FARMERS PRACTICE VERSUS RECOMMENDED PESTICIDES SPRAY PROGRAMMES IN TOMATO AND AFRICAN EGGPLANT PRODUCTION: ACASE OF MVOMERO DISTRICT, MOROGORO, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN RURAL DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

2019

ABSTRACT

The main objective of this study was to analyze the gap between the recommended pesticides spray programmes and the actual farmers' practices in the production of tomato and African eggplant among farmers in Mvomero District, Morogoro Region, Tanzania. The specific objectives were to: (i) Identify the pesticide use recommendations for tomato and African eggplant production (ii) assess the level of farmers awareness on recommended pesticide spray programmes (iii) compare the recommended and actual farmers pesticide spray practice and (iv) find out the factors for farmers abidance by the recommended practices. Cross sectional research design was applied. Data were collected using a questionnaire for farmers and a checklist of questions for the key informants. The region, district and villages were selected purposively while the respondents, 120 in total, were randomly selected among the tomato and African eggplant producers. Data collected were analyzed using statistical package for social sciences (SPSS) for quantitative data and content analysis for qualitative data. Findings from this study show that the recommended pesticides spray programmes comprise of; timing of application, pesticides spray frequency, equipment used and application rates. For a farmer to make sound decision on the application of these programmes they have to do scouting regularly in their farms. Although all farmers had a certain level of awareness on the recommended spray programmes; it was only 45.5% of the respondents who abode by them. The factors which influenced farmer's abidance by the recommendations included level of education, access to agricultural extension services and income. For farmers to abide by the recommended pesticides spray programmes and at the same time decrease misuse of pesticides; extension services have to be improved especially those which promote farmer to farmer learning.

DECLARATION

I, Efraim Tertio Malisa, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor is it being concurrently submitted in any other institution.

_____ _____

Efraim Tertio Malisa **Date**

(MA Candidate)

The above declaration is confirmed by;

_____ _____

Prof. C. P. Mahonge **Date**

(Supervisor)

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DEDICATION

I dedicate this dissertation to my beloved parents Mr. and Mrs. Tertio Ndesamburo Malisa who always encouraged me to go for further studies and to my children Ellyn Efraim, Elizabeth Efraim and Ebenezer Efraim for their prayers.

ACKNOWLEDGEMENTS

I would like to express my heartily thanks to my supervisor, Prof. Christopher P. Mahonge, for guiding me with encouragement. I am very much indebted to him for his timely deep support and willingness to advise me from the stage of designing the research proposal to the final write-up of my dissertation. I also express my sincere gratitude to Prof. A.P. Maerere, the project leader for SEVIA project which supported my research and to SEVIA for accepting my proposal. Last but not least to God the Almighty who gives me strength to do all things.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

1.1.1 Horticulture sub-sector

In Tanzania the horticulture sub-sector is growing fast at an annual rate of 6 -10 % and has contributed to the country's export earnings. The sub-sector has a potential to become one of the main sources of foreign exchange earnings and a significant driver of economic growth. The National Export Strategy (2008) and the *Kilimo Kwanza* resolution identified the horticulture sub-sector as one of the priority sectors and a key component in the diversification of the agricultural sector from overdependence on traditional primary agricultural products. Among other efforts, there has been formulation of the National Horticultural Development Strategy of 2010. According to URT (2010), the strategy envisages facilitating the development of horticultural industry so as to improve nutritional status, increase incomes and reduce poverty while increasing productivity and quality of the produce.

1.1.2 Pesticides use in horticultural production

Tomato and African eggplant are among the important horticultural crops grown in Tanzania. Tomato is the most important vegetable in Tanzania; it represents about 16% of the total production of fruit and vegetable in the country (MMA, 2012). Production of these crops is done mainly by small scale farmers. Adopted crop husbandry practices including planting, disease control, insect pest management and weed management are in most cases inadequate leading to low crop yields. For example, Maerere (2010) reported injudicious use of fungicides provoked by high percent of the produce being lost to a variety of causes with fruit rot accounting for the majority of tomato fruit losses. Cases of

use of pesticides beyond the recommended dosage and frequency as a measure to reduce postharvest loss have also been reported. As Maerere (2010) asserted, this can lead to residues in the fruit that may cause consumer health hazards. Moreover, overuse of pesticides increases the cost of production and reduces profit margins. It is, therefore, important to design and disseminate appropriate spray programmes that can be utilized by the small-scale farmers. Therefore this study aimed at finding out the gap between what has been recommended and the actual farmers' practices for the pesticides use in tomato and African eggplant production.

1.2 Problem Statement

Pesticides are of crucial importance in vegetable production. As Sabur and Molla (2001) argue, pesticides are even important with modernization of agriculture, which basically implies increased use of modern inputs such as chemical fertilizer, irrigation and modern seeds, which provide a favorable climate for rapid growth of pests. A wide range of pesticides is used for pest management and vector control in agricultural areas (Ngowi, 2007).Non-optimal and non-judicious use of pesticides may result in a series of problems related to both loss of their effectiveness in the long run and certain externalities like pollution and health hazards (Sabur and Molla, 2001).On the production side, a slight mistake may lead up to even 100% loss of the crop.

As such, farmers need to have knowledge on the appropriate use of pesticides to avoid impact on human health and the environment. According to SEVIA (2015), without knowledge on appropriate use of pesticides farmers may use wrong chemicals and incorrect rates of pesticides. As important step towards recommending appropriate pesticides use, it is crucial to understand farmers knowledge status quo. This study, therefore, attempted to find out the gap between the recommended pesticide spray

programmes and the farmers' actual practices in the production of tomato and African eggplant.

1.3 Justification of the Study

The study is in line with the Tanzania Plant protection Act of 1999, National Environment Action Plan 2013-2018 of Tanzania and the Tropical Pesticides Research Institute (TPRI), the entities whose role is to ensure proper use of pesticides and other chemicals. Findings from this study are important in informing the policy-makers on the proper measures to take in the area of pesticide use. Pesticides are meant to improve production and eradicate poverty but if not handled carefully their application may enhance poverty instead of eradicating it since overuse of pesticides increases the cost of production and reduces profit margins. It also affects health of farmers and consumers which ultimately reduces strength of the workforce. Therefore, measures to ensure and promote adoption of recommended application of pesticides should be of preference. Towards this end acquiring the knowledge on the way the existing practice of use of pesticides compares with the recommended practices will help to address the issue easily.

1.4 Objectives

1.4.1 General objective

To find out the existing gap between recommended spray programmes and the farmers practice in tomatoes and African eggplant production in Tanzania.

1.4.2 Specific objectives

(i) To identify the pesticide use recommendations for tomato and African eggplant production.

(ii) To assess the level of farmers awareness of recommended pesticide spray programmes.

(iii) To compare the recommended pesticides spray programmes to farmers pesticide spray practices.

(iv) To find out the factors influencing farmer's abidance by the recommended pesticide spray programmes.

1.4.3 Research questions

(i) What are the recommended pesticide spray programmes for tomatoes and African eggplant?

(ii) To what extent are farmers aware of the pesticide use recommendations?

(iii) What are the sources of information on the recommended spray programmes?

(iv) How are the farmers dealing with pests in the production of tomato and eggplant?

(v) To what extent do farmers abide by the recommended pesticide spray programmes

(vi) What influences farmers abidance by the recommended spray programmes?

1.5 The Conceptual Framework

The variables that were studied are summarised in Fig. 1, and the hypothetical relationships among them are explained. The conceptual framework accommodated a set of background and independent variables that influenced the implementation of recommended pesticide spray programmes. The background variables of focus were sex, education level and age.

