Selected Regions as study areas will be used by the investigator to collect the quantitative and qualitative data. Other control subjects will be drawn from peasants in Regions. The study will be conducted from May1st, 2017 **to August** 1st, 2017.

3.2. Study Design

3.2.1. Study Design Selection

Practical and administrative issues will be considered during the initial plan of this research which will include equipment (transport), Laboratory reagents, personnel and stationeries at minimum costs and ensure appropriate run of the proposed activities hence meet with the real existing situation of lack of fund?

However possible, to minimize probable errors in this study, technical issues that are liable to impede the go ahead of activities in the selected study area such as unequal weather (rainy) season, civil disturbances and change of the study interventions are well thought out. The importance of the information is to assist the researcher to timely completion the study.

3.2.2. Type of Study Design

The type of study design proposed is analytical cross-sectional explanatory including experimental laboratory analysis. This will involve the comparability of used pesticides detectable in vegetables (non-equivalent) for examining the variation of residual levels in different vegetables. Also based on Laboratory analysis, characterization will be made regarding the existing toxicity levels of pesticides in vegetables. The type of pesticides to be examined will be are fenitrothion, DDT, endosulfan, organophosphorus, carbamate, pyrethroid in respective cultivated vegetables of Brassica oleracea var. capitata (Cabbage), Brassica oleracea var. acephala (Kale), Brassica rapa subsp. narinosa (Chinese

Savoy) Manihot esculenta subsp. Esculenta (Cassava), Amaranta (Mchcha), lettuce, spinach (Amaranthaceas), kunde, Mchicha, Pea leaves and Wild amarantus.

3.2.3 Selection of study villages

Systematic sampling of proposed districts from selected study regions will be applied in order to get a clear number of target sample district. However, purposively sample selection to villages with extensive cultivation of vegetables will be useful technique. Every 'nth' (number of target villages) consecutive village will be drawn starting with a randomly selected number between one and 'n'.

3.2.4 Sampling Procedures of the Analytical Sample

The analytical samples will be sampled from potential farmers. Each type of vegetables will at least categorize into 10 possible samples or in accordance to agreement by my supervisors. From the farmers, two categories of pesticides and non-pesticides grower of vegetable sample will be separately identified and blind them. Different geographical areas will be Identified and samples taken accordingly. Subsequent storage of samples in a dry container of optimal temperature will be used to keep and store the samples for subsequent transportation to Dar-Es-Salaam for Laboratory analysis.

3.3. Chemical Analyses

The pesticides chemical analyses will be carried in this study using analytical grade reagents for pesticides. These analyses will be done at Dar-Es-Salaam University at Chemistry Laboratory for Chromatography – MS.

Among the applicable methods of Analysis of organophosphorus pesticides (OOPs) used in vegetables are gas chromatography (GC), gas chromatography-mass spectrometry (GC–MS), gas chromatography–ion trap mass spectrometry (GC-ITMS) [Thao, 2010) and gas chromatography–tandem mass spectrometry (GC–MS/MS) had made a imaginary progress in field of monitoring pesticides because of the high separation power, selectivity and identification capabilities of MS (Sharma et al, 2009).

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3.4. Technical Procedure for Gas Chromatography (GC - FID) (Saferstein, 2002)

3.4.1. Equipment, Materials, and Reagents

Equipment

- Agilent 6890 Gas Chromatograph with a Flame Ionization Detector
- Agilent 7890 Gas Chromatograph with a Flame Ionization Detector

Materials

- Auto sampler vials, 150 µL vial inserts, and crimp seals
- Vial crimper and decrimper
- 10 micro-liter auto sampler syringe
- A non - polar capillary column with a (5%-Phenyl) - methylpolysiloxane stationary phase such as a DB-5 or HP-5
- 50% residual gasoline reference material
- 100% diesel fuel reference material

Reagents

- Acetone
- Carbon disulfide -Reagent A.C.S. grade
- Petroleum ether – Optima Grade
- Hydrogen gas
- Air –Zero grade
- Nitrogen – UHP grade

3.1.2. Procedure

- ***Start-up and Calibration***
  - The GC-FID shall be kept on at all times.
  - Monthly GC-FID Performance Check - To ensure performance, the following samples shall be analyzed and the chromatographs electronically archived each month the instrument is in

use. If the instrument was not in use the previous month, the performance check shall be performed prior to casework.

