PRACTICES IN USING PESTICIDES IN URBAN AGRICULTURE: A CASE OF VEGETABLE SECTOR IN DAR ES SALAAM

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN CROP SCIENCE OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

2018

EXTENDED ABSTRACT

Urban Agriculture is crucial to the supply of food especially fresh vegetables in many urban areas including Dar es Salaam in Tanzania. In addition to the supply of food, it serves as a source of employment and income for many urban dwellers. However, the intensive and continued growing of vegetable on same piece of the land tend to trigger enormous pests pressure of diverse species which calls for the most effective and robust pest management practices. As such, most urban growers resort to the use wide range of pesticides in controlling the pests. Kinondoni district in Dar es Salaam, Tanzania was used as a case study to explore the pest problems which farmers face, the pest management practices commonly used and the attitudes of urban farmers towards the use of pesticide. A total of 120 farmers were randomly selected through purposive sampling techniques for data collection. Surveys through structured questionnaires focused on respondents' bio-data, their knowledge on crops and pests problems as well as the management options they employed. The position of pesticides among the commonly used pest management methods which extended to determination of the commonly used insecticides, accessibility and perceived efficacies were also explored. The use of chemical pesticides was found to be the most preferred (68.3%) means by farmers in controlling pests in urban agriculture while cultural and physical control were less common. Farmers expressed confidence in using pesticides due to their effectiveness and easiness to apply. Although highly preferred, some farmers lamented of the limited effectiveness of some pesticides used particularly the insecticides (31.7%). About 30.8% of insecticides used by farmers in Kinondoni district were supplied by private agro dealers in locally available shops while 35.8% were sourced from distant shops away from the farms. Some farmers were aware of other pest control strategies such as Integrated Pest Management (IPM), but lacked in-depth knowledge on the use and application of the strategy. Three most commonly used insecticides identified by growers were experimentally tested in the field at Malolo Agricultural Center in Kinondoni for their effectiveness. The insecticides tested were Cypermethrin 10% + Chlorpyrifos 35% at the rate of 2 ml/l of water ; Imidacloprid 200 g/l at the rate of 1 ml/l of water; Lambdacyhalothrin 50 g/l at the rate of 2.5 ml/l of water and (Untreated Control). Insect pests against which the insecticides were tested were Diamondback moth, *Plutella xylostella* on Chinese cabbage, and Hairy caterpillars, Yellow Bear caterpillar (*Spilosoma viginica*), Fall webworm (*Hyphantria cunea*), Bihar caterpillars (*Spilosoma obliqua*) and Tiger moth caterpillar (*Eurocentric vertebrocentrism*) in eggplant. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and four treatments applied at three week interval. The Field test showed that all insecticides were effective against targeted insect pests provided the proper dosage was applied at the right time and appropriate pests threshold. Pyrethroids such as cypermethrin when used in combination with organophosphates effectively controlled both diamondback moth and hairy caterpillars but when pyrethroid was used singly, the effectiveness was compromised particularly on diamondback moth. The findings in this study resolved the long – standing doubt on efficacy of insecticides traded for vegetable production in Kinondoni district. Thus the need for education on appropriate pesticide application technology to vegetable growers cannot be over emphasized.

DECLARATION

I **JUMA KONDO MZARA**, 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 has neither been submitted nor being concurrently submitted in any other institution.

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ACKNOWLEDGEMENTS

Special thanks to my supervisors Dr. G.M. Rwegasira and Dr. Anna Sikira for their encouragement, advice and intellectual input afforded to me towards the completion of this work. I also wish to thank my Employer Rungwe District Executive Director for granting me a study leave to undertake the Master of Science studies.

I am grateful to vegetable farmers in Kinondoni district for volunteering the much needed information for the research. Others include Mr Salehe Mohamedi (District Agriculture, Irrigation and Cooperative officer) and Ms Beatrice Banzi (Horticulture Subject Matter Specialist) of Kinondoni Council, as well as field attendants; Mr. Mohamedi Fednand, Edwin Milanzi, Maria Chatengwa and Hamis Kibaliko from Malolo Agriculture center for the assistance during data collection.

My sincere gratitude goes to my friend Lucas Mkuki who shared worth ideas towards my research work and encouragement in the course of my study and to the Almighty God for granting the opportunity, strength and resources.

My final appreciation goes to my family. Thank you for the support and prayers. I appreciate you all.

DEDICATION

To my parents, Zamoyoni Said and the late Kondo Mzara and my Children, Hamis Juma and Hamida Juma.

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LIST OF ABBREVIATIONS AND ACRONYMS

@	At the rate of
a.i.	Active ingredient
C.D (P = 0.05%)	Critical Difference at 5% level
CB	Cost benefit
CV	Coefficient of variation
DAS	Days after spray
DBM	Diamondback moth
DBS	Day before spray
EC	Emulsifiable Concentrate
et al.	and others people
FAO	Food and Agriculture Organisation
FGD	Focus group discussion
ha	Hectare
i.e.	That is
IPM	Integrated Pest Management
ITK	Indigeneous Technical Knowledge
kg ha-1	Kilogramme per hectare
l	litre
m	Metre
m^2	Metre square
ml ha^{-1}	Millilitre per hectare
N	Nitrogen
No.	Number
NPK	Nitrogen Phosphorus Potassium

PEDP	Primary Education Development Programme
PPE	Personal Protective Equipment
RCBD	Randomized Complete Block Design
SC	Soluble Concentrate
SL	Soluble Liquid
SSA	Sub-Saharan Africa
t ha^{-1}	Tones per hectare
THDS	Tanzania Health Demographic Survey
UA	Urban Agriculture
UN	United Nation
UNFPA	United Nations Population Fund
URT	United Republic of Tanzania
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION AND LITERATURE REVIEW

1.1 Background Information

Urban agriculture (UA) has been identified as an important source of food including fresh vegetables for many cities in sub-Saharan Africa (Stephan, 2011). In Tanzania, Dar es Salaam is one among major cities where UA is credited with the supply of large chunk of fresh vegetables such as green pepper, amaranthus, Okra, tomato, nightshade, eggplant and Chinese cabbage which are highly demanded due to the interactions among locals and multinationals (Cofie *et al*., 2005). Apart from satisfying the dietary needs of the ever-increasing population of urban areas, UA is also a critical source of employment for the many small-scale farmers who are involved in this venture thereby enhancing their livelihoods and alleviating poverty (Cofie *et al.*, 2003; FAO, 2008).

The Tanzanian Government defines urban agriculture as “the cultivation of crops, horticulture, floriculture, dairy farming, and keeping of pigs, poultry and aqua-culture in areas designated ‘urban’ by the United Republic of Tanzania under the Town and Country Planning Ordinance CAP. 378 of 1956 reviewed in 1991” (Mlozi, 2001).

Past surveys undertaken in Dar es Salaam show that the number of urban households practising farming in the city or in the peripheral areas is always around 68% (van Veenhuizen and Danso, 2007). A nation-wide survey in the early 1990s indicated that UA was a primary economic activity for 12% of urban household heads (both male and female) (URT, 1992; Howorth *et al.*, 2001). Common feature of UA includes: i) small to very small plots, ii) production in very small plots at high housing density is meant for home consumption, iii) selling part of one’s produce occurs more frequently when plots are bigger, iv) mostly women and youth are responsible for the production, v) crop cultivation is done in open areas within or very near to a built-up area. Very commonly, UA is practiced where a wide variety of open spaces exists (Schmidt *et al*., 2015).

1.2 Justification

Urban Agriculture requires repeated use of the same piece of land on continuous basis which creates suitable condition for pest build up. Crop damage from pest infestations often results in serious consequences, warranting the need to use pesticides. The interest in using synthetic chemical pesticides in UA rely on their quick knock down effect and the interest to save everything growers can afford to produce on the small piece of land they have. Despite the benefits gained from pesticides, the toxicants poses potential hazards to human health and the environment when inappropriately handled (WHO, 1990; Kishi, 2005). Developing advisory service for successful implementation of pest management programmes requires an adequate understanding of the knowledge on how farmers perceive pests, their attitude, beliefs and practices on crop protection problems (Heong and Ho, 1987; Tait and Napompeth, 1987). Farmers make decisions on pest control on the basis of how they perceive the relevant factors and what they seek to achieve (Mumford, 1981). In spite of the rapid increase in the quantity of pesticides used in Tanzanian UA, little is known about farmers' knowledge on pests or their perception on the effectiveness of pesticides. Like in many other countries, the largest proportions of chemical pesticides in Tanzania are used by resource-poor urban and peri-urban farmers. Methods for safe handling, application and storage of pesticides are not widely used in most developing countries (Sibanda *et al.*, 2000; Dinham, 2003) particularly in Africa (Williamson *et al*., 2008). Kinondoni and other districts in Dar es Salaam may not be different from the existing facts but relevant data are required to justify the claims. The current study aimed at generating information about pesticide uses and misuse in urban agriculture particularly on vegetables. The findings would guide recommendations for safe use of pesticides for safety of users and end user of the produce in urban centres.

1.3 Objectives

1.3.1 Overall objective

The overall objective of this study was contribution to safe use of pesticides through understanding of malpractices in urban agriculture and developing appropriate recommendations for vegetables production.

1.3.2 Specific objectives

i. To identify the most commonly grown vegetables and key pests affecting vegetables in Kinondoni district, Dar es Salaam.
ii. To determine the pest management techniques used by vegetable growers with emphasis on pesticides.
iii. To evaluate the effectiveness of commonly used insecticides in vegetable production.

1.4 Urban Agriculture

Cities in sub-Saharan Africa (SSA) are growing fast. The current annual urban growth rate of 3.7% is almost double the worldwide average. It is estimated that by 2030, half of Africa's population will be urban (UN, 2008). Apart from its socioeconomic implications, this rapid urbanization is posing major challenges to environmental protection and the supply of adequate shelter, food, water and sanitation (UNFPA, 2007). Common responses to urban food demands have been urban and peri-urban agriculture, which is broadly defined as "the production, processing and distribution of foodstuffs from crop and animal production within and around urban areas" (Mougeot, 2000). The terms 'urban agriculture' and 'peri-urban agriculture' are sometimes used separately but very often synonymously, the later is considered imperative in the current research.

1.5 Urban Vegetable Production

In Tanzania, urban vegetable production is carried out in the three spatial environment systems: the peri urban, open spaces and home gardens (Mwajombe and Mlozi, 2015). Vegetable production in the urban areas takes place in home gardens or on open spaces. Home garden production is by far the most important production system practiced throughout the urban areas. Mlozi noted that several studies on vegetable production show that open spaces produce vegetables for sale while home gardens are mainly for home consumption. In Dar es Salaam, 90 percent of leafy vegetable amaranthus in particular come from the open spaces and home gardens (Stevenson *et al.*, 1996). A study in Dar es Salaam, Dodoma and Arusha towns showed that the reason given by urban farmers producing horticulture crops are the home consumption, to reduce food expenditure and income or employment (Stevenson *et al.*, 1994).

Further (Mlozi *et al.*, 2004) study in Dar es Salaam city showed that amaranths growers can earn a minimum of Tshs. 193 396 (US dollar 277.50), maximum of 1389780 (US dollar 1635) and a mean of 700 272 (US dollar 823.80) per year. This indicates that the contribution of amaranths production is not only on providing additional income but also it can act as a source of capital that can be invested in other projects such as building houses and paying school fees for children. Nevertheless, consumption of fresh vegetables supplements the diet of the household, in addition the consumption from own farms production reduces their expenditures' on food and leaves them with spare cash for buying other house items. Vegetable production has now become a lucrative business in urban, peri urban and rural areas, especially for women and youth during dry season.

1.6 Vegetable Marketing

Market proximity is a major incentive for the intensification of any farming system or change of systems to more profitable ones (Danso *et al.,* 2002). Agricultural produce, which is not consumed, is either processed or marketed through various channels (Yoveva *et al.,* 2000). Much of the urban vegetables are for own consumption with occasional surpluses sold into the local market. Different studies show that, women play a major role in vegetable marketing in both urban and peri urban areas (Danso *et al.,* 2002). Vegetables are highly perishable, as a result, cannot be stored for a long periods of time. The brief storage period means most produce is marketed soon after harvest. The sooner it is marketed the higher the quality of the product. Vegetable produce can be sold direct to the farm gate to the consumer or traders (middlemen) or at the market (retail/whole sale). Prices vary significantly from one buyer to another and from season to another. In Dar es Salaam, Mlozi's (1998) study showed that 20% of vegetable buyers (Middlemen) transported vegetables to various city markets, 8% and 4% stated that women and men (middlemen) sold the vegetables to the same market respectively. Others 11% said that gardeners in low density areas organized transportation of vegetable to the markets especially when the price offered by middlemen buyer was low.

1.7 Challenges in Urban Agriculture

Cities in developing countries are rapidly growing, with higher requirement of building areas and consequently increase in the land value. In this context, land access for the urban farmers becomes quite difficult and represents the most important limiting factor for their activities (Tixier and de Bon, 2006). Consistently, crop growers often occupy marginal lands with low fertility that, apart from limiting the productivity, the land characteristics strongly reduces the choice of crop species to be cultivated. The major threats to health and the environment from agricultural production systems in urban areas arise from inappropriate or excessive use of agricultural inputs namely pesticides, herbicides, fumigants and fertilizers (Mosha, 2002).

Lack of safe disposal of livestock effluent in and around cities and towns compounds is also a problem. Numerous concerns on health risks have been associated with urban agriculture particularly livestock production. Contamination of crops with pathogens usually happens when improperly treated organic waste is used as a soil conditioner (Mosha, 2002). Clean water availability is often limited affecting the quality of pesticide mixture and consequently their effectiveness. Water scarcity sometimes leads to conflict between demand for human consumption, especially in urban areas, and agricultural uses – with agriculture generally losing out. Many urban centres are now suffering extreme water shortages that have led to water rationing which might affect the quality and quantity of pesticide diluents. Adequate supplies of water are critical to the successful integration of UA into the urban environment. It is important to acknowledge that water problems and food problems are connected. Inadequate extension support, agricultural extension and training has to date mainly been confined to rural farmers. There are no urban agricultural officers or urban agricultural demonstrators to parallel the district agricultural officers and agricultural demonstrators found in rural areas.

1.8 Pests Management Techniques in Urban Agriculture

Agrochemicals are often part and parcel of production in UA. According to Tekwa *et al*., (2010) agrochemical is any chemical substance used in agriculture to improve productivity, control pests, and treat or control diseases. It encompasses fertilizers, insecticides, fungicides, rodenticides, acaricides, molluscides, herbicides and plant regulators (Tekwa *et al*., 2010). Though the benefits are substantial, studies have associated the use of certain agrochemicals with some important environmental and health damages (Greenpeace, 2008). In urban farming the use of pesticides is commonly the sole means by which the farmers control pests albeit at limited knowledge level (Halimatunsadiah *et al*., 2016). Even though some farmers are aware of other pest control strategies such as Integrated Pest Management (IPM), they lack in-depth knowledge of the principles of IPM. Agrochemical mishandling constitutes one of the several farm operation hazards confronting farmers, their produce, and the environment. Wrong application timing and dosage, mishandling, ignorance of safety precautions and the use of adulterated or expired agrochemicals in circulation have been shown to impact both aquatic and terrestrial ecosystems (Omari, 2014). Consequently the quality of groundwater destined for human consumption is degraded (Nikolaidis *et al*., 2007; Tekwa *et al*., 2010).

1.9 Pesticide Use and Misuse in Urban Agriculture

According to Macnair (2011) the term pesticide refers to any product that is used to control pests. Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products or any organism that is out of place or causes stress to a desired organism. The product can either be a synthetic or a natural chemical such as pyrethrum. Examples of pesticides are herbicides that control weeds, insecticides that control insects, avicides that control birds, fungicides that control fungal infestations, rodenticides that control rodents, and algicides that control algae among others (Wilkinson *et al.*, 1997). Many types of insecticides are in use such as organochlorines, organophosphotes, carbamates, ureas, anilides, and pyrethroids. Pesticide use has increased over the years in both the developing and developed countries. In the developed countries there are strict pesticide mitigation policies but the case is not the same in developing countries where pesticide misuses have been widely reported (Hasing *et al.*, 2010). Similar study conducted in Nigeria by Kainga *et al.* (2016) indicates that pesticides contribute some benefits for agricultural production; they pose a number of risks and problems such as potential toxicity to humans, animals and negative impacts on the ecological environment. Despite the side effects, pesticides use has made a positive and significant contribution to agricultural production by ensuring reduced pest number on crops. As such, has enabled more efficient production of crops and livestock by reducing loses during production and storage (Atreya and Sitaula, 2010). All over the world, the misuse of pesticide in farm business has often been associated with health problems and environmental contamination (Remor *et al.,* 2009). Misuse of highly toxic pesticides, alongside absent or unenforced legislative framework in the use of pesticides, is a major reason for high incidence of pesticide poisoning in developing countries. Low education levels of the rural populace, lack of information and training on safety measures in pesticide usage, poor spraying technology and inadequate protections during pesticide use have also been identified as a major problem (Atreya, 2008).

Other factors which include beliefs of farmers about pesticide toxicity, environmental hazards, and information about first aid and antidotes given by the label, the use of faulty spraying equipment or lack of proper maintenance of spraying equipment, and lack of use of protective gear and appropriate clothing during handling of pesticides, illiteracy, lack of awareness about the danger of misuse and general knowledge of spraying have been identified to be responsible to unsafe use of pesticides (Ajayi and Akinnifesi, 2008). The use of domestic utensils and broken equipment for measuring and dispensing pesticides in developing countries is still on the increase (Imran and Dilshad, 2011) and public education regarding pesticides handling has been identified to be entirely lacking (Lovász and Gurzau, 2013). In view of the adverse health effects from the unsafe pesticide use, there is dare need to communicate to the farmers potential hazards of unsafe pesticide use and create awareness of the consequences of unsafe pesticide use and the relevance of extension and education programme targeted at reducing risk (Oluwole and Cheke, 2009).