The independent variables incorporated in this framework were farmer's knowledge, perceived benefit, and income extension services, access to credit, farm size, awareness and side business. All these independent variables are conceived of having direct influence

on the dependent variable which is abidance by the recommended pesticide spray programmes. The background variable age is likely to influence the implementation of the recommended practices in terms of experience in the use of pesticides. Men are good adopters of recommended use of practices because they have enough time to look for pesticides and information; this might be because women are the ones who take care of the families or because men don't give them permission. Also the nature of the interventions in the production of these crops requires use of strength which is not easy for women.

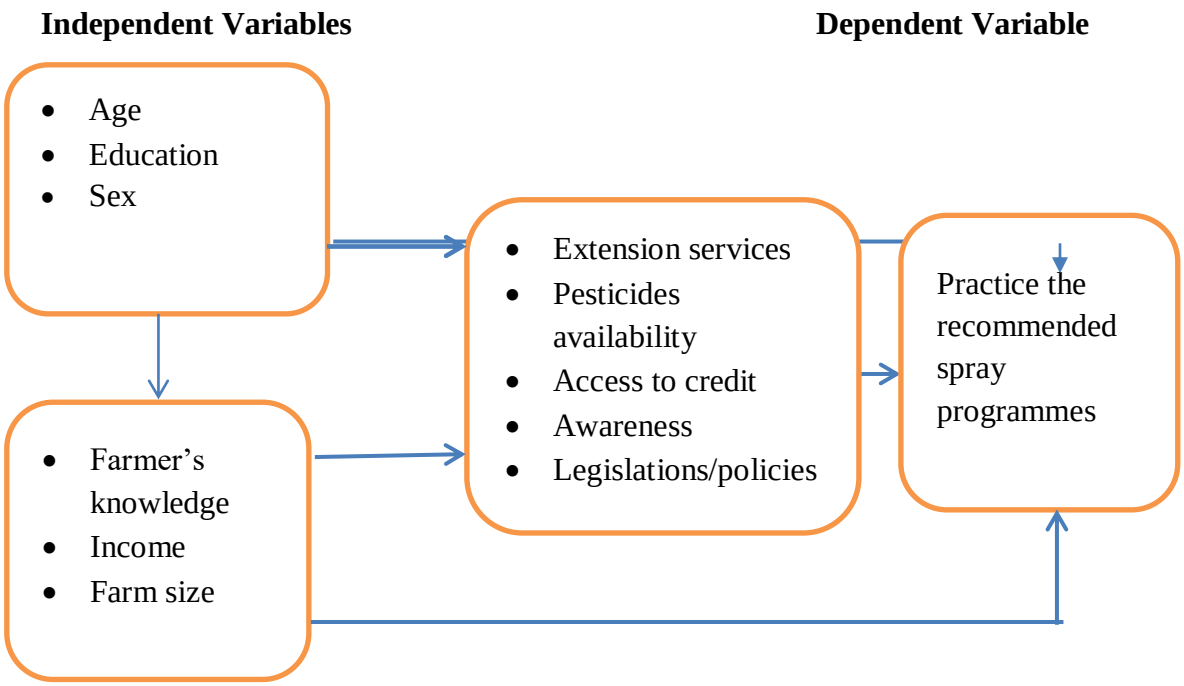

Figure 1: A conceptual framework for a study on farmers practice versus recommended spray programmes in tomato and African eggplant production.

Education level is thought to aid in reading instructions on the pesticide safety label for appropriate use. Therefore farmers with minimum of primary school education are able to read the guidelines especially when written in Swahili.

It is hypothesized that independent variables such as farmers' knowledge, agriculture extension services and awareness on the recommended pesticide spray programmes influence abidance. On the other hand, the role of the government is to make sure there are supportive policies/legislations to enable farmer's access to and appropriate use of the pesticide. The government should also ensure provision of extension services which may enable farmers to use pesticides in a right way hence avoiding wrong use of the pesticides. The adoption of recommended pesticide use practices is also influenced by policy

environment. Some of the relevant policies , which directly or indirectly influence the pesticide use practices include the Plant Protection Act No.13 of 1997, The Tropical Pesticides Research Institute Act No, 18 of 1979 and Pesticide Control Regulations Therefore, abidance by the recommended pesticide spray programmes is the function of a number of factors such as age, sex, education level (knowledge), household size, farmer's awareness, farm size extension services, side business and access to credit, and policy environment.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Agriculture in Tanzania

2.1.1 General information

The contribution of the agricultural sector to economic growth and the development of Tanzanians has continued to increase. In 2015, the agricultural sector contributed 29% of the GDP, compared to 28.8% in 2014. This was the largest contribution, surpassing all other sectors. In addition, agriculture is the largest employer in the country. Currently, the sector alone provides employment to 65.5% of Tanzanians and in favorable seasons, covers more than 100% of the domestic food needs. Seeing most Tanzanians are involved in agriculture, this sector plays an even bigger role in the reduction and alleviation of poverty (DELOITE, 2016).

According to Tanzania National Agriculture Policy (URT, 2013b), the agricultural sector is comprised of crops, livestock and forestry and hunting sub sectors. Tanzanian agricultural sector is an important sector as a source of food, employment, raw materials, and foreign exchange. This sector provides livelihood for more than two-thirds of the population in Tanzania. Although the number of people working in agriculture is decreasing little by little, agriculture is still the most important economic activity. Some 70% of households are headed by individuals who work in agriculture. The sale of agriculture is the main source of cash income for 62% of households (URT, 2010).

Arable land which is defined as land under temporary crops is 13% as of 2011 (WB, 2014). Most of the regions in Tanzania depend on the long rainy season, since few regions receive substantial rain in both long and short seasons. During 2002/03, the total area

planted with annual crop was 7,818,620 ha in the short rainy season, and 6,349,707 ha was planted during the long rainy season (URT, 2010). The main staple foods are maize and paddy. The main cash crops are cashews, coffee, cotton, sisal, sugar, tea and tobacco, as well as spices from Zanzibar. Generally, food crop producers are poorer than cash crop producers. But both farmers are frequently exposed to cyclical and structural constraints, such as drought and flooding**.**

Pesticides are defined by Tropical Pesticide Research Institute (TPRI) Act No.18 of 1979 as "any matter of any description (including acaricides, arboricides, herbicides, insecticides, fungicides, molluscides, nematicides, hormonal sprays and defoliants) used or intended to be used, either alone or together with other material substances (a) for the control of weeds, pest and disease in plants, or (b) for the control of the external vectors of veterinary or medical disease and external parasites of man or domestic animals or (c) for the protection of any food intended for human or human consumptions. It is also defined by Zilberman (2001) as chemicals and other means to reduce or eliminate pests affecting agricultural production. Humans use animals (cats, dogs, etc.), mechanical efforts, and chemicals (arsenic) to control pests. In recent years, the most popular means of pest control are synthetic chemicals. They include: herbicides, insecticides and fungicides.

2.1.2 Pesticides spray programmes

Spray programmes refer to in this study the type of equipment, spraying rate, spraying time, spraying technique and frequencies of the particular pesticides for the crop pest for optimum productivity. Various spraying and dusting machines that control diseases, insects and weeds are available. Home gardeners use hand-operated machines or small power-driven machines best suited for their needs. When a person selects dusting or

spraying equipment, a number of points should be kept in mind including the following: (1) simplicity of design and ease that adjustments and replacements can be made, (2) quality of material and construction, (3) availability of parts and repair service, and (4) cost (Ned, 2005).

2.1.3 Use of agricultural inputs

In Tanzania the use of inputs including improved seeds, inorganic and organic fertilizers varies across districts. According to National Census of Agriculture 2007/08, 18.2% out of all households planted with fertilizer, out of which 11.0% used organic fertilizer and 7.2% used inorganic fertilizer. During the long rainy season, 19.8% out of all households used fertilizers, out of which 9.9% were organic fertilizers and 9.9% were inorganic fertilizers. These data show low use of purchased inputs as other African countries' smallholder farmers sectors do (NBS, 2010 and Hillocks, 2002). Moreover, the data tell that the use of organic fertilizers is not common. With regard to technology, crop growing smallholder farmers' access to improved seeds is 24.3%, 14% to insecticide/fungicide, and 7% to irrigation (UTR, 2010).