- Petroleum ether blank
- Carbon disulfide adsorption elution blank
- 50 % residual gasoline reference material
- 100% diesel fuel reference material

If there is a shift in peak retention time by 0.2 minute or more or a change in peak resolution, maintenance shall be performed or a service engineer must be called. Once maintenance has been performed, the samples shall be re-examined. If the resulting chromatographs are within the limits, the instrument may be used for casework

New Instrument Setup and Performance Verification

- New GC-FID instruments shall be installed by a certified engineer according to the manufacturer's guidelines.

- The samples used in the monthly GC-FID performance check shall be analyzed on the instrument and the resulting chromatographs compared to the same samples acquired on similar instruments. The resulting chromatographs shall have similar peak ratios and component separation in order for the new instrument to be utilized for casework

3.5. Data Analysis

Data analyses will be performed through EPI Info 7 of WHO versions and Excel statistical packages of 2013. All the data collected through fields and laboratory analysis will be initially coded and summarized in tables. The descriptive and inferential statistics such as frequencies means and standard deviation, TWO and THREE ways ANOVA will be useful parameters of interest proposed under this study.

4.0. SOURCE OF FUND AND BUDGET

Table 2: A Summary of Budget Descriptions Justification and total cost of the project

B/L	Major Descriptions	Justification	Total T.Shs
8.1	Personnel and allowances	2 000 000	2 000 000
8.2	Materials, Supplies & Computer Services	1 550 000 x 1	1 550 000
8.3	Travel Including Fuels & Services	500 000 x 3prsons	1 500 000
8.4	Sample characterization and Analysis	35,000 x 70 samples	2,500,000
8.5	Miscellaneous	235 000	520 000
	Grand Tota Budget	**8,120,000**	**8,120,000**

5.0. SCHEDULES OF ACTIVITIES

Table 2. Gantt chart indicating the Research Plan

Activity	Months, 2015 - 2018											
	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
Developing research proposal					2015	2016	2016	2016	2016	2016		
Presentation of Initial proposal draft											2016	2016
Supervisors to Review the Proposal	2016	2016										
Funders review of proposal & funding decisions			2016	2016	2016							
Field Data Collection						2017	2017	2017	2017	2017	2017	2017
Laboratory, Computer Data analysis & results summary	2017	2017	2017	2017	2017							
Literature review						2018	2018	2018				
Discussion of the findings									2018			
Report writing & preliminary draft										2018		
Supervisors review											2018	2018
Presentation of Dissertation and Submission of hard copy												2018
Dissemination of findings and End of the Research Project	2018	2018	2018									

REFERENCES

[1] Agenda. (2006). Pesticide and Poverty, a Case Study on Trade and Utilization of Pesticides in Tanzania: Implication to Stockpiling. Dare-Es-Salaam

[2] ASTM Standard E1387 (2001) "Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography." ASTM International, West Conshohocken, PA, 2001.

[3] ATF National Laboratory Center Class. "Laboratory Detection and Identification of Accelerants Found in Arson Debris."

[4] BC Environment (1990). Handbook for Pesticide Applicators and Dispensers. Retrieved from http://www.ccohs.ca/oshanswers/chemicals/pesticides/health_effects.html 22/03/2016

[5] Bennett, R., Buthelezi, T.J., Ismael, Y., Morse, S. (2003). Bt cotton, pesticides labour and health: A case study of smallholder farmers in the Makhathini Flats, Republic of South Africa. Outlook Agric 2003;32(2):123–128.

[6] Bradberry, S.M., Cage, S. A., Proudfoot, A. T., Vale, J. A. (2005). Poisoning due to pyrethroids. Toxicol Rev; 24(2):93-106.

[7] Centers for Disease Control and Prevention. (2015). Toxicological Profile for DDT, DDE, and DDD. 1600 Clifton Road Atlanta, GA 30329-4027, USA retrieved from http://www.atsdr.cdc.gov/phs/phs.asp?id=79&tid=20

[8] Chemicals Evaluated for Carcinogenic Potential (2006). Cancer Classification: Group E Evidence of Non-carcinogenicity for Humans - USEPA Office of Pesticide Programs,Health Effects Division, Science Information Management Branch

[9] Chen SW, Gao YY, Zhou NN, Liu J, Huang WT, Hui L, et al. (2011). Carbamates of 4'-demethyl-4-deoxypodophyllotoxin: synthesis, cytotoxicity and cell cycle effects. *Bioorg Med Chem Lett*. Dec 15. 21(24):7355-8. [Medline].