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CHAPTER TWO

2.0 URBAN VEGETABLE PRODUCTION AND CHALLENGES: CASE OF KINONDONI DISTRICT, DAR ES SALAAM

2.1 Abstract

Smallholder vegetable production is expanding rapidly in Kinondoni District for local sale in urban markets. A study to examine pest problems in urban vegetable producing areas was conducted in Dar es Salaam, Tanzania using Kinondoni District as a case study. Specifically, the study intended to; (i) identify the most commonly grown vegetables; (ii) Document the demographic variable that affect vegetable production in urban areas; and (iii) explore farming systems under which vegetables are produced in Kinondoni district. Field surveys involving key informant interviews and questionnaires were administered to a total of 120 respondents out of estimated 800 growers in the study areas of Kinondoni district. Six wards were randomly sampled from the two divisions where intensive farming was practiced. Quantitative data were collected through questionnaire, while, qualitative data were collected through semi structured interviews and checklist. Obtained data was analysed using descriptive statistics. The study used cross tabulation, which employed chi-square test to examine whether distribution of demographic variable that affect vegetable production in urban areas differ from one another. A range of serious pests and diseases that affect non-indigenous vegetables such as Brassicas, spinach and eggplant were reported. It was established that majority 47% of the vegetable farmers were aged between 21 and 40 years with the mean of 44.37 years. Majority 86.7% of the farmers were married and 60.8% of the vegetable farmers had primary education. The study findings indicated that, 88% of respondents suffered from insect pests' damage. Various challenges were found to affect the vegetable sector suggesting the urgent need for concerted effort by farmers, the government, non-governmental organization and researchers to address vegetable production constraints for a profitable vegetable production sector.

Key words: vegetable production, vegetable farmers, urban markets, pest problems.

2.2 Introduction

Vegetables are widely cultivated in most parts of sub-Sahara Africa, as a cheap and reliable source of protein, vitamins, zinc and iron. They constitute between 30% and 50% of iron and vitamin A in resource-poor diets Mofeke *et al*. (2003). Urban food needs in cities and towns in Tanzania are growing, and increasingly vegetables are grown in urban and peri-urban areas to meet the demand. However, traditional vegetable farming systems (i.e. without any chemical input, use of crude implements, illiteracy, inexpensive technologies such as the use of cutlass, hoe and watering cans to irrigate their farms) are incapable of meeting this challenging demand. In Dar es Salaam vegetable production is common practiced along the rivers banks, streams and drains that cut across the city. Vegetables such as amaranths, green pepper, carrot, cabbage, Chinese cabbage, cucumber, eggplant and spinach are mostly grown. Vegetable production has been going on for decades, providing employment and income for the increasing numbers of migrants from the rural areas. Biotic factors are among the major constraints of vegetable production. For instance, insects and diseases, which pose big problems in vegetable production, require intensive pest management to control them. Many tropical locations receive high rainfall per year that contributes to high disease and insect pest incidence on vegetables (Bowen and Kratky, 1982). Rain, heavy dews, warm temperatures, and dry climates have been reported as principal conditions that favor establishment of pests (Landston and Eaker, 2009). In Cameroon, (a tropical country as Tanzania) pests and diseases have been identified as major constraints to vegetable production (Ellis-Jones *et al.,* 2008). The cultivation of vegetables is accompanied by the application of agrochemicals. This is mainly because the soils are poor, and indigenous crop varieties have been almost replaced by improved high yielding varieties such as cabbage, lettuce, cauliflower, green pepper, spring onions and carrots, which require a lot of nutrients (Laary, 2014). These vegetables are also susceptible to insect pests, which may not only feed, but also reproduce on them. So farmers have no choice but to treat crops and protect them against insect pests and diseases using agrochemicals this is because pests and diseases cause both economic and health problems for vegetable farmers.

2.3 Materials and Methods

The study was carried out at Kinondoni District, in Dar es Salaam region. The site is located between 39° 12′ 57.6″ to 39° 02′ 56.4″E and 6° 40′ 44.4″ to 6° 47′ 13.2″ S and 16 metres above sea level (Figure 1). Kinondoni district covers an area of about 531 km^2. The district falls within the coastal zone which experiences a modified type of equatorial climate. It is generally hot and humid throughout the year with an average temperature of 29^0C. The hottest season is from October to March (33°C) while it is relatively cool between May and August with temperature around 25^0C. There are two rain seasons (Bimodal rains): - short rain from October to December and long rain season between March and May. The average annual rainfall is 1,100 mm (lowest 800 mm and highest 1300 mm). Humidity is around 96% in the morning and 67% in the afternoons. The climate is also influenced by the Southwest monsoon winds from April to October and Northeast monsoon winds between November and March. According to the National Population and housing census of 2012, Kinondoni has a population of 1 775 049 in habitants with a population growth rate of 5.0% per annum and the population density is 1179 people per square km (URT, 2013). The Kinondoni district attracts a lot of migrants from different parts of the country seeking employment opportunities. According to the Kinondoni Municipal Council profile, as much as 16 % of the residents of Kinondoni are migrants. In addition, about 70% of the population of Kinondoni live in informal settlements within the city while those in the middle and upper class settle at the city's outskirts (URT, 2013). UA especially vegetable production has therefore become part of the informal sector which provides jobs and income for many of the city's unemployed migrants.

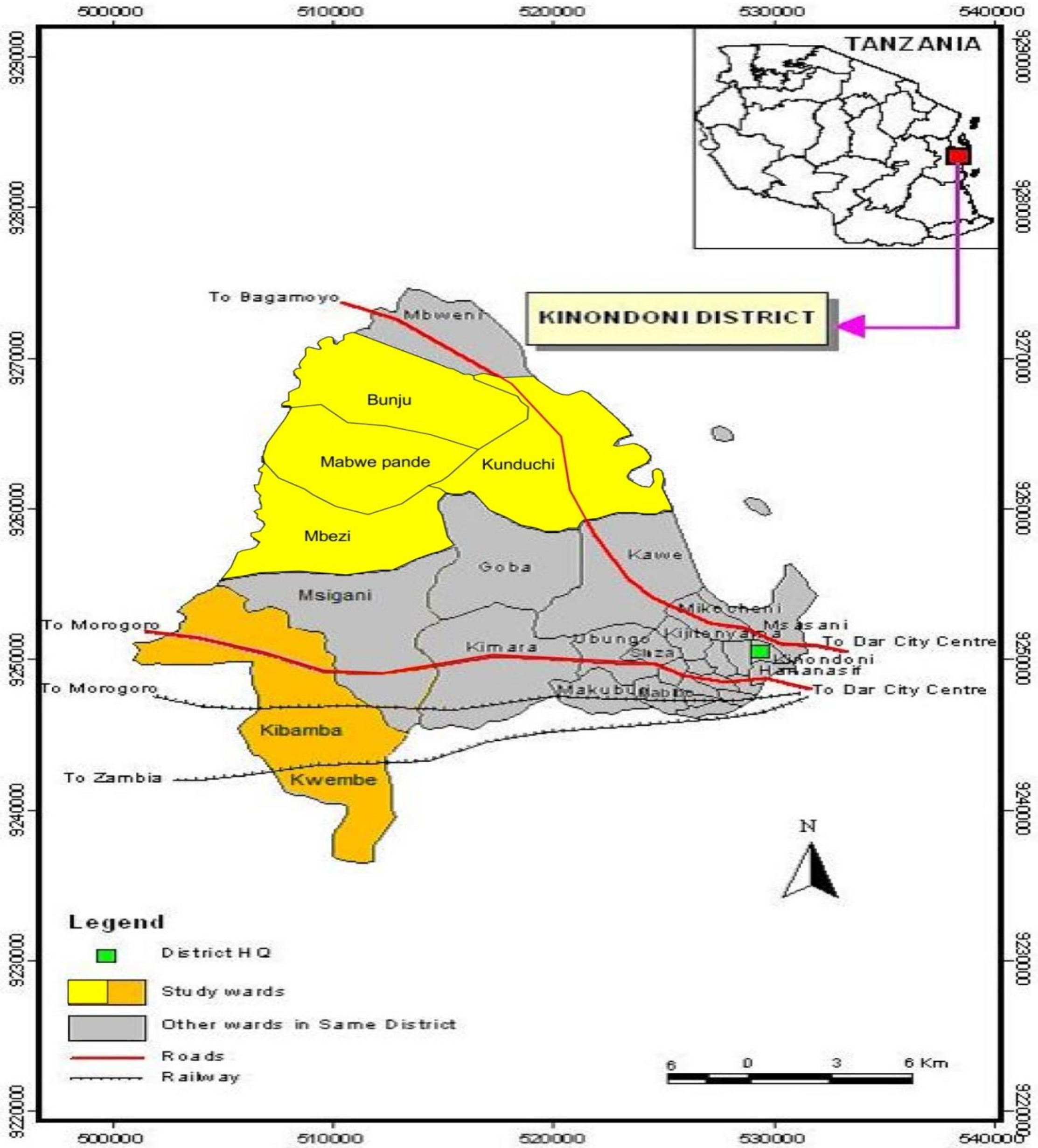

Figure 2.1: Kinondoni District Map with study areas highlighted

2.3.1 Research design

A cross sectional research design was used as data was collected at a single point in time. This design according to (Bailey, 1998) is useful for descriptive purposes as well as for determination of relationship among variables at a particular point in time. During the interview sessions, interviewees were assured of both confidentiality and anonymity. They were also assured that information obtained would be used solely for academic purpose.

2.3.2 Sampling procedure and sample size

2.3.2.1 The Population

Kinondoni district has four (4) divisions namely: Magomeni, Kinondoni, Kibamba and Kawe. These divisions are then divided into thirty four (34) wards, which in turn are sub divided into sub wards commonly known as *Mtaa* (singular) or *Mitaa* (plural). There are 197 *Mitaa*. According to the 2012 population Census, the Municipality has a population of 1 775 049 being the most populous local authority in the country, with the population growth rate of 5.0% per annum with 4 people per household. The population from which the sample for this study was drawn consisted of household heads. The total population was 353 836 in selected number of wards in the two selected divisions was six. Kibamba and Kawe divisions were selected for the study where by two wards Kibamba and Mbezi were selected from Kibamba division these two wards had a total population of 102 299; females being 52 270 and males being 49 477. Four wards Kunduchi, Wazo, Bunju and Mabwepande were selected from Kawe division these four wards had a total population of 251 537; females being 129 267 and males being 122 270. The estimated number of households practicing UA was 6015.

2.3.2.2 Sampling method and sample size

A sample size of 120 farmers was selected for the study. The sample size for the research was determined using the following formula recommended by Kothari (1993).

$N = Z^2pq/e^2$

Where:

N = Desired sample size (where proportion is greater than 1000)

Z = is the standard error associated with the chosen level of confidence (1.96) corresponding to 95% confident interval

P = is the proportion in the largest population estimated to have particular characteristics if not known use 50%

Q = 1.0 – p

e^2 = Degree of accuracy desired, usually set at 0.05 or occasionally at 0.01

Therefore, the sample size was calculated as: $(1.96)^2 * 0.1*(1-0.1)/ (0.05)^2 = 134$

However, sample sizes of 120 households were randomly selected based on manageable area and also to reduce the costs of research. The sample was considered big enough based on Bailey's (1994) argument that 30 cases is the bare minimum for a study in which statistical data analysis is to be done. The selection of the household was guided by the ward agriculture extension officer. A sampling unit was a household.

Purposive sampling was used to choose Kinondoni District for the study due to the extensive involvement of residents in UA. Simple random sampling technique was employed in selecting 120 growers from nearly 1000 farmers in the study area. The survey sites were selected based on the proportion of full-time small-scale farm populations and the willingness of farmers to participate. Random sampling technique was applied to obtain two divisions out of four and purposive sampling technique was employed to obtain six (6) wards out of 34. These wards were selected on condition that there should be urban farmers. The wards covered by the study were Mbezi, Kibamba, Wazo, Kunduchi, Bunju and Mabwepande. Simple random sampling technique was used to select 38 household from two wards in Kibamba division specifically, 15 (male 11, female 4) and 23 (male 13, female10) from Mbezi and Kibamba wards respectively. Besides, 82 households were randomly selected from 4 wards in Kawe division. These included; 20 (male16, female 4), 15 (male 14, female 1), 21 (male 17, female 4) and 26 (male 21, female 5) households from Wazo, Bunju, Kunduchi and Mabwepande wards respectively. This made a total sample size of 120 households.

2.3.3 Questionnaire administration

Quantitative data were collected through questionnaire (Appendix 1) survey. The questionnaire was formulated in English language; thereafter it was translated into Kiswahili so as to facilitate communication between enumerators and the respondents. The collected information included type of vegetables grown in the area, pest challenges (types and nature of damage), pest management practices, pesticides used, sources of pesticides, pesticides distribution channels and uses, pesticide handling and disposal techniques, farmers', attitudes, knowledge and awareness regarding pesticide uses and safety precautions taken during application and after pesticide use as well as the yield attained subject to pesticide use.

2.3.4 Data collection

Primary data were collected using semi- structured questionnaire consisting of both open and close ended questions. Questionnaires were administered to the head of households. In absence of the heads of households, any member of the household represented provided that he or she was in position of providing the required information. Collected data included ethnic groups, age, sex, marital status, education levels and size of house hold. Qualitative data were collected through the use of checklists. This information was obtained through the use of focus group discussion (FGD). A total of 6 focus group discussions were conducted in six wards, one in each ward. More information was collected from key informants such as the District Executive Director (DED), District Agriculture, Irrigation and Cooperative officer (DAICO), Subject Matter Specialist (SMS), Ward Agriculture Extension officers (WAEOs) and Village Agriculture Extension Officers (VAEOs). Information was also collected from the councillors from the six wards. Generally, key informants were asked to give their views on factors that influence community participation in urban farming and give opinion on how community can be mobilized. Secondary data was collected to supplement information obtained from questionnaire survey. Published and unpublished relevant data available at the department of agriculture in Kinondoni, the Sokoine National Agriculture Library (SNAL), and varied websites constituted the secondary data.

2.3.5 Data analysis

Quantitative data collected through questionnaire was sorted cleaned and analyzed using the Statistical Package for Social Science (SPSS 16.0 for windows) computer software. Firstly, the variables were subjected to descriptive statistics to get the frequency of responses. Secondly, the effect of one variable on another was determined through cross tabulations using chi- square test. Proportions as percentages resulting from such output were computed. Finally, to determine if significant differences existed between one variable or a set of variables and another or not, a chi square test was used at the 95% probability level. Qualitative information from checklist of questions was used to supplement useful statistical outcomes. Obtained results were presented as tables and graphs.

2.4 Results

2.4.1 Social-Demographic characteristics

2.4.1.1 Age of respondents

The minimum age of respondents was 21 years while maximum age was 88 years and the average was 44.37 years old. The highest proportion (47.5%) of respondents aged between

21-40 years, representing the most active farming group in the study area, followed by 40.8% respondents in the age group ranging from 41-60 years and 11.7% respondents aged between 61years and above.(Table 2.1).

Table 2.1: Age of respondents (n = 120)

Age group(year)	**Surveyed Wards**						**Total**
	Mbezi	**Kibamba**	**Wazo**	**Bunju**	**Kunduchi**	**Mabwepande**	
21 – 40	5(4.2)	11(9.2)	9(7.5)	5(4.2)	12(10.0)	15(12.5)	57(47.4)
41 – 60	8(6.7)	12(10.0)	8(6.7)	6(5.0)	7(5.8)	8(6.7)	49(40.8)
61 and above	2(1.7)	3(2.5)	3(2.5)	4(3.3)	2(1.7)	3(2.5)	14(11.7)
Total	**15(12.5)**	**23(19.2)**	**20(16.5)**	**15(12.5)**	**21(17.5)**	**26(21.7)**	**120(100.0)**

Chi-square = 10.398 Df = 10 significance =0 .406

Numbers in brackets are percentages of the actual value

2.4.1.2 Marital status of respondents

It was observed that out of the 120 respondents, only 86.7% were married. About 0.8% of respondents were widower, 1.7% were widow, 7.5% were single and only 3.3% were separated (Table 2.2).

Table 2.2: Marital status of respondents (n = 120)

Marital status	**Surveyed Wards**						**Total**
	Mbezi	**Kibamba**	**Wazo**	**Bunju**	**Kunduchi**	**Mabwepande**	
Married	11(9.2)	18((15.0)	16(13.3)	15((12.5)	18(15.0)	26(21.7)	104(86.4)
Single	4(3.3)	3(2.5)	1(0.8)	0(.0)	1(0.8)	0(0.0)	9(7.5)
Separate	0(0.0)	0(0.0)	2(1.7)	0(0.0)	2(1.7)	0(0.0)	4(3.3)
Widow	1(0.8)	0(0.0)	1(0.8)	0(0.0)	0(0.0)	0(0.0)	2(1.7)
Widower	0(0.0)	1(0.8)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(0.8)
Total	**15(12.5)**	**23(19.2)**	**20(16.5)**	**15(12.5)**	**21(17.5)**	**26(21.7)**	**120(100.0)**

Chi-square = 30.924 Df = 25 significance = 0.192. Numbers in brackets are percentages of the actual value

2.4.1.3 Sex of respondents

It was observed that 76.7% of the households were male while 23.3% were female headed (Table 2.3). Of the male headed households 52% were practicing crop and livestock production, 44.6% were only engaged in crop production while 2.2% were livestock keepers, and a small segment of 1.1% were engaged in livestock keeping, crop production and fish production. About 32.1% of female headed households were engaged in crop and livestock production, 64.3% were only engaged in crop production, and 3.6% practiced livestock keeping.