2.2 Horticultural Sub-sector in Tanzania

Horticultural produce has always been part of Tanzania's diet and mainstay of many Tanzanians. Indigenous fruits, vegetables, spices and flowers have been cultivated in Tanzania for generations and traded throughout the region. Tanzania is generally regarded to have started exporting horticultural products outside the region in the 1950s with the production of bean seed for sale in Europe. Perishable horticulture exports to Europe started in the 1970s, following the success of Kenya's horticulture exports. In the mid-1980s, a cut flower industry was established, followed by the development of a cuttings industry of chrysanthemums. More recently, there have been specialized investments in

the propagation of hybrid vegetable seeds, higher value fruits and vegetables, and cut-flowers other than roses. In the past five years, the horticulture sub-sector has achieved rapid growth and is currently averaging 6-10%per annum Developing Tanzania's vast potential land resources for horticulture will require a systematic and localized campaign to identify growth opportunities in geographic clusters, earmark resources, and mobilize investment. Despite the increasing scarcity of land, the northern highlands zone still represents the highest potential for diverse horticulture investment (HODECT, 2010).

According to HODECT (2010), horticulture is still marginalized in Tanzania. The horticultural industry has for many years lacked identity as it was considered an insignificant sub-sector within the agricultural sector. Horticultural crops have also been given low priority, the greater emphasis being on cereals and traditional export cash crops. In the National Agricultural Policy of 1997, horticultural crops are mentioned under non-traditional crops. On the other hand, low purchasing power coupled with negative attitude on consumption of fruits and vegetables among the majority of Tanzanians leads to low-level horticultural produce utilization. For instance, the daily *per capita* consumption of fruits and vegetables in Tanzania was estimated at 219g in 2000 against the FAO daily recommendation of 400g.

2.2.1 Tomato sub-sector

Tomato production is higher than any other fruit and vegetable crop in Tanzania with a total production of 129 578 tons, which represents 51 percent of the total fruit and vegetable production (Tanzania Agriculture Sample Census, 2003). This is followed by cabbage with 41 495 tons (16.3%) and onions with 36 087 tons (14.2%). The production of other fruit and vegetable crops is relatively small. Morogoro Region has the largest

planted area of tomatoes (6,519, 19.3% of tomato planted), followed by Iringa (3 274 ha, 10.3%), Tanga (2 569, 8%) regions and Zanzibar (2 370 ha, 7.4%) island (SCF, 2008).

Some farmers still practice the traditional methods of applying a mix of wood ash, animal droppings, and water to their crops, removing weeds with hands, cutlasses and hoes, and harvesting what is left after pests and diseases infestation at the end of each planting season (Tandi, 2014). Insects have been identified as a major hindrance to tomato production in this area (Ntonifor, 2013). Farmers are very aware of the damages caused by pests to tomato production which has led to almost all small-scale farmers to use pesticides as the major means to control pests and plant diseases (Tandi, 2014).

The use of pesticides has been encouraged by pesticide vendors who divide pesticides into small sachets and containers which are sold to the farmers without labeling (Matthews, 2003). This practice is worrisome for correct and safe use of pesticides is extremely important and the directions on the label are essential to providing information addressing safe and effective pesticide use. Many countries mandate that pesticides are labeled with required instructions and warnings (Tandi, 2014).

2.2.2 African eggplant sub-sector

Eggplant (*Solanum melongena* L.), also called aubergin or brinjal, is one of the top ten vegetables in the world. It is grown on more than 2 million ha with a production of nearly 33 million. China is the world's top eggplant grower, accounting for more than half of world acreage and India is second, with about one quarter of the world total; Indonesia, Egypt, Turkey, Iraq and the Philippines are the other major eggplant producing countries. Asia accounts for about 94 percent of the world eggplant area, with about 92 percent of

world output (FAO, 2007). India and Indochina are considered the centers of origin for eggplant (Vavilov, 1951).

Solanum anguivi (referred hereafter as African eggplant) and *Solanum dasyphyllum* are similar on the basis of morphological traits (Lester, 1986). They constitute important fruit and leaf vegetables in West Africa and East Africa after tomatoes, onions, pepper and okra (Shippers, 2000).

Eggplant is well adapted to high rainfall and high temperatures, and is among the few vegetables capable of high yields in hot-wet environments (Hanson, 2006). Eggplant contains nutrients such as dietary fiber, foliate, ascorbic acid, vitamin K, niacin, vitaminB6, pantothenic acid, potassium, iron, magnesium, manganese, phosphorus, and copper (USDA, 2009); the especially important during times when other vegetables are in short supply.

In Tanzania the fruity forms (*S.aethipicum* Gilo group) are important component of vegetable diet, sold in grocery stores and retail outlets in Arusha, Moshi, Mbeya and Dar es Salaam. The fruit consist of 80% water, 8% carbohydrates, 1.4 protein and 1.5% fibre and increasingly important in ensuring food security and nutrition balance. Cholera, diabetes, asthma, bronchitis, dysuria, tooth ache and decrease in cholesterol are examples of health disorders on which eggplant has positive effects.

Cultivation takes place throughout the year whenever water is not limiting. Both men and women are involved in production, consumption and marketing. In 2008 about 147 000 ha of eggplants were harvested in African countries (FAO, 2009). The cultivation of *S.aethiopicum* is on the increase in Tanzania, though information on yield is yet available.

In northern Tanzania, a maximum of three production cycles are possible per year, usually under monoculture. One negative aspect which needs to be addressed is the presence of a number of Spiro saline alkaloids, which has a bitter tasting (Adenitis, 2012).

Farmers in certain areas of Philippines spray chemical insecticides up to56 times during a cropping season; the total quantity of pesticide used per hectare of eggplant was about 41 liters of different brands belonging to the four major pesticide groups (Gapud and Canapi 1994; Orden, 1994). In Bangladesh, some farmers spray about 180 times during a cropping season (SUSVEG-Asia, 2007).

2.3 Pesticide use in Horticultural Production

2.3.1 Pesticides use position in horticultural production

Agrochemicals are commercially produced, usually synthetic chemical compounds such as fertilizers, pesticides including insecticides, herbicides, fungicides that are used to improve the production of crops in agricultural industries. The current system of agriculture industry in Tanzania promotes the reliance on agrochemicals, both synthetic fertilizers and pesticides. Agriculture, which by definition includes horticulture, continues to play a predominant role in Tanzanian economy. It contributes about 45.6% of the Gross Domestic Product (GDP), generates about 60% of the total export earnings and employs about 80% of the labor force in 2005 (MAFS, 2007).

The existing diversity of agro-climatic zones in Tanzania implies that wide ranges of horticultural crops can be grown. Despite high production potential in many parts of the country at the moment, horticulture is well developed in the Northern regions (like Arusha, Kilimanjaro and Tanga) and the Southern highlands (Mbeya and Iringa). However, more than 85% of commercial horticultural investment is concentrated in the

Northern part of Tanzania, especially in Arusha and Kilimanjaro regions. The lack of proper infrastructure, access to markets and investment programmes form major bottlenecks to other regions with potential to develop commercial and export-oriented horticulture industries (Nyambo, 2005).

2.3.2 Types of pesticides used in Tanzanian in horticultural settings

The horticulture industry in Tanzania mostly uses different classes of pesticides and herbicides such as organochlorines, carbamates, organophorsphorous, pyrethroids and atrazines (Ngowi, 2002; Agenda, 2006; Nonga, 2011). It is estimated that more than 40 different pesticides are used in horticulture of which the most widely used are insecticides (59%), fungicides (29%), with the remaining (12%) being herbicides (Ngowi, 2007). Insecticides are mostly used because insect pests are the most serious problem in horticulture production. Fungicide usage indicates that fungal attacks rank second to insect pests. Herbicides are least in use because weeding can be easily done manually by deploying community members (Ngowi, 2007).