[10] Chikuni O, Polder A. (2003). Human exposure to airborne pesticide pollutants. In: Jacobs M, Dinham B, editors. Silent invaders; pesticides, livelihoods and women's health. Zen books Ltd. p. 127–33.

[11] Cole, D.C., Sherwood, S., Crissman, C., Barrera, V. and Espinosa, P. (2002) Pesticides and health in highland Ecuadorian potato production: assessing impacts and developing responses. International Journal of Occupational & Environmental Health 8 (3) 182-190.

[12] Dabrowski, J. M. (2014). Development of pesticide use maps for South Africa. South Africa Journal of Sciences. 2015; 111(1/2), Art. #2014-0091, 7 pages. [http://dx.doi.org/10.17159/ sajs.2015/20140091] Retrived 19/01/2017

[13] Dalvie, M.A., London L. (2006). The impact of aerial application of organophosphates on the cholinesterase levels of rural residents in the Vaalharts district, Northern Cape Province, South Africa. Environ Res. 2006;102(3):326–332.

[14] Dipakshi Sharmaa, Avinash Nagpal a, Yogesh B. Pakade b, Jatinder Kaur Katnoriaa,∗ (2010). Analytical methods for estimation of organophosphorus pesticide residues in fruits and vegetables: A review. *Elsevier Talanta* 82 (2010) 1077–1089.

[15] Eddleston, M., Karalliedde, L., Buckley N., Fernando, R., Hutchinson, G., Isbister, G., et al. (2002). Pesticide poisoning in the developing world a minimum pesticides list. *Lancet*. Oct 12. 360(9340):1163-7. [Medline].

[16] Emmy LEMA, Revocatus MACHUNDA and Karoli Nicholas NJAU (2014). Agrochemicals use in horticulture industry in Tanzania and their potential impact to water resources. *Nelson Mandela African Institution of Science and Technology (NM-AIST), Department of WaterArusha Tanzania*, Int. J. Biol. Chem. Sci. 8(2): 831-842.

[17] Farm Chemicals Handbook, 70th ed. 1984. R. T. Meister, G. L.Berg, C. Sine, S. Meister, and J. Poplyk, eds. Meister Publishing Co., Willoughby, OH.

[18] Fernandez-Cornejo, J., and S. Jans. 1999. Pest Management in U.S. Agriculture. AH-717, U.S. Department of Agriculture, Economic Research Service, Aug.

[19] Food Alliance (n.d). Supporting sustainability in Food and Agriculture: Reduce pesticide use and toxicity (Retrieved from http://foodalliance.org/about/principles-explained/reducing-pesticide-usage 9/05/2016)

[20] Food for Thought (2014).What Are Pesticides, and Why Do We Use Them on the Farm? THE BLOG. Retrived from http://www.huffingtonpost.com/jenny-dewey-rohrich/what-are-pesticides-and-w_b_5662370.html 9/05/2016)

[21] Government of British Columbia (2014). Permanent stations to protect B.C. from invasive mussels. Office of the Premier. BC Gov News

[22] Henry, L & Kishimba, M.A.(2006). Pesticide residues in Nile tilapia (Oreochromis niloticus) and Nile perch (Lates niloticus) from Southern Lake Victoria, Tanzania. *Environ Pollut.* 2006 Mar;140(2):348-54. Epub 2005 Sep 30. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16199118 16/03/2016

[23] Henry, L, Kishimba, M. A. (2003) Levels of Pesticides in water, soil and sediments from southern Lake Victoria and its Basin. Tanz. J. Sci., 29(1): 77-90.

[24] **Jokha, M. (2011).** Effects of Agricultural Pesticides and Nutrients Residue in Weruweru Sub-Catchment, Tanzania. SUA, MOROGORO.

[25] Kasozi GN, Kiremire BT, Bugenyi FW, Kirsch NH, Nkedi-Kizza P. (2006). Organochlorine residues in fish and water samples from Lake Victoria, Uganda. *J Environ Qual.* 2006 Mar 1;35(2):584-9. Print 2006 Mar-Apr. http://www.ncbi.nlm.nih.gov/pubmed/16510703 16/03/2016.