Table 2.3: Respondents' sex (n= 120)

Sex of respondents	Surveyed Wards						Total
	Mbezi	**Kibamba**	**Wazo**	**Bunju**	**Kunduchi**	**Mabwepande**	
Female	4(3.3)	10(8.3)	4(3.3)	1(0.8)	4(3.3)	5(4.2)	28(23.3)
Male	11(9.2)	13(10.8)	16(13.3)	14(11.7)	17(14.2)	21(17.5)	92(76.7)
Total	**15(12.5)**	**23(19.2)**	**20(16.5)**	**15(12.5)**	**21(17.5)**	**26(21.7)**	**120(100.0)**

Chi-square = 8.224 Df = 5 significance = 0.144. Numbers in brackets are percentages of the actual value

2.4.1.4 Household size

The house hold members included the respondent himself/herself, his/her spouse, Children and other dependants. About 55.8% of respondents had household size of 1 to 5 while 39.2% had household size of 6 to 10 people. The rest 5.0% had household size of 11 and above persons. Mean house hold size was 5.67. This is much higher than the average of house hold size of Kinondoni district itself and of Dar es Salaam region which was 4.0 and 3.7 respectively (Table 2.4).

Table 2.4: Household size (n= 120)

Household size	Surveyed Wards						Total
	Mbezi	**Kibamba**	**Wazo**	**Bunju**	**Kunduchi**	**Mabwepande**	
1 – 5	6(5.0)	13(10.8)	10(8.3)	7(5.8)	10(8.3)	21(17.5)	67(55.8)
6 – 10	8(6.7)	8(6.7)	10(08.3)	8(6.7)	9(7.5)	4(3.3)	47(39.2)
≥11	1(0.8)	2(1.7)	0(0.0)	0(0.0)	2(1.7)	1(0.8)	6(5.0)
Total	15(12.5)	23(19.2)	20(16.5)	15(12.5)	21(17.5)	26(21.7)	120(100.0)

Chi-square = 13.640 Df = 10 significance = 0.190
Numbers in brackets are percentages of the actual value

2.4.1.5 Educational level of respondents

Formal education was considered in assessing the education level of respondents. Obtained data indicated that respondent's education levels ranged from illiterate to University graduates. Categorization on the basis of education is presented (Table 2.5). The highest proportion (60.8%) of respondents had primary level of education, while 20.0% of respondents had secondary level of education. About 8.3% respondents had college level of education, while 5.0% had university level of education and only 5.8% respondents had no formal education.

Table 2.5: Educational level of respondents (n = 120)

Educational level	**Surveyed Wards**						**Total**
	Mbezi	**Kibamba**	**Wazo**	**Bunju**	**Kunduchi**	**Mabwepande**	
No Formal Education	2(1.0)	1(0.8)	0(0.0)	0(0.0)	1(0.8)	3(2.5)	7(5.8)
Primary	5(4.2)	10(8.3)	14(11.7)	10(8.3)	17(14.2)	17(14.2)	73(60.8)
Secondary	5(4.2)	7(5.8)	3(2.5)	3(2.5)	2(1.7)	4(3.3)	24(20.0)
College	2(1.7)	3(2.5)	1(0.8)	0(0.0)	0(0.0)	0(0.0)	6(5.0)
University	1(0.8)	2(1.7)	2(1.7)	(1.7)	1(0.8)	2(1.7)	10(8.3)
Total	**15(12.5)**	**23(19.2)**	**20(16.5)**	**15(12.5)**	**21(17.5)**	**26(21.7)**	**120(100.0)**

Chi-square = 23.245 Df = 20 significance = 0.277
Numbers in brackets are percentages of the actual value

2.4.2 Type of farming activities

A total of four different farming activities could roughly be distinguished in the studied area (Table 2.6). The first was Crop Production (49.2%), which was by far the dominant type. The second type of activity was livestock keeping (2.5%). The third type of activity was a combination of Crop and Livestock Production (47.5%) and lastly was a combination of Livestock Keeping, Crop Production and Fish Keeping. Out of 120 respondents in six wards in Kinondoni district, almost half (49.2%) reported being solely engaged in crop production while (2.5%) were solely involved with livestock keeping as their source of livelihood. A total of 47.5% engaged in both crop production and livestock keeping.

Table 2.6: Respondent's type of farming activities (n = 120)

Types of Farming Activities HH Involved	**Surveyed Wards**						**Total**
	Mbezi	**Kibamba**	**Wazo**	**Bunju**	**Kunduchi**	**Mabwepande**	
Crop and Livestock Production	7(5.8)	10(8.3)	9(7.5)	6(5.0)	9(7.5)	16(13.3)	57(47.5)
Livestock Keeping	0(0.0)	1(0.8)	0(0.0)	1(0.8)	1(0.8)	0(0.0)	3(2.5)
Crop Production	7(5.8)	12(10.0)	11(9.2)	8(6.7)	11(9.2)	10(8.3)	59(49.2)
Livestock Keeping, Crop Production and Fish Keeping	1(0.8)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(0.8)
Total	**15(12.5)**	**23(19.2)**	**20(16.7)**	**15(12.5)**	**21(17.5)**	**25(21.7)**	**120(100.0)**

Chi-square = 12.672 Df = 15 significance = 0.628

Numbers in brackets are percentages of the actual value

2.4.3 Types of vegetable grown

Various types of vegetables were grown in Dar es Salaam region, including leafy, fruit types, shoots and tuber. There we more than nine types of leafy vegetables, five types of fruit vegetables and one bulb vegetable was grown in the study area. Major leafy vegetables (with their percentages based on multiple responses) included Amaranth (*Amaranthus* spp, 61.7%), Chinese cabbage (*Brassica chinensis,* 72.5%), spinach (*Spinacia oleracea,* 63.3%), pumpkin leaves (*Curcubita moschata,* 15%), sweet potato leaves (*Ipomea batatas,* 22.5%), Cassava leaves (*Manihot esculenta*, 25.8%*)*, Ethiopian mustard (*Brassica carinata*, 9.2%) and African Nightshade (*Solanum scabrum*, 33.3%). Other vegetables grown in Dar es Salaam included pepper (*Capsicum* spp, 31.7%), tomatoes (*Solanum lycopersicum,* 35%), egg plant (*Solanum melongena*, 65.8%), okra (*Hibiscus esculentus*, 59.3%), and African eggplant (*Solanum macrocarpon* L, 25%). Bulb has onions (*Allium cepa,* 6.7%). The popular types of vegetables grown in Dar es Salaam were listed (Table 2.7).

Table 2.7: Multiple response analysis of the grown vegetable (n =120)

Common name	**Scientific name**	**n**	**Cases (%)**
Chinese cabbage	*Brassica chinensis*	87	72.5
Egg Plant	*Solanum melongena*	79	65.8
Spinach	*Spinacia oleracea*	76	63.3
Amaranths	*Amaranthus*	74	61.7
Okra	*Abelmoschus esculentus*	64	59.3
Tomatoes	*Lycopersicon esculentum*	49	40.8
African Night Shade	*Solanum scabrum*	40	33.3
Hot Pepper	*Capsicum frutescens*	38	31.7
Cassava leaves	*Manihot esculenta*	31	25.8
African Egg Plant	*Solanum macrocarpon*	30	25.0
Sweet potato leaves	*Ipomea batatas*	27	22.5
Pumpkin Leaves	*Curcubita moschata*	18	15.0
Ethiopian mustard	*Brassica carinata*	11	9.2
Onions	*Allium cepa*	8	6.7
Cowpeas Leaves	*Vigna unguiculata*	7	5.8

Note: *Multiple responses were allowed.*

2.5 Discussion

Analyses of social demographic variables revealed great diversity among respondents. The mean age of the farmers was 46.5 years with majority (47.4%) of the respondents were aged between 21-40 years representing the most active farming group in the region. This indicates that the majority of household member are within the productive age and therefore labour is not likely to be limiting factor in farming activities. However, the results statistically shows insignificant variations at ($P<0.05$) in terms of distribution of labour force among the sampled ward, implying that segregation of labour force in the study area is almost the same ($\chi2 = 10.398$, df = 10, P = 0 .406). These results are slightly above what was reported (Efraji, 2008) that in Tanzania the ages of economically productive class range from 18 to 45years.

In assessing the marital status of respondents the study revealed that, most of respondents (86.7%) were married; others were single, widowed, separated and divorced. This indicates that most of the vegetable growers had stable families. Furthermore, the findings show that Mbezi and Kibamba had more single vegetable growers. This implies that most of the respondents in the study area were mature and responsible for taking care of their families in terms of social and economics welfare. The results also revealed there is no significant variation in terms of marital status in the study area, this implies that the distribution of single, married, widow, widower, separated and will not differ from one ward to another in the study area. Dominance of the married group among the social cultural set up is a common characteristic among Tanzanian communities particularly ones involved in farming. This imply that married couples are likely to be more engaged in income generating activities than single due to labour reinforcement in accomplishing farm activities. Similar findings was reported by Kalimanga'si *et al.* (2014) in their study on contribution of contract cocoa production on improving livelihood of smallholder farmers in Kilombero and Kyela districts. Kalimanga'si *et al*. (2014) reported that married producers had more labour force for agricultural production than single and divorced. Makauki (2000) in his study on factors affecting the adoption of agro forest farming system, which was conducted in Turiani division also found the dominance of married people in agro forest farming. Similarity, in these findings suggest that married people engaged more in agricultural production activities possibly in attempt to supplement the income and carter for the needs of their family members. Thus marriage is one among the vital social cultural component that makes community members responsible and ready to engage in income generating activities for food and financial security.

The probe on to household headship indicated that majority of household were headed by men portraying the patriarch system that dominates most Tanzanian communities. As opposed to some cities on parts of African where in urban centres households are increasingly being headed by women, Tanzania seems to maintain the same grip in urban as is always common in rural set up. Generally, in this survey, there was in significant difference in the sex respondent between the different ward, this implies that the distribution of males and females did not differ from one ward to another in the study area. Comparative analysis among members of the same group suggested that more female farmers were recorded in Kibamba wards as opposed to other wards while more males were recorded from the Mabwepande ward compared to the rest of the wards. . It should be noted however that these observations should not be interpreted as female were inexistent in male dominated vegetable farming areas but rather they were considered as helpers while men were owners of the projects. Togolay (2010) reported the same situation in small-scale paddy production. He argued that in African tradition where marriage plays an important role in the society and husbands in most cases are household heads, it is common to find that resources are mostly controlled by males. That is why males dominate agricultural activities making the proportional of females owning resources to be small. Only female respondents who had never got married, widowed and few who are married had access to own resources. The finding is similar to the report of Similar findings were reported by Adjrah *et al.* (2013) in Togo that the farming activity is dominated by males.

The average household size was 5.67 which were above a mean of 4.7 recorded in Dar es Salaam in 2012 in the household budget survey (URT, 2013). The results also revealed insignificant variation among surveyed wards in terms of house hold sizes. The household size greater than five persons is generally larger than average. Four reasons were attributed to large sized households. These were dependants are coming to Dar es Salaam for better life opportunities; inadequate knowledge on family planning among parents in the respective households; African prestige in having many children which is more of the cultural believes; and taking economic advantages where many children are used as source of cheap labour to work in the farms. The other reason is due to the existence of extended family which is a characteristic of most African communities. However, the recorded family sizes are comparable to other densely populated areas in the country such as Lushoto and Iringa rural District (UNDP, 2010).

The study revealed that the highest proportion of respondents had primary level of education. This indicates that vegetable production is dominated by farmers who have primary education followed by those with secondary educations. Being a blue collar job it had great chances of attracting less educated group of urban dwellers than the educated ones. It is often expected that literate population would prefer white collar job to blue collar ones. The observed trend suggest that the type of farming practiced in the area is characterized by labour intensiveness, low investments, limited mechanization and could be less profitable.

The reason behind most respondents being of primary education in the study area might be due to deliberate effort made by government in 1978 to expand primary education in the country which was made compulsory for all children of 7-14 years (THDS, 1996). The Primary Education Development Programme (PED P) introduced in 2000s increased enrolment for primary school children (URT, 2009). The low number of respondents who had secondary education and post secondary education could be explained by the tendency of educated persons to shun from agriculture due to the drudgeries of the farm work.

Probing on the respondents' main occupation revealed that about 96.7% of the respondents were crop producers and livestock keepers with the sole crop producers commanding a relatively greater proportion compared to sole livestock keepers although the difference between the two could not be statistically justified. The finding indicates that farming is the most important economic activity in the study area as would be expected in rural areas. Green (2012) reported that most Tanzanians derive their income from farming. Tanzania Household Budget Survey Report in 2007 emphasized that most Tanzanians are still smallholder farmers and they depend on agriculture as their primary economic activity (URT, 2007). Mbwambo (2007) reported that, nearly two third of the urban population work as farmer and the rest combine farm and off farm activities including petty trade and carpentry just to mention few which seems to conform to the current finding.

The comparative assessment of the vegetable types grown suggested that majority of farmers grew *Brassica chinensis*. This may be because of its high demand in urban centers. In terms of growth the vegetable is known to perform well under warm humid weather typical of Dar es Salaam. In warm conditions *B. chinensis* grows fast to allow early harvesting for marketing and subsequent utilization. Moreover, the vegetable can perform well on marginal land and has less input demand which makes it a best fit for the limited land usually available in urban areas. Other horticultural crops like *Solanum melongena*, *Spinacia oleracea*, *Amaranthus* spp, *Hibiscus esculentus, Lycopersicon esculentum*, *Brassica carinata*, *Ipomea batatas*, *Solanum scabrum* , *Zea mays* , *Solanum macrocarpon* L, *Vigna unguiculata*, *Curcubita moschata* , *Capsicum* spp, *Citrullus lanatus*, *Capsicum frutescens*, *Allium cepa Musa* spp, *Manihot esculenta*, *Cucumis sativus, Carica papaya, Daucus carota, Mangifera indica, Saccharum officinarum* were also being grown in the area. At some spots, rice was being grown albeit at very small scale. All producers were small land holders, as was also reported by Elizabeth and Zira (2009).

Abang *et al.* (2014) indicated that vegetable cultivation is production of annual plants (shrubby or herbaceous) in a delimited agrarian space, generally exploited intensively. The use of small vegetable farms could be a result of the intensive nature of vegetable production and the high cost of chemical inputs, which increases cost of production. In addition, lack of adequate knowledge of vegetable production and protection from biotic and abiotic constraints could prevent vegetable farm size from increasing. Reduced size of the area enables resource-poor farmers to effectively manage their production. The present study further revealed that, various types of vegetables are grown in Dar es Salaam region, covering leafy, fruit types, shoots and tuber. Major leafy vegetables include amaranth, Chinese cabbage, spinach, pumpkin leaves, sweet potatoes leaves, Cassava leaves, Ethiopian mustard and African Nightshade. Fruit vegetable includes pepper (sweet and hot), tomatoes, egg plant, okra, and African eggplant, while bulb was onion. Their reason for exclusively growing vegetables is due to the fact that vegetables are early maturing, the demand is high and there is a quick return on investment.

Conclusively, the current study revealed that most of the vegetable farmers in the study area are males between the ages of 21 and 40 years. These are likely to stay in the vegetable production business for a long time to come. With the low level of education of the vegetable farmers in the study area, extension agents may have to visit them frequently to educate them and encourage them to always adopt best practices and new technologies in the cultivation of vegetables. Results from the study revealed that farmers use information gathered from the various sources to improve upon their farming activities. This should lead to improved incomes and sustainable livelihoods for the vegetable farmers.

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CHAPTER THREE

3.0 PEST MANGEMENT PRACTICES IN URBAN VEGETABLE PRODUCTION SECTOR OF DAR ES SALAAM, TANZANIA

3.1 Abstract

A study to examine pest management practices in urban vegetable producing areas was conducted in Dar es Salaam, Tanzania. Specifically, the study intended to (i) identify the major pests attacking vegetable crops, (ii) explore the pests management techniques used in the study area, and (iii) determine the pesticides commonly used to control vegetable pests, and (iv) document the pesticides and residue management practices used by vegetable growers. Simple random technique was used to get a total of 120 respondents out of estimated 800 growers. Quantitative data were collected through questionnaire, while, qualitative data were collected through semi structured interviews and checklists. Both qualitative and quantitative methods were used to analyze data. Although farmers use some cultural control methods and occasionally botanical pesticides, pest control was predominantly by the use of conventional pesticides. Farmers irrationally apply pesticides paying little attention to the recommendations including the wrong insecticides to apply, inappropriate dosage, unsafe storage facilities, non-use of protective devices when applying pesticides, and unsafe disposal of insecticide storage containers.

It was indicated that usage of synthetic insecticides by farmers was the most common crop protection strategy to control plant disease and insect pests (87.3 %). The rest (6.9%) of farmers interviewed were solely depending on cultural methods in managing pests in their vegetable garden. About 2.5 % of farmers' use cultural methods were in some cases complemented with use of bio pesticide. About 3.3 % farmers were being used fungicides to control and to minimize crop losses associated with disease infestations in their farm.

The smallholder vegetable sector requires support in the form of improved access to existing pest management information (in an appropriate form) and focused research targeted at the knowledge gaps which currently impede implementation of sustainable IPM.

Key words: Urban Agriculture, Vegetables, Insect Pests, Pest management, Pesticides.