Although Tanzania has a regulatory system on registration and trading of pesticides, however, the pesticides which are imported and used in Tanzania includes both the registered and unregistered. Improper use of pesticide has been found to cause various forms of cancer, birth defects, sterility ,damage of liver, kidney, neural organs and deaths (Ngowi, 2002; McCauley, 2006; Soltaninejad, 2007; Weiss, 2007; Aktar, 2009). Notwithstanding these effects, Table1 shows that some of the pesticides used in horticulture include those which are categorized by WHO as Class 1a (extremely hazardous), Class 1b (highly hazardous).Respective examples include aldicarb and carbofuran which belong to the carbonate class of pesticides and are marked as “restricted use pesticides” by the US Environmental Protection Agency (USEPA). In addition,

majority of the pesticides used are in Class II (moderately hazardous) and a few in Class III (slightly hazardous) or U (Unlikely to present acute hazard).

2.4 Policies, Legislations and Control Regulations on Pesticides Use

The horticultural industry of Tanzania is governed by many rules and regulations relating to the quality of production, processing, marketing and food standards as a whole. Some of those which relate directly or indirectly to this industry include the Plant Protection Act No.13 of 1997, The Tropical Pesticides Research Institute Act No, 18 of 1979 and Pesticide Control Regulations.

2.4.1 Tropical Pesticides Research Institute (TPRI) Act No 18, 1979

The Act in particular, through TPRI needs to ensure effectiveness of pesticides use in the production of crops, fibers, and livestock and for the protection of public health and safety. The Act addresses the need to supervise and regulate the manufacturing, importation, distribution, sale and use of pesticides in the United Republic of Tanzania. Under the Act TPRI is required to establish and maintain a register of pesticides to include the name, specified minimum quality, suitability for use and such other particulars as it may require of every pesticide to be manufactured or compounded in or imported into the country. The Institute is also required to compile and publish in the Government Gazette a list of registered pesticides and amend it from time to time. Under the Act, manufacturers, importers, and distributors are required to ensure that every registered pesticide distributed, sold, offered or exposed for sale, its containers should bear the name, contain a true description of its active ingredient chemical, together with the percentage or proportion of each active ingredient in relation to its net weight or volume, a description of the precautions to be taken on its use and the words “Approved by the Tropical Pesticides

Research Institute" as well as the name and address of the person, firm or company which manufactured or compounded it.

2.4.2 Pesticide control regulations, 1984

The regulations set procedures for importation of pesticides which include import permit from the Registrar and paying application fees, provision of technical data and representative sample for analysis. The importer is also required to register that pesticide in accordance with the TPRI Act and the Regulations. The Registrar is mandated to issue a certificate of registration for any approved pesticide. Under the regulations the licensing authorities should issue trading licenses to persons intending to carry out pesticide business including manufactures, distributors, formulators, fumigators, and other pest controllers only after such persons have produced a written approval or registration certificate from the Registrar. The regulation require every registrant to make records of all quantities of a pesticide product manufactured, imported, stored, used or sold by him/her company and maintain them at least for five years, made the records available to the Registrar annually. The records have to include type of pesticide, origin, port of entry; quantity imported and sold, purpose, etc.

Any organization handling pesticides is obliged by the regulation to provide their handlers with basic protective gears such as face-masks, goggles, aspirators, rubber gloves plastic or rubber aprons, rubber boots, overalls and caps. The regulations require that all pesticides are to be packaged in clean and dry containers designed to provide protection against product deterioration, compaction, weight change or other spoilage. Containers must withstand all anticipated level of handling, storage, stacking loading and unloading conditions and should not become adversely affected by changes in atmospheric conditions, pressure, temperature and humidity. Pesticides should not be transported

together with other commodities like food or foodstuffs and should be stored in areas marked with warning signs and the labels on the containers positioned so that they are clearly visible. The information on the safety and most practical way or ways of disposing any unwanted quantities of pesticides with the least possibility of polluting the environment must be provided.

2.4.3 Plant Protection Act, No. 13 of 1997

The Tanzania Plant Protection Act of 1997 provides provisions to prevent the introduction and spread of harmful organisms, to ensure sustainable plant and environmental protection, to control the importation and use of protection substances, to regulate export and imports of plants and plant products and ensure fulfillment of international commitments. The Act also highlights the procedures and conditions for registration and publication of plant protection substances, labeling procedures and means of taking and submitting samples for analysis. It provides under different sections for safeguards against pollution of groundwater and the natural environment by plant protection substances.

Natural environment is defined to include its components soil, water, air, species or wild flora and wild fauna, as well as interaction between them. Section 18(1) (c) stipulates that the Minister for the time being in force for agriculture shall register the plant protection substance if the application procedures under section 17 of this Act have been complied with and after analysis of the plant protection substance show that when used for its intended purposes and in the correct manner, or as a result of such use, does not have any harmful effects on human and animal health, ground water and the natural environment which are not justifiable in the light of the present state of scientific knowledge. Moreover, the Minister is required under section 27(2) of the Act to develop a Code of Conduct for the proper use of plant protection substances, plant protection improvers and

equipment, which shall include, but not limited to; discouraging or prohibiting the use of plant protection substances, plant protection improvers and equipment in cases where it is expected that their use will have harmful effects on health of man, animals, ground water or the natural environment.

2.5 Pesticides Spray Programmes

2.5.1 Abiding by the recommended pesticides spray programmes

For optimum production the guidelines on how to deal with pests and diseases in crops is provided. The manufacturer is supposed to write on the packets the contents of the pesticides, which pests or diseases have to be dealt with, is it for protection or treatment of the problem. Most of farmers in Mvomero use pesticides on the weekly basis because of the presence of wide range of pests and diseases. It is recommended that farmers have to pay close monitoring on the presence of pests and diseases in the fields so that proper measures can be taken. Farmers need knowledge in the use of pesticides starting with knowing the type of pesticides to be used, whether the pesticides are still active and proper time for application in order to avoid the ineffectiveness. The use of unregistered or banned pesticide scan cause unreasonable risk to the environment and human health. Smallholder horticulture farmers in Tanzania have been reported to lack adequate knowledge in proper use and management of pesticides (Ngowi, 2007; Nonga *et al*., 2011).

2.5.2 Effects of not adhering to the recommended pesticide spray programmes

The pesticides used have implications on health because some of them are classified to be carcinogenic, cholinesterase inhibitors and others suspected to be endocrine disruptors. A few examples include aldicarb, carbofuran, cypermethrin and dimethoate classified by the USEPA as possible human carcinogens and cholinesterase inhibitors. Endosulfan, lambda-

cyhalothrin and chlorpyrifos are listed by WHO as moderately hazardous pesticides though they are suspected to be endocrine disrupting chemicals. Due to the associated risks of toxicity, these pesticides have been banned in the European Union, but are still being used in developing country like Tanzania. There are strong indications that there is substantial human health problems associated with the use of pesticides in horticultural farming in Tanzania but these are inadequately documented (Ngowi, 2007).Pesticide misuse in various sectors of the agriculture often has been associated with health problems and environmental contamination worldwide (Soares *et al.*, 2003; Mancini *et al.*, 2005; Remor *et al.*, 2009).

2.5.3 Factors that lead to infectiveness of pesticides in horticultural production

There are several factors that can reduce the effectiveness of pesticides, making repeat applications necessary. These include weather, plant growth, pest populations and pesticide age.