[26] Lifshitz M, Shahak E, Sofer S. (1999). Carbamate and organophosphate poisoning in young children. Pediatr Emerg Care. Apr. 15(2):102-3. [Medline].

[27] Masson P.(2011). Evolution of and perspectives on therapeutic approaches to nerve agent poisoning. Toxicol Lett. 2011 Sep 25. 206(1):5-13. [Medline].

[28] Mbakaya, C.F., Ohayo-Mitoko, G.J., Ngowi, V.A., Mbabazi,R., Simwa, J.M., Maeda D.N., Stephens, J., Hakuza, H. (1994). The status of pesticide usage in East Africa. Africa Journal of Health Sciences. 1994 Feb;1(1):37-41

[29] National Research Council (NRC), Environmental Studies Board. 1975. Pest Control: An Assessment of Present and Alternative Technologies (Volume 1). Washington, DC: The National Academies Press

[30] Nishijima, D. K. (2014). Organic Phosphorous Compound and Carbamate Toxicity Clinical Presentation. (Medscape) (Retrived from http://emedicine.medscape.com/article/816221-clinical#showall, 14/05/2016)

[31] Nonga, H. E., Mdegela, R. H., Lie, E., Sandvik, M. and Skaare, J. U (2011). Assessment of farming practices and uses of agrochemicals in Lake Manyara basin, Tanzania. African Journal of Agricultural Research Vol. 6(10), pp. 2216-2230.

[32] O.A. Timofeeva, D. Sanders, K. Seemann, L. Yang, D. Hermanson, S. Regenbogen, S. Agoos, A. Kallepalli, A. Rastogi, D. Braddy, C. Wells, C. Perraut, F.J. Seidler, T.A. Slotkin, E.D. Levin. (2008). Brain Res. Bull. 77 404–411.

[33] PAN Africa (2006). Living with poison. Problems of endosulfan in West African growing systems. PAN UK, London.

[34] PAN Germany (2010). A healthy world for all: Protect humanity and the environment from pesticides. Promote alternatives. Hamburg. (Retrieved from (http://www.pangermany.org/download/ddt/ddt_alternatives_2_edition.pdfn 09/05/20160)

[35] PAN Germany (2010). A healthy world for all: Protect humanity and the environment from pesticides. Promote alternatives. Hamburg. (Retrieved from (http://www.pangermany.org/download/ddt/ddt_alternatives_2_edition.pdfn, 09/05/20160)

[36] Polder, A. (2014). Levels and patterns of persistent organic pollutants (POPs) in tilapia (Oreochromis sp.) from four different lakes in Tanzania: Geographical differences and implications for human. Journal of Science of the Total Environment 488–489 (2014) 252–260

[37] Saferstein, R. (2002). Forensic Science Handbook. Volume I, 2nd edition. Upper Saddle River, NJ: Prentice Hall, Chapter 9: Arson and Explosive Investigation. pp. 479-524.

[38] Sinha, S N.,Vardhana Rao, M. V. & Vasudev, K. (2012). Distribution of pesticides in different commonly used vegetables from Hyderabad, India. *Journal of sciencedirect*, Volume 45, Issue 1, January 2012, Pages 161–169

[39] Tao, C.J., Hu, J.Y., Li, J.Z., Zheng, S.S., Liu, W., Li, C.J. Bull. Environ. Contam. Toxicol. 82 (2009) 111–115. In D. Sharma et al. / Talanta 82 (2010) 1077–1089

[40] The Pesticide Manual: A World Compendium, 7th ed. 1983. C.R. Worthing, ed. The British Crop Protection Council, Croydon, England. 695 pp.

[41] TPAWU and TPRI. (2004). Analysis of the presence and the regulations of dangerous pesticides in Tanzania –PAN Africa study

[42] TPRI (1979). A case study on trade and utilization of pesticides in tanzania: Implication to Stockpiling. Dar-Es-Salaam, Tanzania.

[43] U.S. Environmental Protection Agency (EPA). 2011. Pesticide Industry Sales and Usage: 2006 and 2007 Market Estimates. Biological and Economic Analysis Division, Office of Pesticide Programs (A.Grube, D. Donaldson, T. Kiely, and L. Wu). Feb.