3.2 Introduction

Demand for food in cities and towns in Tanzania are high, and vegetables are increasingly grown in urban and peri-urban areas to meet the consumer needs. Crop production in urban and peri-urban areas is commonly referred to as urban agriculture (UA). Production is intensively done on small and fragmented units of land forcing on continuous basis promoting suitable environment for perpetuation of pests and disease pressure. This triggers excessive use of inputs inclusive of fertilizer and pesticides in attempt to sustain crop vigour and manage the pest problems. Effective pest management is an important tool in contributing to high yields. In order to reduce crop losses by the pest attacks, farmers tend to use a wide range of pesticides, including insecticides, fungicides, and bio pesticides (Jinius *et al.,* 2001). Chemical control is practiced by farmers for higher gains (Gerken *et al.,* 2001), but these pests can quickly develop resistance to chemical insecticides. Moreover, the misuse of chemical insecticides in terms of quantity applied or in dangerous combinations has created problems including pest resistance, resurgence of pests, pesticide residues, destruction of beneficial insects, and environmental pollution (Obeng-Ofori *et al.,* 2002; AVRDC, 2003). However, the inappropriate use of chemical pesticide by farmers has been greatly discussed worldwide (Ngowi *et al*., 2007; Williamson *et al.*, 2008; Xu *et al*., 2008; Zhou and Jin, 2009). Very few studies have indicated that farmers in low-income countries uses much smaller quantities of pesticide than farmers in high-income countries and their usage leads to more vulnerable risks. In vice versa, developed countries tend to go in direction of fewer chemical applications and use pesticide that is more environmentally friendly (Carvalho, 2006; Panuwet *et al.*, 2008). Pesticide misuse has been a concern due to the posed health risks and pollution to the environment. This paper aimed at determining pest problems and farm based management practices in vegetable producing urban areas in Kinondoni District, Dar es Salaam, Tanzania.

3.3 Materials and Methods

The study was carried out at Kinondoni District, in Dar es Salaam, Tanzania located between 39° 12′ 57.6″ to 39° 02′ 56.4″E and 6° 40′ 44.4″ to 6° 47′ 13.2″ S and 16 metres above sea level (Figure 1). Kinondoni district covers an area of about 531 km^2. The district falls within the coastal zone which experiences a modified type of equatorial climate. It is generally hot and humid throughout the year with an average temperature of 29^oC. The hottest season is from October to March (33^oC) while it is relatively cool between May and August with temperature around 25^0C. Bimodal rains are usually experienced with short rains from October to December and long rains between March and May. The average annual rainfall is 1100 mm (lowest 800 mm and highest 1300 mm). Humidity is around 96% in the morning and 67% in the afternoons. The climate is also influenced by the Southwest monsoon winds from April to October and Northeast monsoon winds between November and March. According to the National Population and housing census of 2012, Kinondoni District has a population of 1 775 049 inhabitants with a population growth rate of 5.0% per annum and the population density is 1179 people per square km (URT, 2013). The Kinondoni district attracts a lot of migrants from different parts of the country seeking employment opportunities in Dar es Salaam city. According to the Kinondoni Municipal Council profile 16 % of the residents of Kinondoni are migrants. In addition, about 70% of the population of Kinondoni lives in informal settlements within the city while those in the middle and upper class settle at the city's outskirts (URT, 2013). UA especially vegetable production has therefore become part of the informal sector which provides jobs and income for many of the city's unemployed migrants.

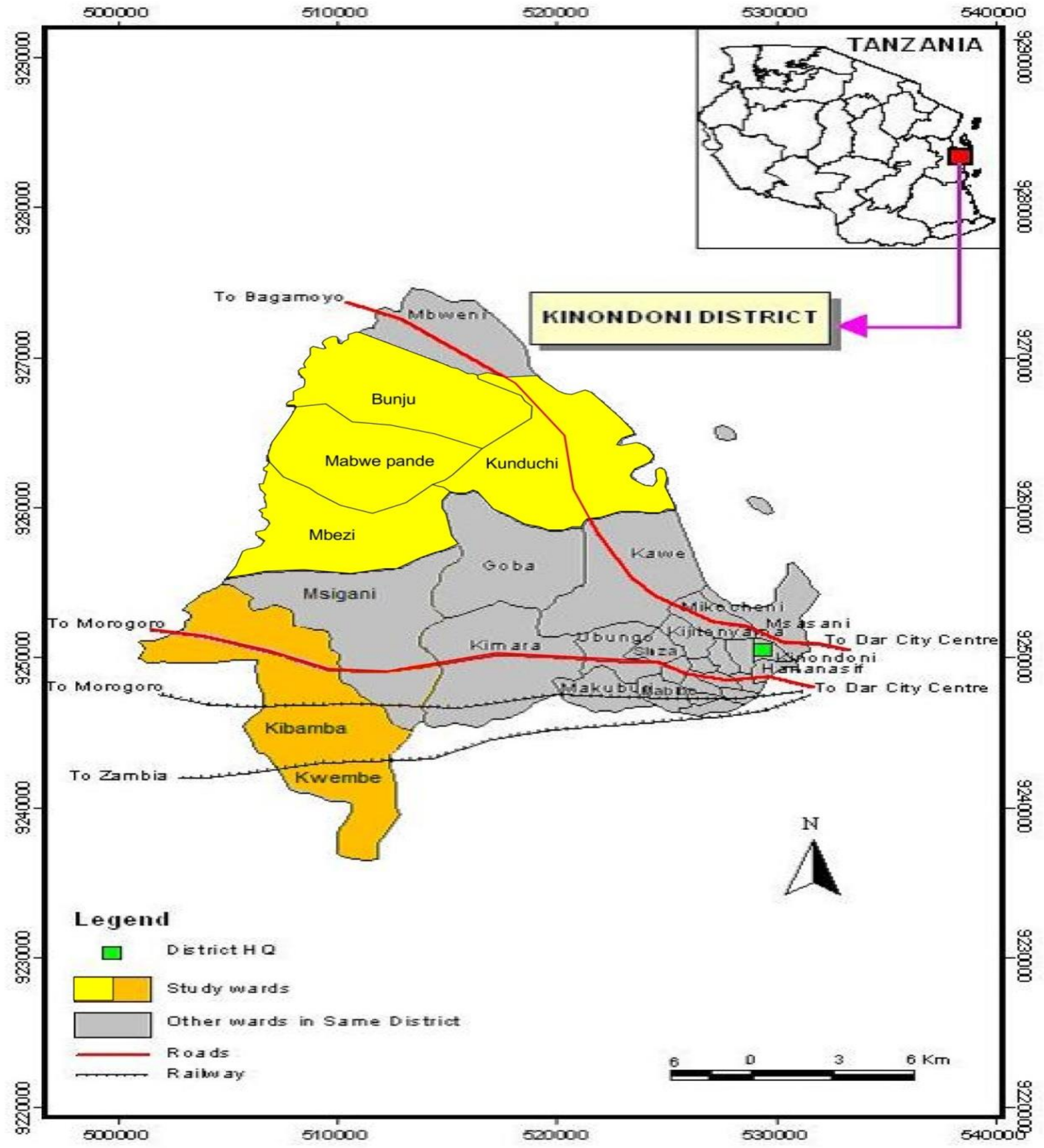

Figure 3.2: Kinondoni District Map with study areas highlighted

3.3.1 Research design

A cross sectional research design was used as data was collected at a single point in time. This design according to (Bailey, 1998) is useful for descriptive purposes as well as for determination of relationship among variables at a particular point in time. During the interview sessions, interviewees were assured of both confidentiality and anonymity. They were also assured that information obtained would be used solely for academic purpose.

3.3.2 Sampling procedure and Sample size

3.3.2.1 The Population

Kinondoni district has four (4) divisions namely: Magomeni, Kinondoni, Kibamba and Kawe. These divisions are then divided into thirty four (34) wards, which in turn are sub divided into sub wards commonly known as *Mtaa* (singular) or *Mitaa* (plural). There are 197 *Mitaa*. According to the 2012 population Census, the Municipality has a population of 1 775 049 being the most populous local authority in the country, with the population growth rate of 5.0% per annum with 4 people per household. The population from which the sample for this study was drawn consisted of household heads. The total population was 353 836 in selected number of wards in the two selected divisions was six. Kibamba and Kawe divisions were selected for the study where by two wards Kibamba and Mbezi were selected from Kibamba division these two wards had a total population of 102 299; females being 52 270 and males being 49 477. Four wards Kunduchi, Wazo, Bunju and Mabwepande were selected from Kawe division these four wards had a total population of 251 537; females being 129 267 and males being 122 270. The estimated number of households practicing UA was 6015.

3.3.2.2 Sampling method and sample size

A sample size of 120 farmers was selected for the study. The sample size for the research was determined using the following formula recommended by Kothari (1993).

$N = Z^2pq/e^2$

Where:

N = Desired sample size (where proportion is greater than 1000)

Z = is the standard error associated with the chosen level of confidence (1.96) corresponding to 95% confident interval

P = is the proportion in the largest population estimated to have particular characteristics if not known use 50%

Q = 1.0 – p

e^2 = Degree of accuracy desired, usually set at 0.05 or occasionally at 0.01

Based on the equation the sample size was calculated as: $(1.96)^2 * 0.1*(1-0.1)/ (0.05)^2$ = 134. However, the sample size of 120 households was randomly selected based on manageable area and also to reduce the costs of research considering that it did not deviate much from the expected. The sample was considered big enough based on Bailey's (1994) oservation that 30 cases is the bare minimum for a study in which statistical data analysis is to be done. The selection of wards from which samples were derived was guided by the ward agriculture extension officer. A household was considered a sampling unit.

Purposive sampling was used to choose Kinondoni District for the study due to the extensive involvement of residents in UA. Simple random sampling technique was employed in selecting 120 growers from nearly 1000 farmers in the study area. The survey sites were selected based on the proportion of full-time small-scale farm populations and the willingness of farmers to participate. Random sampling technique was applied to obtain two divisions out of four and purposive sampling technique was employed to obtain six (6) wards out of 34. These wards were selected on condition that there should be urban farmers. The wards covered by the study were Mbezi, Kibamba, Wazo, Kunduchi, Bunju and Mabwepande. Simple random sampling technique was used to select 38 household from two wards in Kibamba division specifically, 15 (male 11, female 4) and 23 (male 13, female10) from Mbezi and Kibamba wards respectively. Besides, 82 households were randomly selected from 4 wards in Kawe division. These included; 20 (male16, female 4), 15 (male 14, female 1), 21 (male 17, female 4) and 26 (male 21, female 5) households from Wazo, Bunju, Kunduchi and Mabwepande wards respectively. This made a total sample size of 120 households.

3.3.3 Questionnaire administration

Quantitative data were collected through questionnaire (Appendix 1) survey. The questionnaire was formulated in English language; thereafter it was translated into Kiswahili so as to facilitate communication between enumerators and the respondents. The collected information included type of vegetables grown in the area, pest challenges (types and nature of damage), pest management practices, pesticides used, sources of pesticides, pesticides distribution channels and uses, pesticide handling and disposal techniques, farmers', attitudes, knowledge and awareness regarding pesticide uses and safety precautions taken during application and after pesticide use as well as the yield attained subject to pesticide use.

3.3.4 Data collection

Primary data were collected using semi- structured questionnaire consisting of both open and close ended questions. Questionnaires were administered to the head of households. In absence of the heads of households, any member of the household represented provided that he or she was in position of providing the required information. Collected data included ethnic groups, age, sex, marital status, education levels and size of house hold. Qualitative data were collected through the use of checklists. This information was obtained through the use of focus group discussion (FGD). A total of 6 focus group discussions were conducted in six wards, one in each ward. More information was collected from key informants such as the District Executive Director (DED), District Agriculture, Irrigation and Cooperative officer (DAICO), Subject Matter Specialist (SMS), Ward Agriculture Extension officers (WAEOs) and Village Agriculture Extension Officers (VAEOs). Information was also collected from the councillors from the six wards. Generally, key informants were asked to give their views on factors that influence community participation in urban farming and give opinion on how community can be mobilized. Secondary data was collected to supplement information obtained from questionnaire survey. Published and unpublished relevant data available at the department of agriculture in Kinondoni, the Sokoine National Agriculture Library (SNAL), and varied websites constituted the secondary data.

3.3.5 Data analysis

Quantitative data collected through questionnaire was sorted cleaned and analyzed using the Statistical Package for Social Science (SPSS 16.0 for windows) computer software. Firstly, the variables were subjected to descriptive statistics to get the frequency of responses. Secondly, the effect of one variable on another was determined through cross tabulations using chi- square test. Proportions as percentages resulting from such output were computed. Finally, to determine if significant differences existed between one variable or a set of variables and another or not, a chi square test was used at the 95% probability level. Qualitative information from checklist of questions was used to supplement useful statistical outcomes. Obtained results were presented as tables and graphs.

3.4 Results

3.4.1 Pest challenges

Based on responses given, the agricultural pest problems were classified as major and minor with regards to the impacts on the crops. Pests considered major were those that could destroy the plants or significantly reduce the potential yield. Pests which did not impact heavily on the plants were considered as minor pests. Some pests were quite specific to host plants and some had a wide range of hosts (polyphagous). The pest problems on vegetables in Kinondoni included insect pests and diseases caused by pathogens. The vegetable insect pests mentioned by respondents were categorized with reference to their respective orders which included lepidopteran, hemipteran, orthopteran, mesostigmata and tylenchida. Insect like leafhoppers, aphids and thrips also acts as disease vectors. Insect pest infestation involve damages such as leaf defoliation, holes on the leafs, fruit/shoot borers, withering due to dehydration caused by sap-sucking. Diseases in vegetables are caused by micropathogens such as fungi, bacteria and viruses. The major diseases are identified as leaf-spot (anthracnose), damping-off, rotting, powdery and downy mildews. Detailed list of the pests of vegetables identified in Kinondoni (Table 3.1)

Table 3.1: List of Major Insect Pests of Vegetables found in Kinondoni

Common Name	Scientific Name	Vegetable Host
A. Lepidoptera		
Tomato fruit borer	*Helicoverpa armigera*	Tomato
Tomato leaf miner	*Tuta absoluta*	Tomato (polyphagous)
Diamondback moth	*Plutella xylostella*	Brassica vegetables
Cutworm	*Agrotis spp*	Polyphagous
Eggfruit caterpillar	*Sceliodes cordalis*	Polyphagous
Eggplant fruit and shoot borer	*Leucinodes orbonalis*	Eggplant (Polyphagous)
African Maize Stalkborer	*Busseola fusca*	Cereals crops
Spotted stem borer	*Chilo partellus*	Cereals crops
B. Hemiptera		
Aphids	*Aphis* spp	Polyphagous
White flies	*Bemisia tabaci*	Polyphagous
Lace bug		ornamental plants
vegetable leafhopper	*Empoasca fabae*	Polyphagous
Leafhoppers	*Amrasca devastans*	Okra (polyphagous)
Leafhoppers	*Amrasca biguttata*	Okra (polyphagous)
White fly	*Bemisia tabaci*	Polyphagous
White fly	*Aleurodicus dispersus*	Polyphagous
Mealybugs	*Paracoccus marginatus*	Eggplant
D. Orthoptera		
Elegant grass hopper	*Zonocerus elegans*	Polyphagous
E. Mesostigmata		
Redmites	*Dermanyssus gallinae*	Polyphagous
F. Tylenchida		
Nematodes	-	Polyphagous

3.4.2 Pest management practices in vegetable production

The pest management practices found being used by vegetable growers in the study area are presented (Table 3.2). It was indicated that usage of synthetic insecticides by farmers was the most common crop protection strategy to control plant disease and insect pests (87.3 %). The rest (6.9%) of farmers interviewed were solely depending on cultural methods in managing pests in their vegetable garden. One of the most important observation showed that farmers using cultural methods like uprooting and crop rotation had their farms or plots located nearby their residences. Uses of cultural methods were in some cases complemented with use of bio pesticide which accounted for 2.5 % of respondents. It was found that cultural control practices were the second choices of interest among farmers to be used in pest control. On the other hand, fungicides were being used by some farmers (3.3 %) to control and to minimize crop losses associated with disease infestations in their farm.

Table 3.2: Multiple response analysis of pest management practices in vegetable

Pest management method			n	Cases (%)
Synthetic pesticides	Insecticides	Duduba	119	99.2
		Attakan	96	80.0
		Tanzacron	92	76.7
		Supaclop	91	75.8
		Ninja	90	75.0
		Dume	64	53.3
		Karate	55	45.8
	Insecticdes/Acaricides	Agromectin	89	74.2
		Abanil	34	28.3
Biopesticide	Biopesticide	Tobacco	21	17.5
	Fungicides	Ridofarm	28	23.3
Cultural practices	Cultural practices	Uprooting	36	30.0
		Crop rotation	22	18.3

3.4.3 Sources of knowledge on pesticides use

A total of 30% of respondents indicated that extension officers played a key role in disseminating information to farmers on pesticides. Agro shop dealers contributes 26.7%

of the knowledge on pesticides, self acquired skills accounted for 25% and neighbours contributed 10.0% in the provision of information on pesticides to farmers (Table 3.3). The findings suggest that extension officers don't play their role in disseminating information to famers in Kinondoni without motivation and facilitation.