Weather: Many pesticides volatilize or lose effectiveness in a matter of days or weeks after being applied. Factors such as temperature, humidity, wind, and sunlight affect the life of pesticides. The greater the extremes of these factors, the quicker pesticides lose their toxicity. Rain, to some degree, physically removes pesticides from plant foliage. In general, a pesticide is less likely to be washed off if it has had an opportunity to dry thoroughly on foliage before rain. Most materials should be reapplied the day after a heavy rain. Strong sunlight and driving winds also shorten the effective life of pesticides.

Plant growth: New plant growth early in the season results in unsprayed and unprotected parts if spray applications are not repeated at regular intervals.

Pest populations: Pest populations are continuously moving and/or multiplying, requiring repeated spray applications.

Pesticide age: Although most pesticides retain their toxicity for several years when properly stored, it is best to buy only enough for one season's use. Most pesticides gradually lose their effectiveness when exposed to moisture, air, light, and high temperatures. Prolonged low or freezing temperatures frequently cause liquid formulations to separate, making them unsafe and non-effective for further use (Durham, 2013).

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of the Study Area

This study was done in Mlali Ward in Mvomero District. The area is found in Morogoro Region which is located in the Eastern part of Tanzania. Morogoro Region is one of the significant producers of tomato and feeds other regions of Tanzania (Mvena, 2013). Morogoro Region has the largest planted area of tomatoes (6519 ha, which is 19.3% of tomato planted), followed by Iringa Region (3274 ha, which is 10.3%), Tanga Region (2569, which is 8%) and then Zanzibar Island (2370 ha, which is 7.4%) (SCF, 2008). Mlali is known for production of tomato for many years both seasonal and offseason and to acknowledge this, the government has built a tomato market at Kipera Village to facilitate tomato marketing. African eggplant, which is losing its popularity due to introduction of the improved variety locally called "*Yeboyebo*" but is still being cultivated by few farmers in Mlali Ward. The fact that in Mlali farmers are involved in both seasonal and off season production of tomato, makes the ward a relevant study area because such production arrangement necessitates use of pesticides. Pesticide use is especially necessary during off season production. According to Schreinemachers *et al.* (2016), pests and diseases are a particular problem during off-season production.

3.2 Target Population

The target population for this study was the smallholder farmers who are engaged in tomato and eggplant production. These were selected from Mlali, Kipera, Mkuyuni and Mongwe villages in Mlali ward, Mvomero District in Morogoro Region.

3.3 Research Design

Cross-sectional research design was used in this study since it allows collection of data to make inferences about a target population at one time (Kothari, 2014). The survey targeted only farmers who are engaged in the production of either tomatoes or African eggplant or both crops in the last season. The main purpose was to analyze the gap between farmers' practice and the recommended spray programme.

3.4 Sampling Procedure and Sample Size

Region, district, ward and villages were purposively selected based on the availability of farmers producing tomatoes and African eggplant both on and off season. In this regard, four villages namely Kipera, Mlali, Mkuyuni and Mongwe were selected in Mlali ward which is in Mvomero District in Morogoro Region. In each village, a list of tomato and African eggplant producers was obtained. From each village's list, thirty (30) respondents were randomly selected making a sample size of 120 respondents for the whole study area. The 120 respondents sample is big enough considering the Bailey's (1994) minimum recommended sample size of 30 cases for a research in which statistical data analysis is to be done. Key informants interviewed were agro dealers from Kipera and Mlali villages, a horticulture expert from Horticulture Unit of Sokoine University of Agriculture and an expert from Syngenta Company, Morogoro. These were selected based on their knowledge on pesticides and pesticide use by farmers in the study area.

3.5 Data Collection

The study collected both quantitative and qualitative data using questionnaire survey and key informant interview respectively. The questionnaire survey involved the use of a structured questionnaire composed of both open and closed ended questions. The questionnaires were pretested in Peko misegese village in Mlali ward before it was

improved for the actual data collection. During pre-testing, the researcher was assisted by two enumerators who were trained before taking part in data collection. The same enumerators participated in the actual data collection. Questionnaires were administered to individuals who cultivated either tomato and/or African eggplant in the previous season to collect data on farmers' knowledge and awareness, practices and the side effects of pesticides. As for key informant interview, a checklist of questions was developed, pretested and used to gather information from key informants on pesticide use recommendations for tomato and African eggplant production.

3.6 Data Analysis

Statistical Package for Social Sciences (SPSS) was used in data analysis. For the descriptive statistics; frequency and percentages were used to analyse the questions on farmer's awareness, knowledge and practices. In addressing the question on factors influencing abidance by the recommended practices, the binary logistic regression statistical model was used. In this regard, the dependent variable was abidance by the recommended spray practices. The variable is a dichotomy in that, the responses were either "Yes"denoted by 1 for a farmer abiding or "No" denoted by 0 for a farmer not abiding by the recommended practices. According to Agresti (2002), binary logistic regression is used when the dependent variable is a dichotomy and the independent variables are of any type.

The dependent variable was measured based on four indicators namely:(1) farmer abode by the recommended spray timing (observed the threshold point), (2) farmer abode by the recommended frequency i.e. depending on the severity of the problem, (3) farmer has been using knapsack sprayer, (4) farmer applies the rates as directed by the manufacturer. Farmers who implemented 3 to 4 practices were regarded as having abode by the

recommended spray programmes and hence assigned "Yes" (0), while those who adopted less than 3 practices were considered as not having abode by the recommended spray programmes and hence assigned "No" (1). Independent variables were income, access to credit, farmers' awareness of recommended practices, and access to extension services, level of education, age, pesticide availability, a side business, and farm size. The model used in that matter is indicated hereunder

(i) Logit (pi) = log (pi/1-pi) = b0 + b1x1 + b2x2 + … + bjxj (Agresti, 2002), where:

Logit (pi) = ln (odds (event)), that is the natural log of the odds of an event occurring

pi = prob (event), that is the probability that the event will occur

1-pi = prob (non-event), that is the probability that the event will not occur

b_0 = constant of the equation

b_1 to b_j = coefficients of the independent (predictor) variables

k = number of independent variables

x_1 to x_j= independent variables entered in the model, which were:

x_1 = income

x_2 = access to credit

x_3 = farmer's awareness of recommended practices

x_4 = access to extension services

x_5 = land security

x_6 = level of education

x_7 = age

x_8 = pesticides availability

x_9 = side business

x_{10} = farm size

Content analysis was used in analysing qualitative information from the respondents. This was done by coding the information to make replicable and valid inferences by interpreting and coding textual material.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents and discusses the empirical findings of the study. Firstly, it presents the socio-demographic characteristics of the respondents, then, other results are presented and discussed following the order of the four specific objectives.

4.1 Demographic Characteristics

As shown in Table 1, more than 60% of the respondents interviewed were male indicating that the production of tomatoes and African eggplant is dominated by males. This is due to the nature of works like clearance of land and handling the pesticides. More than 83% of the respondents were married showing that it's an important source of income for the couples.

Table 1: Demographic characteristics of respondents surveyed

Response	Frequency	Percent
Sex of respondent		
Female	46	38.3
Male	74	61.7
Total	120	100.0
Marital status		
Married	100	83.3
Single	20	16.6
Age of respondent by category		
20-35	55	45.8
36-60	52	43.3
>60	13	10.8
Level of education of the respondent		
Primary	106	88.3
Secondary	12	10.0
College/University	2	1.7

More than 80% of the respondents' ages ranged from 20 to 60 years showing that most of the tomatoes and African eggplants are falling in the active productive age as it requires

close attention in all stages from land preparation to harvesting. In terms of education, more than 88% of the respondents had primary school education, 10% secondary education and only 1.7% had attended post-secondary education, this is due to the fact that farming is a self-employment and can be practiced through farmer to farmers learning, what is needed is readiness and not level of education. The only challenge here is when the instructions are written in English and the medium of communication is Swahili.