Table 3.3: Source of information about pesticide use among farmers (n = 120)

	Surveyed Wards						Total
Source	**Mbezi**	**Kibamba**	**Wazo**	**Bunju**	**Kunduchi**	**Mabwepande**	
Neighbours	3(2.5)	1(0.8)	1(0.8)	1(0.8)	3(2.5)	3(2.5)	23(10.0)
Agro Shop Dealers	1(0.8)	6(5.0)	8(6.7)	3(2.5)	4(3.3)	10(8.3)	32(26.7)
Extension Officer	9(7.5)	8(6.7)	6(5.0)	6(5.0)	5(4.2)	2(1.7)	36(30.0)
Self-acquired Skills	1(0.8)	7(5.8)	3(2.5)	3(2.5)	7(5.8)	9(7.5)	30(25.0)
Agro-shop Dealer and Self-acquired Skills	1(0.8)	1(0.8)	2(1.7)	1(0.8)	1(0.8)	0(0.0)	6(5.0)
Extension Officer and Self-acquired Skills	0(0.0)	0(0.0)	0(.0)	1(0.8)	1(0.8)	2(1.7)	4(3.3)
Total	**15(12.5)**	**23(19.2)**	**20(16.7)**	**15(12.5)**	**21(17.5)**	**26(21.7)**	**120(100.0)**

Chi-square = 30.071 Df = 25 p = 0.222
Numbers in brackets are percentages of the actual value

3.4.4 Availability and sources of pesticides

Farmers purchased pesticides in small quantities in local shops which were within easy reach of their homes (Table 3.4). The primary sources of pesticides were local commodity shops, followed by both local shops and distant shops. Of the 120 farmers interviewed, more than 35% purchased insecticides from distant shops and 30.8% from local outlets, while 31.7% purchased from both local and distant shops. Few (1.7%) tended to buy pesticides from their neighbours.

Table 3.4: Pesticides Source (premises from which pesticides were obtained) (n= 120)

Pesticides Source	**Surveyed Wards**						**Total**
	Mbezi	**Kibamba**	**Wazo**	**Bunju**	**Kunduchi**	**Mabwepande**	
Distant Shops	3(2.5)	7(5.8)	7(5.8)	4(3.3)	3(2.5)	19(15.8)	43(35.8)
Local Shops	1(0.8)	8(6.7)	11(9.2)	7(5.8)	10(8.3)	0(0.0)	37(30.8)
Local and distant Shops	9(7.5)	8(6.7)	2(1.7)	4(3.3)	8(6.7)	7(5.8)	38(31.7)
Neighbours	2(1.7)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	2(1.7)
Total	**15**	**23**	**20**	**15**	**21**	**26**	**120(100.0)**

Chi-square = 53.694 Df = 15 p = 0.000
Numbers in brackets are percentages of the actual value

3.4.5 Personal protection during pesticides handling and application

The adoption of safety measures during and after pesticide application is an important factor for preventing against harmful impacts of pesticide. There are various safety options that could be used including wearing of gloves, Overall, Face Mask/Nose Mask, Gumboots etc. More than half (61.7%) of the respondents claimed that they had personal protective equipment against exposure to pesticides (Table 3.5). However, further probing and field visits indicated that about 38% of these farmers did not have gloves, boots and long sleeved shirt for pesticides handling and application. The present study showed that 19.2% of respondents used either face masks or nose mask as safety measures while 15.2% used hand gloves and 2.5% used gumboots. Almost one third (38.3%) of the farmer in the study area did not use precautionary measures against pesticides including full body covers (overall), mask, glasses, gloves and boots when spraying pesticides.

Table 3.5: Protective equipment used by farmers during pesticides handling and application against literacy level (n= 120)

Protective Gears	Education level of Respondent					
	No Formal Education	**Primary**	**Secondary**	**Collage**	**University**	**Total**
Hand Gloves	3(2.5)	9(7.5)	6(5.0)	1(0.8)	0(0.0)	19(15.8)
Overall	0(0.0)	1(0.8)	1(0.8)	0(0.0)	0(0.0)	2(1.7)
Face/Nose Mask	1(0.8)	12(10.0)	7(5.8)	1(0.8)	2(1.7)	23(19.2)
Not Using personal protective equipment	3(2.5)	31(25.8)	4(3.3)	1(0.8)	7(5.8)	46(38.3)
Gumboots	0(0.0)	1(0.8)	2(1.7)	0(0.0)	0(0.0)	3(2.5)
Hand Gloves, Face Mask/Nose Mask and Gumboots	0(0.0)	9(7.5)	2(1.7)	1(0.8)	0(0.0)	12(10.0)
Hand Gloves and Face Mask/Nose Mask	0(0.0)	6(5.0)	2(1.7)	1(0.8)	1(0.8)	10(8.3)
Hand Gloves, Glasses and Face mask/nose mask	0(0.0)	1(0.8)	0(0.0)	0(0.0)	0(0.0)	1(0.8)
Hand Gloves, Overall and Face/Nose Mask	0(0.0)	3(2.5)	0(0.0)	0(0.0)	0(0.0)	3(2.5)
Overall and Face Mask/Nose Mask	0(0.0)	0(0.0)	0(0.0)	1(0.8)	0(0.0)	1(0.8)
Total	**7(5.8)**	**73(60.9)**	**24(20.0)**	**6(5.0)**	**10(8.3)**	**120(100)**

Chi-square = 45.612 Df = 36 p = 0.131

Numbers in brackets are percentages of the actual value

3.4.6 Cleaning the equipments after application of pesticides

The survey revealed that majority (70%) of the respondents wash their equipment at field margin using bucket water while 23.3% wash their equipment after spray nearby pond or river, 5.8% and 0.8% wash their equipment at the public tap water point and at home respectively (Table 3.6).

Table 3.6: Cleaning of equipments after application of pesticides against literacy level (n = 120)

Where cleaning done	Education level of Respondent					Total
	No Formal Education	Primary	Secondary	University	College	
Field Margin Using						
Bucket Water	6(5.0)	57(47)	10(8.3)	7(5.6)	4(3.3)	84(70.0)
Nearby Pond/River	1(0.8)	16(13.3)	10(8.3)	0(0.0)	1(0.8)	28(23.3)
Public Tap Water Point	0(0.0)	0(0.0)	3(2.5)	3(2.5)	1(0.8)	7(5.8)
At Home	0(0.0)	0(0.0)	1(0.8)	0(0.0)	0(0.0)	1(0.8)
Total	**7(5.8)**	**73(60.8)**	**24(20.2)**	**10(8.3)**	**6(5.0)**	**120(100.0)**

Chi-square = 31.617 Df = 12 p = 0 .002
Numbers in brackets are percentages of the actual value

3.4.7 Relationship between levels of education and pesticide storage

The relationship between literacy level in formal education and knowledge on appropriate storage of pesticide by the respondents is presented (Table 3.7) following the Chi-square analysis at 5% level of significance. The level of education was measured by number of years spent in formal training by the respondents. Details on the obtained results showed that 36.7% of the respondents stored pesticides in food store at home, 35.0% stored pesticides at farm, 13.3% bedroom/living room, 5.0% store for agricultural equipments, 4.2% hide outside the house and 4.2% in animal shade while 1.7% kept in the kitchen.

Table 3.7: Relationship between levels of education and pesticides storage (n = 120)

	Education level of Respondent					
Storage of pesticides	No Formal Education	Primary	Secondary	University	College	Total
Bedroom/Living room	2(1.7)	9(7.5)	5(4.2)	0(0.0)	0(0.0)	16(13.3)
Animal Shade	0(0.0)	3(2.5)	1(0.8)	0(0.0)	1(0.8)	5(4.2)
Food Store at Home	1(0.8)	28(23.3)	10(8.3)	3(2.5)	2(1.7)	44(36.7)
Kitchen	0(0.0)	2(1.7)	0(0.0)	0(0.0)	0(0.0)	2(1.7)
At Farm	4(3.3)	25(20.0)	7(5.8)	6(5.0)	0(0.0)	42(35.0)
Hide Outside House	0(0.0)	3(2.5)	0(0.0)	1(0.8)	1(0.8)	5(4.2)
Store for Agriculture Equipment	0(0.0)	3(2.5)	1(0.8)	0(0.0)	2(1.7)	6(5.0)
Total	**7(5.8)**	**73(60.8)**	**24(20.0)**	**10(8.3)**	**6(5.0)**	**120(100.0)**

Chi-square = 30.086 Df = 24 p = 0.182
Numbers in brackets are percentages of the actual value

3.4.8 Disposal of remnant pesticides after use and the containers

The majority of the pesticides used by the farmers were packaged in bags and plastic containers, which should be properly disposed off after use. Farmers had different practices for disposing the empty pesticide containers (Table 3.8). Disposing of empty containers in a pit was most frequently reported by respondents (60.8%) followed by burning (27.5%), leaving them in the crop field (22.3%) and burying (7.5%).

Table 3.8: Disposal of remained pesticides after use and the containers (n = 120)

Disposal of remained pesticides after use and the container	Education level of Respondent					
	No Formal Education	Primary	Secondary	University	College	Total
Flowing River	0(0.0)	1(0.8)	0(0.0)	0(0.0)	0(0.0)	1(0.8)
Throw in Pits	7(5.8)	45(37.5)	13(10.8)	6(4.0)	2(1.7)	73(60.8)
Garbage Collection Point	0(0.0)	2(1.7)	1(0.8)	1(0.8)	0(0.0)	4(3.3)
Burning	0(0.0)	18(15.0)	9(7.5)	3(2.5)	3(2.5)	33(27.5)
Burying	0(0.0)	7(5.8)	1(0.8)	0(0.0)	1(0.8)	9(7.5)
Total	**7(5.8)**	**73(60.8)**	**24(20.0)**	**10(8.3)**	**6(5.0)**	**120(100.0)**

Chi-square = 12.10 Df = 16 p = 0.737

Numbers in brackets are percentages of the actual value

3.4.9 Education levels and Safety precautions adopted

The results from correlation analysis (Table 3.9) indicate that among the assessed variables, Personal protective equipment used by farmers during pesticides handling and application, cleanliness of equipments after application, storage of pesticides and disposal of the remained pesticides after use are positively correlated with the education level of respondents. Cleanliness of equipment after application of pesticides, (0.265) was positively correlated with literacy level and was highly significant (P < 0.003).

Table 3.9: Correlation between Education levels and Safety precautions adopted

Variable	Coefficient	Sign.
Personal protective equipment used by farmers during pesticides handling and application	0.087	0.342
Cleanliness of equipment after application of pesticides	0.265**	0.003
Storage of pesticides	0.112	0.223
Disposal of remained pesticides after use the container	0.148	0.106

** Correlation is significant at the 0.01 level (2-tailed).

(Using Pearson correlation, 2- tailed, N = 120)

3.5 Discussion

Challenges realized from Agricultural pest could be classified as major and minor problems with regards to the impact to the crop. Pests considered major are those that can destroy the plants or significantly reduce the potential yield. Pest which does not affect the plants very much are considered as minor pest. Some pests are quite specific to host plants and some have a wide range of hosts (polyphagous). For example, diamondback moth (DBM) infests all crucifers in the study areas; while shoot and fruit borer (*Leucinodes orbonalis*) infest eggplants only. A long list of vegetable insect pests that were found infesting the farmers crops were categorized into respective orders and included lepidopterans, hemipteran, orthopteran, mesostigmata and tylenchida. Specifically, some of major arthropod pests mentioned by the respondents included diamondback moth, *P. xylostella* (Lepidoptera: Plutellidae), cutworm, *Agrotis ipsilon* (Hufnagel) (Lepidoptera: Noctuidae), Elegant grass hopper, *Zonocerus elegans* (Orthoptera: Pyrgomorphidae), Red spider mites, *Dermanyssus gallinae* (Mesostigmata: Dermanyssidae), aphids, *Aphis* spp (Hemiptera: Aphidoidea), Tomato leafminer, *Tuta absoluta* (Lepidoptera: Gelechiidae), White flies (Hemiptera: Aleyrodidae), Lace bug (Hemiptera: Pseudococcidae), Nematodes, (Tylenchida: Dolichodoroidea), vegetable leafhopper, *Empoasca fabae* (Hemiptera: Cicadellidae), Cutworm, *Agrotis* spp (Lepidoptera: Noctuidae), Eggfruit caterpillar, *Sceliodes cordalis* (Lepidoptera: Crambidae), Eggplant fruit and shoot borer, *Leucinodes orbonalis* (Lepidoptera: Noctuidae), African Maize Stalkborer, *Busseola fusca* (Lepidoptera: Noctuidae) and Spotted stem borer, *Chilo partellus* (Lepidoptera: Crambidae). Identification of the insect pests observed in farmers' fields was also in accordance with the species mentioned by farmers.

Almost all the vegetable farmers were using pesticides as their means of managing their vegetable pests problems since they are easily available, simple and cheap to apply, less labour intensive and "highly" effective.

The most commonly used insecticides in controlling vegetable pests were Duduba 450EC (Cypermethrin 10% + chlorpyrifos 35%), Supaclop (Imidacloprid 200 g/l), Ninja 5EC (Lambda cyhalothrin 50 g/l), Abanil (Abamectin 18g/l), Tanzacron (Profenofos 720 g/l), Karate 5EC (Lambda cyhalothrin 50 g/l), Attakan (Imidacloprid 350 g/l), Dume 40EC (Dimethoate 400 g/l), Agromectin (Abamectin 18 g/l) and the most commonly used fungicides was Ridofarm 72WP (Mancozeb 640 g/kg + Metalaxyl 80 g/kg). Dominance of Ridofarm 72WP as a priority fungicide among vegetable grower has been reported (Matthews *et al*., 2003). This is an indication that pesticides play an important role in the control of pests and increase of the crop yields (Mahantesh and Singh 2009). Apart from chemicals a few farmers used botanical pesticides such as tobacco leaf extracts to manage insect pests. Other methods of crop protection were crop rotation and uprooting of infested plants. Combination of methods in form of integrated pest management (IPM) was far from being considered by respondents probably due to limited knowledge and complexity in implementation of the practices. Likewise, biological control was not being practiced in the study area.

The results indicated that more than 67% of farmers in the study area acquire information about pesticides they use from other sources including pesticide vendors in shops, agents of pesticide selling companies and fellow farmers. Only one third of respondents acquired knowledge on pesticides from extension officers. This might be explained by the reason that extension officers don't play their role in disseminating information to famers in Kinondoni without motivation and facilitation. This trend was alike across all wards from which respondents were interviewed. The observed different trend is not different from the findings of Elizabeth and Zira (2009) who reported that most vegetable farmers received extension information from neighbours and had little or no contact with government departments. They also reported that almost all respondents were aware of extension services, and an equal percentage recognized the usefulness of extension services. However, most were never visited by the extension service, which likely resulted in farmers' inability to identify pests and diseases of vegetables, poor pest management skills, and lack of good knowledge of the use of chemical pesticides. In similar studies conducted in Tanzania (Ngowi *et al.,* 2007), it was reported that farmers were not receiving agricultural extension services hence have attempted various means especially in pesticides use when dealing with pest problems but were constrained by the lack of appropriate knowledge.

Probing into the availability and access to pesticides revealed that farmers normally purchased pesticides in small quantities in local shops which were within easy reach of their homes. The primary sources of pesticides were local commodity shops, followed by distant shops and neighbours. The reason for this was that pesticides in the local shops were cheaper, readily available and with no limitations to their usage by the farmers. All the farmers interviewed considered price and efficacy of the pesticides as most important in deciding which pesticides and where to buy them. Farmers' consideration of prices and the efficacy of pesticides as reported in this study were also reported by Williamson *et al.* (2008) as a regular practice among farmers in developing countries. Conversely Nagenthirarajah and Thiruchelvam (2008) asserted that farmers' choice of pesticide was primarily based on efficacy rather than safety.

The use of protective gears during application of pesticides was found lacking. None of the farmer in the study area used precautionary measures of full body covers such as mask, goggles, respirator, gloves, hat and boots during spraying of pesticides. Only a handful (19.2%) of respondents used face or nose masks while about 16% used hand gloves. Only about 2% used overall suggesting that contamination of food and water sources through pesticides and associated health risks are among major threat to the community of vegetable growers and the consumers. Non-precautious use of pesticides implies that growers are either unaware of the negative outcome of pesticide misuse or simply negligent of the associated risks. Intensive training should be a major priority among players in urban agricultural sector. The potential risks are suggestively more pronounced to consumers to whom the vegetables are sold. Unlike Dar es Salaam, farmers elsewhere are reported to use pesticides more precautiously. A study carried in Western Uttar Pradesh and Ahmednagar showed majority 34% of respondent had used mask/hand gloves and 81% were using mask followed by 67% who used gloves (Kishore *et al.*, 2008).

Similar study conducted in Cambodia, Palestine and Bolivia revealed that majority (90%) of growers used mask as Personal protective equipment (PPE) (Assis and Mohd Ismail, 2011; Jensen *et al.*, 2011). Negligence in the use of pesticides observed in the present study has been reported elsewhere in Cambodia, Nepal, and Baharain where majority of the respondents were using only aprons as personal protective equipment (PPE) and rest of them did not use protective device due to discomfort (Sameer and Adel, 2013). Plianbangchang *et al*. (2009) also reported that small scale farmers did not wear suitable personal protection, apply pesticides inappropriate fashion and discard the wastes unsafely. Sometime farmers have the knowledge on unfavourable effects of indiscriminate use of pesticides but they do not practice due to lack of legal measures taken against the abuser (Yassin *et al.*, 2002). Therefore, it is essential to educate the farmers in the study area to practice safety measures while handling pesticides.

Cleaning of equipment after application of pesticides was considered an important part of operation by pesticide users but wrongly executed. The majority (70.0%) of the respondents washed their sprayers after spray of pesticides directly at field margin using bucket water and others in the nearby pond or river while others washed it in their public tape water point at home. Studies conducted in Philippines showed similar findings where majority of the respondents washed their pesticide bottles and sprayers in the nearby canal or washed it in their water pump at home or washed it directly in the field (Yap and Demayo, 2015). The education level of respondents influenced the appropriateness of the choice of methods being used to cleaning the equipments after application of pesticides. Suggestively, the higher the level of education the better the knowledge on the right choice of safe way to clean the equipment after application of pesticides.

Moreover, the levels of education did not have influence on the appropriate storage of pesticide among respondents. More than a third of the respondents stored pesticides in food stores. Generally, there were no proper storage methods used by the respondents. The tendency of farmers storing pesticides in their home is not peculiar to the current study. Report by Rajendran (2003) in Hebron governorate, occupied Palestinian territory revealed that majority of the farmers up to 51.7% stored pesticides in their homes. Elsewhere in rural area of Ahmednagar in India it has been observed that up to 50% of farmers stored the pesticide in the field at farm house, and 20% at home (Singh and Gupta, 2009) implying that there could be several factors considered by farmers on pesticide storage and safety might not be the only case.

In depth segregation of the respondents based on their education level indicated that about 90% had education levels lower than the college level. Thus formal training of up to secondary school does not impart adequate knowledge on proper storage of pesticides. It could even be embarrassing to realise that growers with up to secondary school education cannot read the instructions provided on pesticide labels on safe storage. The results also revealed no significant variation among the different wards in terms of knowledge in pesticides storage techniques in the study area. The results in the present study are in contrast with the findings by Horna *et al.* (2007) who asserted that, skills and education amplify the efficiency in storage of pesticides. All in all the obvious must be noted that negligence in storing pesticides may lead to unwanted fatal accidents, especially where there are little children in the family.

Attempt to understand the mechanics in which the residual pesticides and used containers are disposed revealed that nearly two third of the respondents threw the empty pesticide cans in normal garbage pits and nearly few respondents threw on flowing rivers. Moreover the respondents' education level had no influence on the choice of pesticides and containers disposal methods. The rest of farmers threw the empty pesticide containers at the garbage collection points. Burying or burning the pesticide sachets and containers after use was being practiced by few respondents. As such low-level of awareness about disposal methods of pesticide was a unifying character among most farmers. When empty containers are left in the field, during rainy season the remnants may be washed to reach water bodies thereby polluting water and intoxicating the aquatic fauna. Further the left outs could give chances for accidental intake of pesticides, especially by children, pets. Safe disposal of used pesticide containers is therefore important to reduce environmental pollution and in turn it will eventually protect the human health (Sutharsan *et al.,* 2014). Similar study by Sawalha *et al*. (2010), reported that improper dumping of empty pesticide containers such as discarding these into immediate surroundings, into local waste bins, or in flowing water or even burying and reusing it at home can render danger to the environment and the human health. The pesticide containers are expected to be disposed as described in the pesticide manuals. Nagenthirarajah and Thiruchelvam (2008) recommended that burying is the safest method of pesticide disposal. Therefore, after use of pesticides, the empty containers should be disposed in proper safe way like burying.

Conclusively, the current study established that most of vegetable growers in the study area do not adhere to the recommended safety procedures and set regulation and laws on pesticide use. Lack of knowledge on appropriate pesticide handling and safety precautions was apparent and requires immediate remedies. Malpractice in pesticide application could lead to harmful chemicals getting into human food chains with consequent adverse effects on human health. Provision of education through purposeful training and regular inspection on the use of pesticides and disposal of their residues should be of urgency and absolute necessity to farmers in this vegetable sector in Dar es Salaam and elsewhere in Tanzania.

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CHAPTER FOUR

4.0 EFFECTIVENESS OF COMMONLY USED INSECTICIDES ON VEGETABLE PRODUCTION IN DAR ES SALAAM

4.1 Abstract

Vegetable growers in urban and peri-urban centres of Dar es Salaam, Tanzania have been using various types of insecticides to control vegetable pests. These insecticides are neither documented nor tested for efficacy. However some farmers have been complaining of the ineffectiveness of some of the currently traded insecticides such that worries on to possible development of resistance or rampancy of counterfeit pesticides in the market had become a growing concern by scientists. The present study was undertaken to document the major types of insecticides that are used by vegetable growers and test the efficacy of the three most preferred and commonly used insecticides available in the market. The efficacy of common insecticides identified through survey in a current study was experimentally tested in the field against the major pests of Chinese cabbage and eggplant at Malolo Agricultural Center in Kinondoni District. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and four treatments applied at three week interval. The insecticides tested were: Cypermethrin 10% + Chlorpyrifos 35%, Imidacloprid 200 g/l and Lambdacyhalothrin 50 g/l and were compared with a control. The results showed that Cypermethrin 10% + Chlorpyrifos 35% at the rate of 2 ml/l of water, Imidacloprid 200 g/l at the rate of 1 ml/l of water, and Lambdacyhalothrin 50 g/l at the rate of 2.5 ml/l of water, caused significant reduction in larval population. These insecticides also provided equal protection against larval damage on leaves of Chinese cabbage and eggplant fruits. Consistently, the control plots gave significantly lower yield of marketable leaves in Chinese cabbage and fruits in eggplant as compared to the insecticide treated plots. The maximum yield of Chinese cabbage was

obtained in the plots treated with Chlorpyriphos 10% + Cypermethrin 35% EC (8.6 t/ ha^{-1}) and Imidacloprid 200 g/l (6.7 t/ ha^{-1}), followed by Lambdacyhalothrin 50 g/l (4.6 t/ ha^{-1}) and maximum yield of eggplant fruits was obtained in the plots treated with Imidacloprid (6.7 t/ ha^{-1}). The yield obtained in the plots treated with Cypermethrin 10% + Chlorpyrifos 35 % and Lambdacyhalothrin 50 g/l was (5.9 t / ha^{-1}) and (5.7 t / ha^{-1}) respectively. The study recommended the use of Cypermethrin 10% + Chlorpyrifos 35 % and Imidacloprid 200 g/l for effective control of diamondback moth in Chinese cabbage and hairy caterpillar in eggplant.

Key Words: Field efficiency, insecticides, vegetables, Diamondback moth, caterpillars.

4.2 Introduction

Vegetables are important components of daily diets in Tanzania, and an important income-generating activity for smallholder farmers in urban centers and rural areas (Kanda *et al.*, 2014). The delicate nature of vegetables makes them vulnerable to insect pests which often require intervention by growers through various control measures. Despite the diverse options for pest control that exists, vegetable growers in Tanzania rely heavily on commercial inputs particularly pesticides (Coulibaly *et al.,* 2008). Several types of agricultural pesticides are being used by farmers to control diverse vegetable crop pests.

However, malpractices by farmers in using insecticides have often portrayed that some pesticides are ineffective against major vegetable pests. Whether the limited efficacy is caused by the farmers themselves or the insecticides had not been documented. Some researchers reported that synthetic insecticides are the most available pesticides on the markets in Tanzania and consequently, the most accessible to farmers but inadequately used (Mondédji *et al*., 2014). In spite of the excessive amounts of pesticides used on vegetables, significant crop losses are often reported by farmers at which suggests a reduced sensitivity in some vegetables pests against the applied insecticides. The diamondback moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae), a common pest of brassica vegetable is one among the reported insensitive pest to the applied insecticides. In Tanzania, the pest can cause more than 50% of crop losses in Chinese cabbage despite of using various groups of synthetic insecticides (Ahmad *et al*., 2009). Likewise, Hairy caterpillars can cause more than 45% of crop losses in Eggplant farms treated with various groups of synthetic insecticides (Srinivasan, 2009). This study aimed at assessing the effectiveness of commonly used insecticides in vegetable production under field conditions upon which suitable recommendations in managing the respective pests would be made.

4.3 Materials and Methods

A field study on efficacy of three commonly used insecticides in vegetable production was conducted in a randomized complete block design at Malolo Agricultural Center (Mabwepande ward) in Kinondoni district between 2016-2017. A questionnaire consisting of structured items was designed. Data was collected through a farm survey by face to face interviews with farmers during farm activities. The site was selected based on the leafy vegetable grown, insecticides usage and ease of accessibility. The vegetable farmers use more than 9 type's insecticides (by trade or common name) to control pest infestation and minimize crop losses. The choice of the three commonly used insecticides was based on the results obtained during survey in the study area. A total of twelve plots for each vegetable were made of equal size (2.3 m x 4.0 m) for Chinese cabbage and (3.6 m x 6.0 m) for eggplant with a two meter space between the plots. Chinese cabbage and eggplant seedlings were initially grown in an insect proof screen house for five weeks, after which they were transplanted in the field on raised beds (1.2 m x 4.0 m) beds were spaced 75 cm apart for Chinese cabbage and (1 m x 6.0 m) beds were spaced 75 cm for eggplant, each experimental unit had two beds for Chinese cabbage and three beds for eggplant. The beds were enriched with chicken manure at the rate of 15 tonnes/ha, two weeks before transplanting. There were 40 plants per experimental unit for Chinese cabbage and 60 plants per experimental unit for eggplant, separated by two guard rows, planted on a triangular pattern and spaced at 0.5 m between plants. Top dressings of compound fertilizer (NPK 15:15:15) were applied at one week and four weeks after transplanting at a rate of 12 g per plant at each application. Chicken manure was again applied at the rate of 100 g/plant two weeks after transplanting.

Three insecticidal treatments and a control at the rate of 15 1 of water per replicate, were carried out for each replicate. The treatments applied were: Duduba 450EC (Cypermethrin 10% + Chlorpyrifos 35%) at the rate of 2 ml/l, Septer 200SC (Imidacloprid 200 g/L) at the rate of 1 ml/l, Ninja 5EC (Lambdacyhalothrin 50 g/L) at the rate of 2.5 ml/l, and water (applied as the control treatment). A total of three rounds of spray applications were made at an average of three weeks intervals in Chinese cabbage, starting two weeks after transplanting, with JACTO=HD400 Knapsack sprayer (Jacto inc., Tulatin, OR,USA) fitted with a hollow cone nozzle. One spray was made in eggplant.

4.4 Assessment of Insect Pests

The assessment of pest incidence and their number were recorded one day before spraying as pre-treatment counting of the larvae. Post treatment count was recorded at one, three, five and seven days after each spraying. For recording the pest population counts, five plants were randomly selected and tagged in each plot, excluding border rows. The diamondback moth larvae population was recorded from top, middle and bottom leaves during the early morning hours (at most before 10 am). The number of larvae from each tagged plant was counted with the help of hand lens 50 mm diameter and 10x magnification (Thomas Scientific) and mean number per plant was calculated. First spraying was applied after 49 days of transplanting followed by second spray was done at 21 days interval on Chinese cabbage to allow subsequent population build-up in the experimental plots.

Figure 4.1: Assessment of insects on eggplant plant

Figure 4.2: Assessment of insects on Chinese cabbage plant

4.5 Data Collection

Data were collected on insecticide used, numbers of insect counted before and after each spray, eggplant fruits yield and Chinese cabbage marketable leaves yield harvested. Assessment of insects was done by visual examination of the entire plants as described by (Lal, 1998).

4.6 Data Analysis

Data from the field survey were coded and analysed using the Statistical Package for Social science (SPSS 16.0) computer software. Descriptive statistics such as means, frequencies and percentage were computed (By which method). The collected data for insects count were tested for normality using SPSS statistical package upon which conformity to the normal distribution suggested no need for transformation. Data for insect count were subjected to the analysis of variance (ANOVA) and mean separation tested at $P<0.05$ by using Gen stat 14 edition statistical package (VSN international).

Data on the percentage reduction in the population of insect pests over untreated check in different treatments was computed using the modified Abbot’s formula (Fleming and Retnakaran, 1985) as given below.

Percent population reduction =

$$\left(1 - \frac{\text{Post treatment population in treatment x Pre population in the untreated check}}{\text{Pre treatment population in treatment x Post treatment in the untreated check}}\right)$$

4.7 Results

4.7.1 Types of pesticides commonly used by farmers

Farmers in Kinondoni use different types of pesticides to control different pests although some farmers admitted that they sometimes mix more than one chemical before spraying. Total of five different types of insecticides (by trade or common name) were commonly being used by farmers to control insect pests infestation on vegetables. Insecticides were being applied without adequate knowledge of pest ecology, economic injury levels and type of recommended insecticides to control specific insect pest, their quantities and method of application, pre harvest interval and protective measures. The commonly used insecticides (Table 4.1) to control insect pests were Duduba 450 EC (44.9%), Agromectin (9.7%),Ninja 5 EC (8.0%), Supaclop (8.0%), Attakan C (7.9%) and Tanzacron (6.7) and the only fungicides Ridofarm 72WP (2.3%) was being used to control fungal disease on vegetables.

Table 4.1: Common pesticides used by vegetable farmers in Kinondoni District (n=120)

Trade Name	Active ingredient	Chemical group	Proportion (%)
Duduba 450EC	Cypermethrin 10% + chlorpyrifos 35%	PY + OP	47.1
Supaclop	Imidacloprid 200 g/l	Neonicotinoids	9.9
Ninja 5EC	Lambda cyhalothrin 50 g/l	PY	8.4
Abanil	Abamectin 18 g/l	OC	8.4
Tanzacron	Profenofos 720 g/l	Neonicotinoids	8.3
Karate 5EC	Lambdacyhalothrin 50 g/l	PY	7.1
Attakan C	Imidacloprid 350 g/l	OC	5.5
Ridofarm 72WP	Mancozeb 640 g/Kg + Metalaxyl 80 g/kg	C + HG	2.4
Dume 40Ec	Dimethoate 400 g/l	OP	2.3
Agromectin	Abamectin 18g/l	OC	0.6

Source: Field Survey Data, 2016

OP – Organophosphorus compound, PY - Pyrethroid, OC -Organo chlorine compound, C- Carbamate, HG- Mercury compound

4.7.2 Efficacy of insecticides on (*P. xylostella*) in Chinese cabbage after first spray

One day after spraying, chlorpyrifos 50% EC + cypermethrin 5% EC and recorded hundred per cent reduction of *P. xylostella* followed by Imidacloprid 200 g/l (0.73 larvae per plant) 86 per cent reduction and the minimum reduction of 58 per cent (2.53 larvae per plant) was noticed in Lambdacyhalothrin 50g/L while in control maximum population (7.27 larvae per plant) was recorded.

On third day after spraying, chlorpyrifos 50% EC + cypermethrin 5% EC and Imidacloprid 200g/L were most effective recorded hundred per cent mortality of *P. xylostella.* The Lambdacyhalothrin 50g /l recorded minimum reduction 93 per cent (0.47 larvae per plant) as compared to untreated control (8.47 larvae per plant).

At five days after spraying, chlorpyriphos 10% EC + cypermethrin 355% EC, imidacloprid 200 g/ and Lambdacyhalothrin 50 g/l all insecticides recorded hundred per cent reduction of *P. xylostella* population as compared to untreated control (8.0 larvae per plant).

At seven days after spraying, among the insecticides tested, chlorpyriphos 10% EC + cypermethrin 35% EC, imidacloprid 200 g/l and Lambdacyhalothrin 50 g/l all registered hundred per cent mortality, whereas untreated control had maximum *P. xylostella* population (10.6 larvae per plant).

Table 4.2: Mean number of diamondback moth per plant and percent mortality after first spray at various intervals on Chinese cabbage

Treatment	Average number of DBM larvae / Plant						% reduction larva population DBM				
	Dose (l/ha)	DBS	1DAS	3DAS	5DAS	7DAS	1DAS	3DAS	5DAS	7DAS	MEAN
Duduba 450EC	1	5.07a	0.00a	0.00a	0.00a	0.00a	100	100	100	100	100
Septer 200SC	0.3	5.13a	0.73a	0.00a	0.00a	0.00a	86	100	100	100	96.5
Ninja 5EC	0.3	5.8a	2.53b	0.47a	0.00a	0.00a	58	93	100	100	87.75
Control		7.07a	7.27c	8.47b	8.0b	10.6b	-	-	-	-	-
P-value		0.27	<.001	<.001	<.001	<.001					
SE(±)		0.71	0.67	0.59	0.47	0.31					
CV %		21.2	31.3	45.4	40.9	20					

Key to abbreviations: DBS= Day before spray, DAS= Days after sprays, DBM= Diamondback moth

Means followed by the same letters in column are not significantly different at P≤ 5% level of significance (DMR test

4.7.3 Efficacy of Insecticides after Second Spray

Observation recorded at one day after spray (Table 4.3) indicated that the plots treated with (Duduba 450EC) Cypermethrin 10% + Chlorpyrifos 35% and Septer (200SC) Imidacloprid 200 g/l registered hundred per cent population reduction of *P. xylostella* followed by (Ninja 5EC) Lambdacyhalothrin 50 g/l (4.2 larvae/plant) 48 per cent reduction as compared to untreated control (14.6 larvae per plant).

Three day after spraying, chlorpyrifos 10 % EC + cypermethrin 35 % EC (Duduba 450EC) and imidacloprid 200 g/l (Septer 200SC) recorded hundred per cent reduction of *P. xylostella* , the minimum reduction of 94 per cent (0.4 larvae per plant) was noticed in Lambdacyhalothrin 50 g/l (Ninja 5 EC) while in control maximum population (15.73 larvae per plant) was recorded.

Diamondback moth larvae population recorded at five days after spray indicated that minimum (0 larvae per plant) counts were found in plots sprayed with Cypermethrin 10% + Chlorpyrifos 35% (Duduba 450 EC), Imidacloprid 200 g/l (Septer 200SC) and Lambdacyhalothrin 50 g/l (Ninja 5EC) compared to untreated control (18.0 larvae per plant).