4.2 Recommended Spray Programmes for Tomato and African Eggplant Production

Specific objective one aimed at examining the recommended spray programmes and data for the same were collected through a checklist of questions asked for horticulture experts, agricultural officers, agro-dealers and the pesticide companies' representatives. To be able to know the existing gap the study first looked at the common diseases, insect pests and physiological problems for the two crops in question then the spray programmes based on their control.

4.2.1 Diseases, insect pests and physiological problems for tomato

Tomato production is adversely affected by insect pests, diseases/pathogens, and physiological problems. From the study area, troublesome problems identified are listed in Table 2.

Table 2: Diseases, pests and physiological problems for tomato

Insect pests	Diseases/pathogens	Physiological problem
• Mites • Aphids • *Tuta absoluta* (major) • Leaf miner • Bollworm	(i)Fungal diseases • Late blight • Fusarium wilt • Early blight • Leaf spot • Spot canker • Dumping off (ii)Bacterial diseases • Bacteria wilt (iii)Viral diseases • Tomato yellow leaf curl • Tomato mosaic diseases	• Blossom end rot • Cracking • Malformation

According to the key informants, tomato is attacked by a range of diseases which include, fungal, bacterial and viral. The control of these needs the right knowledge and capability to access the drugs.

4.2.2 Common diseases and pests for African eggplant

African eggplant production is severely constrained by several insect pests. Identifying common insect pests attacking African eggplant in the study area, one key informant mentioned eggplant fruit and shoot borer, leafhopper, whitefly, trips, aphid, spotted beetles, leaf roller, stem borer, blister beetle, red spider mite, and little leaf disease. Growers rely heavily on chemical pesticides to protect their eggplant crop (SUSVEG-Asia, 2007).

4.2.3 Recommended spray programmes for tomato and African eggplant

In order to control insect pests and diseases affecting tomatoes and eggplants, it needs careful monitoring including type and extent of damage and these will determine the appropriate frequency of application of pesticides. Based on key informant interviews, the following are the key aspects for consideration regarding spraying for insect pests and disease control:

Timing for pesticides application: Based on pesticide use recommendations farmers should scout the field regularly to find out if there is an infestation of diseases or pests. This will help a farmer in deciding whether to start using pesticides or not. The application of pesticides depends on the magnitude of problem. If the amount is likely to cause production loss then treat using the proper pesticide and the rates recommended by the manufacturer. Elaborating the point, one horticulture expert said:

> *"Farmers are supposed to ensure judiciary application of pesticide which involves, among others, spraying when the diseases or pests reach the threshold point".*

Application frequency: Basing on the agricultural officers; frequency of application depends on the type and severity of the problem. He continued describing that some problems need single touch application while others need repetition in order to be sure of the effectiveness in controlling the pest available.

Equipment to be used: "For smallholder producers, it is recommended to use the knapsack sprayer because it allows the liquid to be pressurized and sprayed evenly on the leaves and fruits" said the horticulture expert. The conventional knapsack sprayer has changed little since it was first developed in 1800s (Mathew, 1969). However, interest has remained high with this type of equipment as its versatility in use with different types of pesticides suits requirements and resources of small-scale farmers aiming to increase

agricultural productivity under harsh conditions in developing nations. This equipment is also easy to operate and repair. The use of leaves or water cane lead to loss of the liquid and takes long time in the operation.

Rate of application: Both horticultural expertise and the agricultural officers insisted that rate of application should be according to the type of pesticide and manufacturers instruction. It was added that these rates may change if IPM approach to manage tomato and African eggplant production is applied. This is the combination of cultural, biological, and chemical in dealing with pests in crops production.

Continuous monitoring: After the first application of pesticides a farmer has to continue observing the progress and takes the appropriate measure in case of another problem. Depending on the manufacturers' instruction, the waiting period before harvesting after pesticide application ranges from 3 to 21 days.

Safety measures to be observed: From the key informants it was learnt that, while applying pesticides, it is important that farmers take care of their health by making sure they wear protective gears like masks, overcoat and gloves, as well as observing the wind direction. Mask help to filter the poison and prevent the operator from inhaling it. over coat helps protecting the back as the liquid may ooze on the back and cause burning or bruises. Gloves are important when mixing pesticides to avoid the possibility of hands contact and hence ingestion.

4.3 Farmers Awareness and Knowledge on the Recommended Pesticides spray Programmes

The second objective of this study aimed at assessing the level of farmers' awareness on the recommended use of pesticides spray programmes in tomato and African eggplant

production. This was done by asking questions on the components of recommended spray programmes. The possible answers to the question answered were Yes or No. Then the responses were put in a scale of 1-4 to know the level of awareness as explained in section 4.3.1. To address the issue of awareness on the recommended spray programmes; farmers were asked a question on how they dealt with pests and diseases focusing on the frequency, rate of application, equipment used and the timing of pesticides application. A scale of 1-4 was used for assessing the levels of awareness of the farmers. Value 1 stood for low awareness, 2 Medium awareness, and 3-4 high awareness. Table 3 shows that 53.3% of the respondents had low awareness on the recommended spray programmes. Farmers with medium level of awareness were 34.2% and while those with high level were only 12.5%. Generally all farmers had awareness on at least one component of the recommended spray programmes.

Table 3: Levels of awareness of the recommended practices

Level of awareness	Frequency	Per cent
High level	15	12.5
Medium level	41	34.2
Low level	64	53.3

4.3.1 Sources of knowledge

When farmers were asked the source of awareness on the spray programmes in the production of tomato and African eggplant; 72.5% said it was from fellow farmers or family members who had applied the spray programmes and found it useful. About 22.5% said that they learnt from the agro dealers while only 3.3% gained the knowledge from the public extension officers (Table 4). When asked why majority learnt from their fellow farmers and not extension officers they said they trust their fellow because they have practical experience unlike most of the extension officers who only instruct but never

practiced. This has a big impact on the way farmers use pesticides as they mostly do according to their colleagues' experience; in case of a change in the formula or chemical composition there is a high risk of applying wrongly hence inefficiency in pests and dieses control. Farmers' reliance on labels for information on pesticides may reflect the fact that the proliferation of pesticide suppliers under trade liberalization policies in Tanzania (Nalwanga and Sempebwa, 2011) which facilitated an 80-fold increase in the number of unregulated suppliers in the 1990s, resulting in the involvement of children in pesticide retailing as well as insufficient technical support for small farmers (Lekei, 2014).

Table 4: Source of knowledge

Source	Frequency	Per cent
Friend	87	72.5
Extension officers	4	3.3
Agro dealers	27	22.5
Seminars/trainings	2	1.7

4.4 Farmers Practice Versus Recommended Spray Programmes

Specific objective three of this study assessed farmer's practices in dealing with pests and diseases in the production of tomato and African eggplant then compared them with the recommended spray programmes. Questions asked covered the timing of pesticide application, equipment used, application rates and the frequency of application.

4.4.1 Pesticides timing and frequency of application

Regarding pesticide application timing; the majority (67.5%) of the respondents indicated that they apply immediately when the seedling is taken to the field followed by one two weeks interval application. This is because farmers lack knowledge on the importance of scouting for the presence of a problem hence they do not wait for the threshold level. The

market demand clean fruits with no spots so farmers are forced to apply pesticide's throughout the time when the crops are in the field to attain this quality. Only 15.8% of the respondents said that they observe the threshold level, which is the time at which the extent of damage can cause economical loss and start spraying (Table 5). The rest have been starting pesticides application whenever they notice sign of invasion or when they hear their neighbors complaining about presence of a problem.

On the application frequency, 57.5% of the respondents applied pesticides on the weekly interval to treat and protect their crops, 29% applied pesticides after 10-14 days, only 13.3% applied pesticides depending on the severity of the problem (Table 5), the similar results were also given by Halimatumsadiah (2016) who said that for the pesticides spray frequency, a total of 47 farmers (55.3%) indicated that they applied pesticide on crops once in a week, with every 5-7 days of each application. A more frequent pesticide application was used by 30 farmers (35.3%), where they usually applied pesticide in every four days and bellow for each application. The more frequent application of pesticides without observing the economic loss leads to increase in production costs. Sometimes farmers use poisonous chemicals to make sure no pests attack to the fruits and this may have a side effect on the consumer's health.

Table 5: Pesticides application routine (n=120)

Time of application	Frequency	Percent
Observed threshold level (recommended)	19	15.8
Whenever neighbours complain of the problem	5	4.2
Whenever I notice signs of diseases or pests in my field	15	12.5
I always apply pesticide after every certain period to protect my crops	81	67.5
Frequency of application		
After every seven days	69	57.5
Depends on the severity of the problem (recommended)	16	13.3
After ten to fourteen days	35	29.2

4.4.2 Equipment and rate of application

Equipment used: In farmers practice all respondents used the knapsack sprayer as recommended. This is because all famers had access to this type by either buying it or borrowed from fellow farmers. Moreover it is easy to use and when one could not use it they hired someone for that purpose.

Rates of application: When asked whether they followed the rates advised by the manufacturers, it was only 32.5% said yes while 67.5% said no they did not use the recommended rates, the later either underused, overused or as cocktail. Out of 39 respondents who used the recommended rates, only 11 (28.2%) observed the safety measures (wearing over coat, observe wind direction, wear masks and gum boots). This is only 9.16% of all respondents.

Table 6: Equipment used in pesticide application and rates (n=120)

Variable	Response	Frequency	Percentage
Knapsack	Yes	120	100.0
Right rates	Yes	39	32.5
	No	81	67.5

Total	**120**	**100.0**

The reasons for not observing the safety measures included; ignorance, negligence, availability difficulties and low purchasing power. For the agro dealers they said they did not bring these safety gears because no demands from the farmers. The only protective gear with high demand and was available is gumboots. Pesticides can pose hazards to humans. The severity of a harmful effect or poisoning depends on the pesticide's chemical makeup and formulation, its path into the body, the amount that enters the body, and the length of exposure. Wearing Personal Protective Equipment, or "PPE", can greatly reduce the potential for dermal, inhalation, eye, and oral exposure, and thereby significantly reduce the chances of a pesticide poisoning.

Tables 7 and 8 below summarize the comparison between farmers pesticides spray practices to the recommended spray programmes, showing the percentages of farmers who abode by recommended practices and the reason for that.

Table 7: Application timing and the spraying frequency

Recommended practices	Farmers actual practices	Remarks
1.***Timing of application***: Farmers are advised to start application when the damage is likely to cause los.(Observe the threshold level)	Only 15.8% of farmers interviewed were observing the threshold level. Majority applied pesticides every after certain intervals. This becomes costly for them.	There is a notion that if the fruits are not well treated with pesticides will not fetch a good price in the market.
2.***Application Frequency*** should depend on the intensity of the problem	Only 13.3% of Farmers interview abode by the recommended application frequency (Depending on severity). Whereas the rest applied pesticides at the	This increases the cost of production and also may cause certain pathogens to become resistant to certain types of pesticides

interval of 7-14 days.

From table 7 it shows that farmers rely on their best judgment in deciding when to start treatment and the frequency of application regardless of severity of the problem. One reason for this is lack of right knowledge on the need to observe the threshold level. For economic, ecological, and social reasons, preventative spraying with heavy doses of nonselective, persistent insecticides is becoming obsolete. Pest resistance, rapid pest resurgence due to a lack of natural control by predators recently killed from application of pesticides, socially unacceptable environmental costs, and other phenomena resulting from preventative spraying have gradually led to more remedial spraying with selective pesticides (Hall, 1973).

Table 8: Application rates, Equipment and the safety measures

Recommended practices	Farmers actual practices	Remarks
3. **Application rates**: This depends on the type of pesticides and the manufacturer's instructions.	Only 32.5% of Farmers observed the spray rate as recommended by the manufacturers, The rest either used more, less or mixed different pesticides	Most of these farmers tend to copy from their fellows even if it's not recommended by the manufacturer. Some farmers mix different types of pesticides for more effectiveness.
4. **Equipment:** For small scale farmers a Knapsack sprayer is recommended since it is easy to use, ensure evenly application of pesticides and easily repaired.	100% of farmers interviewed used the knapsack sprayer to spray pesticides.	This is possible because the equipment is easy to use and repair, almost everyone has a knapsack sprayer.
5. **Observe the safety measures:** Farmers are advised to put on Masks, gloves and overcoat when applying pesticides. And also they should observe the wind direction	Out of 120 farmers interviewed only 11 farmers who are equal to 9.1% observed the Safety measures.	More than 66% of Farmers said they have low income 23% said they thought that it was not, important while others said that they are not available.

4.5 Factors Influencing Farmers' abidance by Recommended Spray Programmes

Objective number four finds out factors for farmers abidance by the recommended practices. This was done by asking farmers four questions on the recommended spray programmes. The questions covered application timing, application frequency, use of knapsack sprayer and observing the spray rates. The answers to these questions were 0= Yes, 1=No. If a respondent implemented less than two (2) of the recommended practices, he was regarded as not abiding**,** while the one who implemented 3-4 of the

recommended practices he was regarded as abiding by the recommended spray programmes**.** Taking into account the four recommended practices results shows that only 45.8% abode by the recommended spray programmes.

In binary logistic regression model, adoption of the recommended pesticides spray programme was the dependent variable whereas the independent variables selected were income, household size, extension services, and level of education, farm size, side business and access to credit. Results of the binary logistic regression (Table 9) show that the value of Hosmer and Lemeshow chi-square obtained was 6.014 which was not significant (p = 0.0646). Typically, in any case where the Hosmer and Lemeshow chi-square value is greater than 0.05, the goodness of fit is desirable (Garson, 2008). Thus, the model used in this study fitted the data adequately. Moreover, Garson (2008) notes that Nagelkerke R^2 is normally higher than Cox-Snell R^2 and is the most-reported of the pseudo R^2 estimates. Therefore, based on the results in Table 9 which show that Nagelkerke R^2 was 0.507, it means that the independent variables entered in the model explained 50.7% of variance in the dependent variable.

4.5.1 Extension services

According to the results (Table 9), the variable that significantly influenced adoption of recommended spray programmes is the access to extension services (p = 000). The positive B value suggests that extension services increase chances of farmers to adopt the recommended spray programmes. This was expected since the role of the extension officers is to extend the right knowledge of production from researchers to farmers. That is extension officers improve farmers' awareness of the recommended spray programmes. Agricultural extension includes the provision of farmers with knowledge, information, experiences and technologies needed to increase and sustain productivity and for improved

wellbeing and livelihoods (NRI, 2011). In order to ensure more farmers access the right extension services there is a need to invest in farmer to farmers training and this can be done through farmer field schools.

Table 9: Binary logistic regression analysis

Variable	B	S.E.	Wald	Df	Sig.	Exp(B)	95%C.I.for EXP(B)	
							Lower	Upper
SEX	0.403	0.547	0.545	1	0.461	1.497	0.513	4.369
HH Size	0.064	0.155	0.169	1	0.681	1.066	0.786	1.446
Age of respondent	0.024	0.025	0.893	1	0.345	1.024	0.975	1.076
Education level	0.316	0.679	0.216	1	0.642	1.371	0.363	5.184
Annual Income	0.000	0.000	0.042	1	0.838	1.000	1.000	1.000
Access to credit	1.24	1.309	0.904	1	0.342	3.471	0.267	45.139
Farm Size	0.218	0.454	0.230	1	0.632	1.243	0.511	3.026
Extension service	3.36	0.603	31.155	1	0.000***	28.993	8.888	94.574
Constant	2.65	2.398	1.229	1	0.268	.070		

Pseudo R^2 = 0.379 (Cox and Snell) & 0.507 (Nagelkerke); (Hosmer and Lemeshow) = 0.646
***Denotes significance at 1%

4.5.2 Education level

Did not show any significant influence as expected. This can be explained by the fact that farmers rely on their experience rather than training. They usually trust what they see others doing and succeed even if they did not follow the manufacturer's instructions. Farmers learn better by doing or when the see other farmers practicing. As it has been explained earlier more than72% of farmers surveyed learnt from their fellow farmers on how to deal with pests and diseases. This is because they saw what their fellow did and copied in their fields.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the findings of this study it is concluded that;

(i) Farmers practice the spray programmes partially since they are not adequately informed on the importance of scouting the fields for the presence of pests. Even for the few who abode by the recommended spray programmes, not all of them observed the safety measures for their health. This includes wearing of the protective gears (overcoat, gloves, gumboots and masks) and at the same time observing the wind direction.