At seven days after spraying, among the insecticides tested, chlorpyriphos 10% EC + cypermethrin 35% EC (Duduba 450EC), imidacloprid 200 g/l (Septer 200SC) and Lambdacyhalothrin 50 g/l (Ninja 5EC) all registered hundred per cent mortality, whereas untreated control had maximum *P. xylostella* population (17.87 larvae per plant).

Table 4.3: Mean number of diamondback moth per plant and percent mortality after second spray at various intervals on Chinese cabbage

	Average number of DBM larvae / Plant						% reduction larva population DBM				
Treatment	**Dose (l/ha)**	**DBS**	**1DAS**	**3DAS**	**5DAS**	**7DAS**	**1DAS**	**3DAS**	**5DAS**	**7DAS**	**MEAN**
Duduba 450EC	1	2.33a	0.00a	0.00a	0.00a	0.00a	100	100	100	100	100
Septer 200SC	0.3	3a	0.00a	0.00a	0.00a	0.00a	100	100	100	100	100
Ninja 5EC	0.3	7.6b	4.2b	0.4a	0.00a	0.00a	48	94	100	100	85.5
Control		13.87c	14.6c	15.73b	18b	17.87b	-	-	-	-	-
P-value		<.001	<.001	<.001	<.001	<.001					
SE(±)		0.903	0.874	0.758	0.929	0.754					
CV %		23.3	32.2	32.5	29.2	17.2					

Key to abbreviations: DBS= Day before spray, DAS= Days after sprays, DBM= Diamondback moth
Means followed by the same letters in column are not significantly different at P≤ 5% level of significance (DMR test)

4.7.4 Efficacy of Insecticides after third Spray against Diamondback moth in Chinese cabbage

One day after application of insecticides, it was observed that all the treatments were found significantly superior to untreated control in reducing the larval population of diamondback moth, however, significant difference existed among them (Table 4.4). The maximum reduction of hundred per cent (0 larvae per plant) population was recorded in the treatment of Cypermethrin 10% + Chlorpyrifos 35% (Duduba 450EC) followed by Imidacloprid 200 g/l (Septer 200SC) which resulted in (1.33 larvae per plant) 33 per cent reduction. The minimum reduction of (1.8 larvae per plant) 23 per cent was recorded in the treatment of Lambdacyhalothrin 50 g/ l (Ninja 5EC), whereas untreated control had maximum *P. xylostella* population (10.33 larvae per plant).

After three days of spray maximum reduction in larval population was found in Cypermethrin10% + Chlorpyrifos 35% (Duduba 450EC), 0 larvae per plant hundred percent reduction followed by Imidacloprid 200 g/l (Septer 200SC), 0.33 larvae per plant 84 per cent which was at par with. The next effective treatment was Lambdacyhalothrin 50 g/l (Ninja 5EC) with 0.73 larvae per plant 71 per cent reduction; while in control maximum population (11.07 larvae per plant) was recorded on the check plot.

After five days of spray, Cypermethrin10% + Chlorpyrifos 35% (Duduba 450EC) and Imidacloprid 200 g/l (Septer 200SC) proved to be the most effective treatment with (0 larvae per plant) hundred per cent reduction in larval population of *P.xyostella* followed by Lambdacyhalothrin 50 g/l (Ninja 5EC) with 0.27 larvae per plant 90 per cent reduction, these stood at par with each other in their efficacy, while in control maximum population 9.87 larvae per plant was recorded.

The maximum reduction of (0 larvae per plant) hundred per cent were recorded in the treatment of Cypermethrin 10% + Chlorpyrifos 35% (Duduba 450EC) and Imidacloprid 200 g/l (Septer 200SC) even after seven days of spray followed by Lambdacyhalothrin 50 g/l (Ninja 5EC) 0.47 larvae per plant 79 per cent, these were statistically at par with each other, whereas untreated control had maximum *P. xylostella* population 9.87 larvae per plant.

Plate 4.1: Chinese cabbage infested with diamondback moth larvae

Table 4.4: Mean number of diamondback moth per plant and percent mortality after third spray at various intervals on Chinese cabbage

	Average number of DBM larvae / Plant						% reduction larva population DBM				
Treatment	**Dose (l/ha)**	**DBS**	**1DAS**	**3DAS**	**5DAS**	**7DAS**	**1DAS**	**3DAS**	**5DAS**	**7DAS**	**MEAN**
Duduba 450EC	1	1.73a	0.00a	0.00a	0.00a	0.00a	100	100	100	100	100
Septer 200SC	0.3	2.8a	1.33b	0.33a	0.00a	0.00a	33	84	100	100	79.25
Ninja 5EC	0.3	3.27a	1.8b	0.73a	0.27a	0.47a	23	71	90	79	65.75
Control		14.47b	10.33c	11.07b	12.4b	9.87b	-	-	-	-	-
P-value		<.001	<.001	<.001	<.001	<.001					
SE(±)		0.574	0.252	0.265	0.307	0.936					
CV %		17.9	12.3	15.1	16.8	26.6					

Key to abbreviations: DBS= Day before spray, DAS= Days after sprays, DBM= Diamondback moth

Means followed by the same letters in column are not significantly different at P≤ 5% level of significance (DMR test)

4.7.5 Efficacy of Insecticides Spray against Hairy caterpillar in Eggplant

One day after application of insecticides, it was observed that all the treatments were found significantly superior to untreated control in reducing hairy caterpillar, however, significant difference existed among them (Table 4.5). The maximum reduction of (0.607 caterpillar per plant) 59 per cent was recorded in the treatment of Cypermethrin10% + Chlorpyrifos 35% (Duduba 450EC) followed by Lambdacyhalothrin 50 g/l (Ninja 5EC) which resulted in (0.73 caterpillar per plant) 47 per cent reduction, however, both treatments were at par with each other in their efficacy and significantly superior to rest of the treatments. The minimum reduction per cent was recorded in the treatment of Imidacloprid 200g/l (Septer 200SC) which resulted in (0.93 caterpillar per plant) 44 per cent reduction; while in control maximum population (1.53 caterpillars per plant) was recorded on the check plot.

After three days of spray maximum reduction in caterpillar population was found in Imidacloprid 200 g/l (Septer 200SC) 0.467 caterpillar per plant 74 percent which was at par with Cypermethrin10% + Chlorpyrifos 35% (Duduba 450EC) 0.467 caterpillar per plant 73 per cent. The next effective treatment was Lambdacyhalothrin 50 g/l (Ninja 5EC) with 0.53 caterpillars per plant 65 per cent reduction, while in control maximum population (1.66 caterpillars per plant) was recorded on the check plot.

After five days of spray, Cypermethrin10% + Chlorpyrifos 35% (Duduba 450EC) proved to be the most effective treatment with 0.267 caterpillars per plant 86 per cent reduction in caterpillar population followed by Iimidacloprid 200 g/l (Septer 200SC) with 0.33 caterpillar per plant 84 per cent reduction and minimum reduction of (0.4 caterpillar per plant) 76 per cent was noticed in Lambdacyhalothrin 50 g/l (Ninja 5EC), all these stood at par with each other in their efficacy.

The maximum reduction of (0.13 caterpillar per plant) 93per cent was recorded in the treatment of Cypermethrin10% + Chlorpyrifos 35% (Duduba 450EC) even after seven days of spray followed by Imidacloprid 200 g/l (Septer 200SC) 0.27 caterpillar per plant 87per cent and minimum reduction per cent was recorded in the treatment of Lambdacyhalothrin 50 g/l Ninja 5EC which resulted in 0.33 caterpillar per plant 80 per cent reduction, check plot, these were statistically at par with each other. While in control maximum population 1.8 caterpillars per plant was recorded on the check plot.

Figure 4.3: Different species of hairy catepillar on eggplant

Table 4.5: Mean number of hairy caterpillar per plant and percent mortality after first spray at various intervals on Eggplant

	Average no. of caterpillar larvae per plant						% reduction caterpillar population				
Treatment	**Dose (l/ha)**	**DBS**	**1DAS**	**3 DAS**	**5 DAS**	**7 DAS**	**1 DAS**	**3 DAS**	**5 DAS**	**7 DAS**	**MEAN**
Duduba 450EC	1	1.47a	0.67a	0.47a	0.27a	0.13a	59	73	86	93	78
Septer 200SC	0.3	1.53a	0.93ab	0.47a	0.33a	0.27a	44	74	84	87	72
Ninja 5EC	0.3	1.27a	0.73a	0.53a	0.40a	0.33a	47	65	76	80	67
Control		1.4a	1.53b	1.67b	1.87b	1.80b	-	-	-	-	
P-value		0.823	0.049	0.002	0.003	0.003					
SE(±)		0.207	0.180	0.189	0.199	0.196					
CV %		21.6	18.2	19.5	20.1	18.2					

Key to abbreviations: DBS= Day before spray, DAS= Days after sprays

Means followed by the same letters in a column are not significantly different at P≤ 5% level of significance (DMR test)

In the present study, all the treatments showed significant increase of yield. Highest marketable leaves yield was recorded in Cypermethrin10% + Chlorpyrifos 35% (Duduba 450EC) treated plot (8.6 t/ha) closely followed by Imidacloprid 200 g/l (Septer 200SC) (6.7 t/ ha). In case of Lambdacyhalothrin 50 g/l (Ninja 5EC) treated plot, the yield was comparatively lower (4.6 t/ha), whereas in control plot, the yield was severely low (2.5 t/ha) in Chinese cabbage crop (Table 4.6).

Table 4.6: Yield of marketable leaves cabbage at harvest

Treatment	Dosage (L/ha)	Yield(Kg/plot)	Yield (T/ha)
Duduba 450EC	1	7.9a	8.6
Septer 200SC	0.3	6.3b	6.7
Ninja 5 EC	0.3	4.2c	4.6
Control	-	2.3d	2.5
Grand mean		5.2	5.6
P-value		<.001	
SE(±)		0.236	
CV		6.5	

Means followed by the same letter in a column are not significantly different at 5% level of probability (Duncan's Multiple Range Test).

In case of eggplant yield, the present study revealed that all the treatments were superior including untreated control. The highest yield in eggplant was obtained from Imidacloprid (Septer 200SC) 200 g/l (6.7 t/ha). This was followed by Lambdacyhalothrin 50 g/l (Ninja 5EC) treated plot effecting the yield of (5.9 t/ha). In case of untreated plot, the yield was comparatively lower (5.2 t/ha) than Cypermethrin10% + Chlorpyrifos 35% (Duduba 450EC) treated plot (5.7 t/ha) (Table 4.7).

Table 4.7: Yield of eggplant fruits at harvest

Treatment	Dosage (L/ha)	Yield(Kg/plot)	Yield (T/ha)
Duduba 450EC	1	12.3a	5.6
Septer 200SC	0.3	14.4a	6.7
Ninja 5 EC	0.3	12.7a	5.9
Control	-	11.3a	5.2
Grand mean		12.65	5.85
P-value		0.583	
SE(±)		1.1	
CV		19.9	

Means followed by the same letter in a column are not significantly different at 5% level of probability (Duncan's Multiple Range Test).

4.7.6 Cost economics

Cost economics of different chemicals revealed that Imidacloprid 200 g/L and Lambdacyhalothrin 50 g/l gave net profit of Tshs 232 000 and 72 000, respectively (Table 4.8). The lowest net profit was obtained from Cypermethrin 10% + Chlorpyrifos 35% which recorded only Tshs 10 000. The results on benefit cost benefit ratio revealed that highest cost benefit (CB) ratio was obtained from Imidacloprid 200 g/l treatment which recorded 3:4. This was followed by Lambdacyhalothrin 50 g/l which recorded CB ratio of 1:1. The lowest CB ratio of 0:1 was recorded in Cypermethrin 10% + Chlorpyrifos 35% treatment in eggplant crop.

Cost economics of different chemicals revealed that Cypermethrin 10% + Chlorpyrifos 35% and Imidacloprid 200 g/l and gave net profit of Tshs 1 315 000 and 846 000, respectively (Table 3.8). The lowest net profit was obtained from Lambdacyhalothrin 50 g/l which recorded only Tshs. 321 000. The results on benefit cost ratio revealed that highest benefit cost ratio was obtained from Cypermethrin 10% + Chlorpyrifos 35%treatment which recorded 6:3. This was followed by Imidacloprid 200 g/l which recorded CB ratio of 4:1. The lowest CB ratio of 1: 6 was recorded in Lambdacyhalothrin 50 g/l treatment in Chine cabbage crop.

Table 4.8: Cost economics as influenced by different treatments – Eggplant

Treatment	Dosage (L/ha)	Yield (Kg/ha)	Increased in yield over control (Kg/ha)	Value of increased yield (Tshs/ha)	Cost of treatment (Tshs/ha)	Benefit due to treatment (Tshs/ha)	C:B ratio
Duduba 450EC	1	5600	400	80 000	70 000	10 000	1:0.1
Septer 200 SC	0.3	6700	1500	300 000	68 000	232 000	1:3.4
Ninja 5EC	0.3	5900	700	140 000	68 000	72 000	1:1.1
Control	-	5200		-	-	-	-

Price of green leaves per kg during season was 200Tshs.

Table 4.9: Cost economics as influenced by different treatments - Chinese cabbage

Treatment	Dosage (L/ha)	Yield (Kg/ha)	Increased in yield over control (Kg/ha)	Value of increased yield (Tshs/ha)	Cost of treatment (Tshs/ha)	Benefit due to treatment (Tshs/ha)	C:B ratio
Duduba 450EC	1	8600	6100	1 525 000	210 000	1315 000	1:6.3
Septer 200 SC	0.3	6700	4200	1 050 000	204 000	846 000	1:4.1
Ninja 5EC	0.3	4600	2100	525 000	204 000	321 000	1:1.6
Control	-	2500	-	-	-	-	-

Price of fruits per kg during season was 250Tsh

4.8 Discussion

In Tanzania, according to our results, there is a great diversity of vegetable grown in the Kinondoni district, making it possible to establish beneficial crop rotation systems against pests. Chinese cabbage, spinach, Amaranths, eggplant and okra were the most significant plants species according to the area occupied on the farms and the proportion of farmer who cultivate them throughout the country. Their reason for exclusively growing vegetables is early maturing, the demand is high and there is a quick return on investment.

The major constraint of vegetables production revealed by most farmers is the attacks of insect pests. This result is similar to those of the surveys on vegetable production sites carried out by Avicor *et al.* (2011) in Ghana and Mondédji *et al.* (2014) in Togo. For Chinese cabbage production in particular, in spite of the great dependence of farmers to chemical control, it was revealed that the major pest *P. xylostella* continues to cause serious damage. Indeed, the excessive use of synthetic insecticides on Chinese cabbage by farmers, would involve a rapid reduction of the susceptibility of in the targeted insects to the compound used against them, because of the development of resistance mechanisms of insecticide. It is well known that when a population of insects is continuously exposed to one type insecticide, its sensitivity that partcular molecules decreases, because of the selection of resistant individuals (Shono and Scott, 2003). It is the case of *P. xylostella* which is largely known for its great capacity to develop resistance to several classes of insecticides (Tsukahara *et al.,* 2003; Nakasuji *et al.,* 2006). Most of pesticides used by farmers were synthetic insecticides, confirming their efforts to fight against insect pests which represent the major constraint of vegetable crops. The insecticides used belong to various classes of which the most significant are organophosphates and synthetic pyrethroids. The class of pyrethroids was also identified in west Africa, precisely in Ghana like the most insecticide class used by farmers (Obeng-Ofori and Ankrah, 2002). Insecticides belonging to the class of organ chlorines are still being used on vegetable crops by the farmers, although they are obsolete. These are probably from old and not destroyed stocks which continue to circulate illegally in the country.

Moreover, the majority of pesticides used by farmer are highly or moderately hazardous according to the WHO Hazard Class. PAN UK, (2007) and Coulibaly *et al.* (2008) reported that farmers' crop protection practices are based on the intensive use of hazardous pesticides throughout most of vegetable farms in West Africa especially in Togo would constitute a factor worsening not only the farmers and consumers intoxication but also the environmental pollution.

The effectiveness of a particular insecticide varies greatly from one field to another depending on previous insecticide use, pestiferous insect's species and level of tolerance to insecticide classes (Mulrooney and Elmore, 2000). The decision to control key insect pest on eggplant and Chinese cabbage in current study was greatly influenced by damage thresholds, type of insect pest and type of insecticide used. Chlorpyrifos 10% + Cypermethrin 35% EC gave best results for the control of diamondback moth in Chinese cabbage because it contained cypermethrin which is a contact insecticide with the immediate knock down effect and chlorpyrifos which is a systemic insecticide. The combination of two insecticides increased potency to control insect pests. Imidacloprid 200 g/l and lambda cyhalothrin 50 g/l gave good results for the control of hairy caterpillar in eggplant and diamondback moth in Chinese cabbage. This could be due to their high knock down effect that kills natural enemies which would have otherwise preyed on caterpillars and diamondback moth and consequently reducing the populations.

Control of all major insect pests in the first spray gave similar results at threshold because insect pest population was not that much high to warrant significant difference at ($p \leq 0.05$), after chemical application however the unsprayed check had more of the damaged leaves and insect pests because spraying onto the rest of all other plots killed most of the insect pests. The results from this study shown that the insecticides deployed were active and/or combinations dependent effect on *P. xylostella and* hairy caterpillar's abundance. This is buttressed by the synergistic effect of Chlorpyrifos 10% + Cypermethrin 35% EC which is both systemic and contact translocated poison through the plant sap, the translocation delayed its degradation under field conditions, this account for its high efficacy in controlling larva of diamond back moth and hairy caterpillars (Adebayo *et al*., 2007), which is an advantage over Imidacloprid 200 g/l where is systemic only mode of action and Lambdacyhalothrin 50 g/l contact only mode of action.