(ii) Farmers got the awareness on the recommended spray programmes from friends, agro dealers, extension officers and some from seminars. Despite of the presence of all these sources farmers seemed to have awareness on one or two recommended practices.

(iii) In comparing the actual farmers spray practices to the recommended spray programmes, farmers do not always abide by the recommendations for application timing, application rates and frequency of application but all of them used the knapsack sprayer as recommended. This is because it is easily accessed, easy to use and repair and it also saves time.

(iv) Abiding by the recommended spray programmes did not depend only on the availability of pesticides or awareness on recommended spray programmes; it depended a lot on the access to the right source of information like agriculture extension officers and at the right time.

5.2 Recommendations

(i) The rural change agents have to make sure there are manuals like fliers in both Swahili and English explaining in details the recommended spray programmes and their importance in the production of tomato and African eggplants. The manual should explain clearly and in detail the importance of scouting the farms for farmers to be able to make right decision on the implementation of the recommendations. Use of the agricultural fair is also a good approach to disseminate this knowledge to many farmers.

(ii) Since farmers awareness on the recommended spray programmes was mostly from their fellow farmers, there is an importance of training lead farmers who will eventually create awareness to the another members of the community. This can be reinforced by conducting study visits in the places where the others are implementing the recommended spray programmes.

(iii) Emphasis on the importance of scouting the plots for the presence of pests is important as the entry point for farmers to abide by the recommended spray programmes. This will help farmers know when to start pesticides application followed by the frequency according to the severity of the problem and the right rates which is according to the type of pesticide and manufacturers instruction. Scouting is the key then others follow.

(iv) To deal with the important factors for of farmers abidance by the recommended spray programmes, strengthening the agricultural extension service is of paramount important. This can be done through establishment of farmers field schools (FFS) and demonstration plots where selected farmers will practice the recommended spray programmes and others will learn through seen. Seeing believing.

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APPENDICES

Appendix 1: A questionnaire for farmers

SOKOINE UNIVERSITY OF AGRICULTURE (SUA)

DEVELOPMENT STUDIES INSTITUTE (DSI)

Efraim Malisa (Masters of Rural Development)

Research Title 1.0 Title::Farmers practice vs. recommended spray programmes in tomato and African eggplant. A case of Mlali, Mvomero, Tanzania**.**

Phone: +255718940851 E-mail: efratema@yahoo.com

A. Background Variables

1. Village…….
2. Ward.....
3. Sex (1) Male (2) Female
4. Marital status (1) Married (2) Single (3) Separated
5. Household size
6. Age.....
7. Education Level. (1) Primary (2) Secondary (3) College/University
8. Occupation..... Side business.....

B. Agricultural environment

9. Which crops are you cultivating at what farm size?

Type	**Size of plot(acres)**
Tomatoes	
African eggplant	

C. Socio- economic variables

10. What is you estimated annual income …….. T.shs

11. What is the contribution of Tomato/Eggplant …… T.shs

12. Do you access credits Yes…… No……. If yes go to next

13. Where (a) From a Friend (b) SACCOS (c) Bank (d) Others……

14. How much did you use last season for pesticides treatment?.....TZS

D. Awareness on recommended spray programmes

15. Do you know the pests which destroy your crops(Yes/No)

Pest and Disease for Tomato		Pest and Disease for A Eggplant	
Insect Pests	Diseases	Insect Pests	Diseases

16. How did you deal with these problems?

(0)Use pesticides

(1)Use ashes (Botanicals)

(2)Uproot and burn them

(3) None

17. Where did you get the knowledge on how to use pesticides?

(0)From friends

(1)From extension officers

(2)Agro dealers

(3)Training and seminars

18. Did you access extension service on Time? **Yes…….No……..**

19. Which of the following are applicable applying pesticides?

1. I use the recommended ratios? Yes……. No……

2. I put on mask when applying pesticides Yes……..No……

3. I put on gloves Yes……No…….

4. I wear coat/overall Yes……..No……

5. I wear gumboots Yes ….. No…….

6. I apply when wind is still or observe wind direction**.** Yes…….No…..

20. Do you start the application of pesticides

(0)When I notice that there is a good number of invasion which can cause crop loss

(1)Whenever neighbors complain of the problem

(2)Whenever I notice any sign of pest or disease in my plot.

(3)I always apply pesticide after every certain period to protect my crops

21. What is the frequency of pesticide application?

(0)After every 7 days

(1)Depends on the severity of the disease or pest.

(2)After every ten to fourteen days

22. Which equipment to you use in application of pesticides?

(0)Knapsack

(1)Leaves

(2)Water cane

23. Some farmers are abiding with the recommended practices while others are not; what motivates farmers to abide or not abide with the recommendations.

(0)Low income

(1)Not aware

(2)I don’t think it’s important

(3)Not available

24. Where do you sell your produce? (a) Local Market (b) For export (c) Process and Pack

25. What is the market preference (a) Pesticides treated (b) Not treated with Pesticides

26. Have you ever faced any side effect while applying pesticides? Yes…… No……

27. If yes Mention (0) Flue (1) Irritation and skin bruise (2) Dimness (3) Others

28. What is your advice in decreasing the burden of using pesticides in the production of horticultural crops? (a) Issue resistant seeds (b) Government to provide support (c) Insist organic farming with the supervision of government. (d) Others…….

Appendix 2: Checklist of questions to Key informants

SOKOINE UNIVERSITY OF AGRICULTURE (SUA)

DEVELOPMENT STUDIES INSTITUTE (DSI)

EfraimMalisa(Master of Rural Development)

Research Title Title: Farmers practice vs. recommended spray programmes in tomato and African eggplant. A case of Mvomerodistrict,Morogoro Tanzania

Phone: +255718940851 E-mail: efratema@yahoo.com

(ii) Checklist for Key informant

Name:

Sex:

Office/institution……Position ……

1. What is your role in making sure farmers use right pesticides for crops?

2. What is the response of farmers in using pesticides?

3. Do farmers use the recommended spray programmes?

4. What efforts by your office to make sure the correct use of pesticides by farmers?

5. Is there something else you would like to share concerning tomatoes and African eggplant production?

Appendix 3: Binary logistic regression

The model was specified as follows:

Logit (pi) = log (pi/1-pi) = b0 + b1x1 + b2x2 + … + bjxj (Agresti, 2002), where:

Logit (pi) = ln (odds (event)), that is the natural log of the odds of an event occurring

pi = prob (event), that is the probability that the event will occur

1-pi = prob (non-event), that is the probability that the event will not occur

b_0 = constant of the equation

b_1 to b_j = coefficients of the independent (predictor) variables

k = number of independent variables

x_1 to x_j = independent variables entered in the model, which were:

x_1 = income

x_2 = access to credit

x_3 = farmer's awareness of recommended practices

x_4 = access to extension services

x_5 = land security

x_6 = level of education

x_7 = age

x_8 = pesticides availability

x_9 = side business

x_{10} = farm size