However, there are several factors which affect insecticides efficacy on leaf surface, the most important being, foliage growth, physicochemical properties of the chemicals, types and concentration of the additives, type of applicators, knowledge of person responsible for spraying, water for mixing the insecticides and environmental condition during and after application (Wang and Liu, 2007).

Foliage structure might also have affected the efficacy of insecticides. Foliage growth not only dilute non-systematic insecticides deposits on the leaf surface but also results in some insecticides free leaves playing refuges to pests which could also decrease the mean efficacy of the insecticides. Rainfall, temperature and sunlight intensity have also been reported to cause insecticides degradation under field conditions, but given the fact that all insecticides were applied under same condition, the effects of weather parameters was assumed to be uniform (Liu *et al.*, 2003).

The effect of spraying insecticides was accounted on abilities to suppress pests and allow realization of expected yield. In the current study, the reduction in Chinese cabbage and eggplant yield was mostly related to diamondback moth and hairy caterpillar infestation and economic yield would be almost impossible to achieve without the chemical control. Chlorpyriphos 10% + Cypermethrin 35% EC and Imidacloprid resulted into higher marketable Chinese cabbage leaves and when compared to Lambdacyhalothrin 50 g/l. The population of *P. xylostella* increased greatly during the vegetative stage (Ahmad and Ansari, 2010, Kahuthia-Gathu, 2013, Sow *et al.,* 2013) and caused substantial damage on marketable leaves therefore at this stage control measures become necessary. In the present study, three different insecticides were applied to check the population of *P.xylostella* on Chinese cabbage and hairy caterpillar on eggplant. These results cannot be compared in absolute terms to any of the studies conducted so far as none of them used this combination of insecticides. However, these findings are in general agreement with those of (Rahimgul and Sasya, 2016; Dotasara *et al*. 2017; Boopathi *et al*., 2013; Lal and Meena, 2001; Rao and Lal, 2001) because they also reported that the application of insecticides reduced the larval population of *P. xylostella* and hairy caterpillar to a considerable extent and hence increased the yield. Moreover, the studies of Boopathi *et al*. (2013) are in close conformity with the results of present study that Cypermethrin10% + Chlorpyrifos 35%, was the most effective insecticide. In past, the best insecticide was reported to be the cypermethrin (Khan *et al.*, 1993) and endosulfan (Rizvi *et al.*, 1986), but in the present study chlorpyrifos 10% EC + cypermethrin 35% EC, proved to be the best insecticide. Control of this pest was not adequate now probably due in part to the development of insecticide resistance because of frequent use of insecticides. Phokela *et al*. (1990) observed a tendency of increased resistance to cypermethrin in the population of *P. xylostella.* Moderate to high levels of resistance to cypermethrin and moderate resistance to endosulfan were recorded in field populations of *P. xylostella in* Pakistan (Ahmad *et al*., 1995). Chlorpyrifos was proved to be the best insecticide against the insect pests. However, other insecticides may also remain fully effective against *P. xylostella* if used according to manufacturers' recommendations (Sharma and Chawla, 1992) and insecticides should be applied aimed at preserving insecticide efficacy for future control of this and other pests.

The insecticide, Duduba 450EC (Chlorpyrifos 10% + Cypermethrin 35% EC) has been registered mainly for controlling bollworm, thrips, shoot and fruit borer, beetle in various agriculture crops like cotton, okra, eggplant etc (Anonymous, 2015). It has no phytotoxic effect if used as recommended dose. It acts as strong contact, stomach and respiratory action (Rahman *et al*., 2015).

Only cypermethrin 10 EC at 1 ml/l of water sprayed after observing 5% level of plants infestation can control caterpillar effectively and economically (Rahman *et al*., 2014) because of cypermethrin is a pyrethroids group of insecticide and it acts as a sodium channel modulators in the nervous system of the insect. The combination of (Chlorpyriphos 10% + Cypermethrin 35% EC), being the most effective and economically viable insecticide to manage caterpillars in eggplant crop (Sharma *et al.*, 2012). Imidacloprid was the second effective in controlling the caterpillars but higher in yield (Jat and Pareek, 2001) this might be contributed to the other agronomical factors although all factors were kept constant. Several researchers reported the best performance of Cypermethrin in producing highest yield of eggplant (Dutton *et al.,* 2003). So, in our study (Chlorpyrifos 10% + Cypermethrin35% EC) supports the previous results. It is noticeable that, due to used of synthetic pyrethroids for the control of eggplant Caterpillars, leading to whitefly, aphid and mite resurgence (Srinivasan, 2009). Imidacloprid is one of a group of insecticides called neonicotinoids, which work by interfering with an insects' nervous system. It acts as an agonist of the acetylcholine receptor and is known to have a very selective toxicity, which is attributable mostly to its higher affinity for the insect than for the vertebrate nicotinic acetylcholine receptor (Liu and Casida, 1993). Imidacloprid is extremely effective against various sucking and mining pests including Apple maggot, Second generation codling moth, Oriental fruit moth, First generation spotted tentiform leaf miner, Leafhoppers, Aphids, Japanese beetle, Mullein bug, Second and third generation spotted tentiform leaf miner and so on (Liburd *et al.,* 2003). Exposure to this compound can be through contact or ingestion. Its excellent systemic properties and lasting action make it suitable for foliar treatments (Pfliiger and Schmuck, 1991). In this experiment we found that this insecticide is very much effective against lepidopteran insect mainly in Eggplant. Lambdacyhalothrin 50 g/l also this insecticide is effective against various sucking and mining insect pests. Insect exposure to this compound can be through contact. It is excellent knock down properties and lasting action makes it suitable for foliar application.

The number of hairy caterpillar varied from 1.27 to 1.53 per plant before application of insecticides. The variation among the treatments was not significant, but after each spray significant reduction of hairy caterpillar was noted (Table 3.7), it is evident that all the insecticides were capable of keeping the population of hairy caterpillars at the minimum level and significant differences were noted among the treatments after different days of observation and spraying. The overall mean percent reduction of hairy caterpillar over control was noted in (Cypermethrin10% + Chlorpyrifos 35% EC (78.0%) and Imidacloprid 200g/l (72.0%) treated plots. These results were similar to the findings by (Mandal *et al.,* 2013) reported that all the insecticides were capable of keeping the population of caterpillars at the minimum level and significant differences were noted among the treatments after different days of observation and spraying. These findings also are similar with current findings. Muthusamy *et al.* (2011) studied the effectiveness of different insecticides against the bihar hairy caterpillar and they found that imidacloprid was less toxic to hairy caterpillar the results is contrary with this study.

It was noticed that the net returns obtained from different treatments in eggplant ranged from Tshs. 232 000 to Tshs.10 000 per hectare. Imidacloprid 200 g/l and Lambdacyhalothrin 50 g/l, recorded higher net profit of Tshs. 232 000 and Tshs. 72 000 respectively. Cypermethrin 10% + Chlorpyrifos 35% treatment recorded low net returns of Tshs.10 000. The highest cost benefit ratio was obtained from Imidacloprid 200 g/l (3.4) treatment. This was followed by Lambdacyhalothrin 50 g/l which recorded BC ratios of 1. Higher CB ratios were recorded in the present study is due to higher yield of eggplant fruits (6.7 t/ha). Imidacloprid 200 g/l effectively suppressed pest which resulted in increased yield and net returns. The Lambda cyhalothrin 50 g/l emerged as best insecticide against the targeted pest as other chemicals due to its high knock down mode of action. It was noticed that the net returns obtained from different treatments in Chinese cabbage ranged from Tshs. 1 315 000 to Tshs 321 000 per hectare. Cypermethrin 10% + Chlorpyrifos 35% and Imidacloprid 200 g/l recorded higher net profit of Tshs. 1 315 000 and Tshs. 846 000 respectively. Lambdacyhalothrin 50 g/l treatment recorded low net returns of Tshs.321 000. The highest cost benefit ratio was obtained from Cypermethrin 10% + Chlorpyrifos 35% (6.3) treatment. This was followed by Imidacloprid 200 g/l which recorded BC ratios of 4.1 Higher CB ratios were recorded in the present study is due to higher yield of Chinese cabbage marketable leaves (8.6 t/ha). Cypermethrin 10% + Chlorpyrifos 35% effectively suppressed pest which resulted in increased yield and net returns.

4.9 Conclusion

In this study, amongst the three potential insecticides, Duduba 450 EC (Cypermethrin10% + Chlorpyrifos 35%) and Septer 200SC (Imidacloprid 200 g/l) perform better than other insecticide for controlling Diamondback moth and Hairy caterpillars effectively. Duduba 450 EC and Septer 200SC may be used for controlling Diamondback moth and Hairy caterpillars as per recommended dose. It might be a suggestion to the farmers not to use insecticide indiscriminately but also used as a rational manner to get better yield as well to keep the environment sound from toxic materials.

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CHAPTER FIVE

5.0 GENERAL CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Based on the findings from the present study, it is concluded that there are malpractices in pesticide use on vegetable farming in Kinondoni district. Majority of the respondents were unaware of risks associated with the pesticide exposure transportation, handling, application and storage. Recommended practices on safe handling, uses, storage of pesticides and the application equipments are not adhered to. Protective clothing is far from consideration by farmers. Duduba 450EC was established as the best insecticide in controlling Diamondback moth while Imidacloprid 200 g/l was the best option against Hairy catteplillars on eggplants.

5.2 Recommendations

In view of the major findings and the above conclusions, the following recommendations are made:

i. Awareness programme are essential to educate farmers on appropriate and safe use of pesticides enabling them control and prevent pesticides associated ailments. This should be done by agricultural extension services through farmer field school, field campaign, mobile extension program, method demonstrations, and displaying cut-outs, banners and posters on ill effects of pesticides in the urban areas for promoting famers for safe use of pesticides.

ii. Insecticides with limited residual effect like Cypermethrin10% + Chlorpyrifos 35% and Imidacloprid 200 g/l may be useful in devising proper integrated pest management strategy against diamondback moth and hairy caterpillar.

iii. The IPM package on management of the most prevalent pests: diamondback moth (*Plutella xylostella*) and hairy caterpillar is required to reduce vegetable yield losses and irrational use of pesticides.

iv. Studies on effect of frequent used insecticides in Kinondoni district to the environment should be carried out.

APPENDICES

Appendix 1: Questionnaire Administered to Urban Farmers

Household survey

SECTION 1; IDENTIFICATION PARTICULARS

<table>
<tr><td colspan="2">DISTRICT;</td><td>VILLAGE/STREET:</td></tr>
<tr><td colspan="2">DIVISION:</td><td>NAME OF HHH:</td></tr>
<tr><td colspan="2">WARD:</td><td></td></tr>
<tr><td colspan="3">MARITAL STATUS: I. Married, 2.Never married, 3.Single, 4.Divorced, 5. Separate,

6. Widow, 7.Widow</td></tr>
<tr><td>SEX</td><td colspan="2">1. Male…….. 2. Female……………</td></tr>
<tr><td>NAME OF RESPONDENT</td><td colspan="2"></td></tr>
<tr><td>RESPONDENT/HH

PHONE NUMBER</td><td colspan="2"></td></tr>
</table>

1: NAME OF INTERVIEWER;…………………………Phone No……….……….……

2: DATE OF INTERVIEW…...

SECTION 2: HOUSEHOLD DEMOGRAPHICS

3. Household size…………………………………………..

4. Record information of each respondent in the following table.

Name	Sex:1=m,2=f	Age (in complete years)	Relationship with the HH (1=Head,2=Spouse, 3=Son/ Daughter, 4=Grandchild, 5=Servant, 6=0thers-specify)	Highest grade of school (o=None, 1=primary ed, 2=secondary ed, 3=tertiary ed. 4=others (specify)	Main occupation of the HH member 0=child not schooling 1=student/pupil 2=housewife / HH Chores 3=civil servant 4=private sector employee 5=integrated farming 6=business 7=casual labour 8=others (specify)

SECTION 3A: URBAN AGRICULTURE

5. Types of farming activities that household head is involved in (Tick what is appropriate)

(i) Livestock keeping [ ], (ii) Crop production [ ] (iii) Both crop and livestock production [ ], (iv) Shop/ kiosk selling agriculture products [ ], (v) Fish farming [ ], (vi) Others (specify)

SECTION 3B: INFORMATION ON URBAN FARMING

6. What is the purpose of your farming activities?

1. Subsistence [ ] 2. Commercial [ ] 3. Both 1and2 [ ]

What type of crop do you grow?

Crops	Farm Size(ha)	Distance from Residence(km)	Nature of land tenureStructure:1=private 2=Lease3=Gifted land4=Bought	Yield per farm size for the last season (2015)
1=				
2=				
3=				
4=				
5=				
6=				
7=				

7. Do you grow horticultural crops? 1=Yes 2=No

8. What type of horticultural crops do you grow?

What type of crop do you grow?

Crops	Farm Size(ha)	Distance from Residence(km)	Nature of land tenure Structure:1=private2 Lease 3=Gifted land 4=Bought	Yield per farm size for the last season (2015)
1=				
2=				
3=				
4=				
5=				
6=				
7=				

9. What type of vegetable do you grow?

Crops	Farm Size(ha)	Distance from Residence(km)	Nature of land tenureStructure:1=private 2=Lease3=Gifted land4=Bought	Yield per farm size for the last season (2015)
1=				
2=				
3=				
4=				
5=				
6=				
7=				

10. What type of agricultural input do you use in your farming activities?

Type of input	Source. I) local shops ii)shops outside	Price per unit	Quantity purchased last season
Fertilizer (Inorganic)			
Fertilizer (Organic)			
Seeds			
Pesticides			
All of the above			

11. What are the major pests and disease problems do you encounter in vegetable production?

Type of pest/ disease	Crop affected	Damage Signs and symptoms	Plant part affected
1			
2			
3			
4			
5			

12. How do you manage the pest and disease problem?

Pests Disease problem	Management options	Effectiveness	Costs of the management option per acre

13. Do you use pesticide to manage pest problems on your crop? YES/NO

14. What pesticide types do you commonly use?

Type of pesticide	Target pests (mention)	Effectiveness	Remarks
Insecticides			
Fungicides			
Herbicides			
Bactericides			
Nematicides			

15. Where do you buy your pesticide from?

Type of pesticide	Nearby Agro shop	Cooperative/Saccos	City- based agro shops
Insecticides			
Fungicides			
Herbicides			
Bactericides			
Nematicides			

16. Where do you acquire knowledge on the pesticide use?

i) Extension officer ii) Agro-shop dealers iii) Self-acquired skills

iv) Neighbour v) other (mention)

17. Which of the following protective after using it to applying insecticides?

i) Hand gloves ii) Overall iii) glasses

iv) Face mask/nose mask v) others (mention)

18. Where do you wash your sprayers after using if to apply insecticides?

i) At field margin using bucket water ii) in the nearby pond/river

iii) At the public tap water point iv) others (mention)

19. Where do you keep your pesticides?

i) In food store at home ii) in the bedroom/living room iii) In animal shade iv) In the kitchen iv) others (mention)

20. How do you dispose off the remained pesticides after use and the containers?

i) Throw in pits iii) To garbage collection point iii) To the flowing river iv) In tight collection containers v) others (mention)

21. What are the challenges in accessing inputs? ....

22. Do you receive any support from the government? (I)YES [ ] (II) No [ ]

23. If yes, in what form……………………….…………………………………………

24. Is the support you received from the government sufficient?

25. What challenges do you face in relation to urban farming?

(i)Lack of manpower [ ], (ii) Lack of capital [ ] iii) Transport [ ] iv). Shortage of land [ ] (v).Weather condition [ ] (vi). Disease [ ], (vii) By-laws and regulations (viii) Other (specify)……………………….

26. How do you cope with these challenges? ....

Thank you for your participation

Appendix 2: List of Vegetables Grown in Kinondoni

English Name	**Scientific Name**
A. Leafy Vegetables	
Amaranth	*Amaranthus gangeticus*
Chinese Cabbage	*Brassica chinensis*
Spinach	*Spinacia oleracea*
Ethiopian mustard	*Brassica carinata*
African Night Shade	*Solanum scabrum*
Sweet potato leaves	*Ipomea batatas*
Pumpkin Leaves	*Curcubita moschata*
Cowpea Leaves	*Vigna unguiculata*
Cassava leaves	*Manihot esculenta*
B. Fruit Vegetable	
Okra	*Abelmoschus esculentus*
Chilli	*Capsicum annuum*
Egg Plant	*Solanum melongena*
Tomato	*Lycopersicon esculentum*
C. Bulb Vegetable	
Onions	*Allium cepa*

Appendix 3: Checklist for Focus Group Discussion

1. Do you understand UA……………………………………………………………….
2. What is the main source of vegetable in this area………………………………..
3. What are your experiences as a vegetable farmer at this site and what are some of the challenges?
4. Do you have problems with pests?
5. Can you identify the various pests that you destroy your crops?
6. How do you control the pests?
7. At what time during the production cycle do you start controlling pests?
8. Has there been any training on the management of insects' pests in the area?
9. Are you aware of different ways of controlling pests apart from spraying with pesticides?
10. Are you prepared to switch from the use of chemicals to other sustainable strategies?
11. What can be done by government, NGOs and researchers to help you reduce your dependence on chemicals to control pest?
12. What is the main problem associated with poor management of pests problems?
13. From your experience with this district who usually manage pests problem (Men/Women)?
14. Are there any factors which hinder gendered participation in the management of pests problems?(yes/no) please mention
15. Is gender important in the management of pests problem
16. What do you think are there benefits in the management of pests' problem when men and women participate?
17. Is there any extra information you would like to share?