ASSESSMENT OF CONSUMERS' KNOWLEDGE ON THE SAFETY OF VEGETABLES PRODUCED IN MOROGORO URBAN USING LOW QUALITY WATER

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL EDUCATION AND EXTENSION OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

This study sought to assess the knowledge of consumers on the safety of vegetables produced in Morogoro Urban using Low Quality Water (LQW). The study determined how the knowledge of consumers influenced the perception and preference of various types of vegetables irrigated with LQW. A cross sectional study design was adopted and the 130 respondents were selected using simple random and purposive sampling techniques. Data collection was done using an interview schedule, focus group discussions and direct observation. Simple descriptive statistics, cross tabulations and chi-square test were used to analyse data. The study results indicated that, the vegetable consumers had knowledge that some vegetables in urban Morogoro were irrigated with LQW, but some of them were not sure if the vegetables they consumed were irrigated with LQW. Knowledge had a significant influence on the perception of consumers as it was revealed in this study that, consumers with knowledge that the vegetables were irrigated with LQW washed thoroughly and cooked the vegetables to maintain its safety. The study also found that five types of vegetables; Chinese cabbage, Amaranths, Pumpkin leaves, Sweet potato leaves and Okra were frequently bought and an average of 0.6kg was consumed at household per day. Sweet potato leaves were found to be the most preferred vegetables by respondents among the five types; consumers recognized it's nutritious regardless of the kind of water used for irrigation. The study concluded that knowledge about the safety of vegetables had influence to the preference and perception of consumers. Based on the findings from this study, it is recommended that Morogoro Municipal Council through Morogoro Rural and Urban Water Supply Authority should set strategies of treating LQW frequently and the community should be assured on its safety before is allowed to use it. The community health officers should provide sanitary education to vegetable vendors and consumers. Also, extension agents should provide education to farmers on improved methods of irrigation.

DECLARATION

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

_____ _____

Shukrani Mdegela Date

(MSc Candidate)

The declaration is confirmed

_____ _____

Prof. M.R.S. Mlozi Date

(Supervisor)

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LIST OF ABREVIATIONS

FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
IWMI	International Water Management Institute
KI	Key Informants
LQW	Low Quality Water
MMC	Morogoro Municipal Council
MORUWASA	Morogoro Rural and Urban Water Supply Authority
SAWAFO	Safe Water for Food
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Science
Tshs	Tanzanian Shillings
UA	Urban Agriculture
UK	United Kingdom
UNDP	United Nations Development Programme
URT	United Republic of Tanzania
USA	United States of America
WHO	World Health Organization
IGAs	Income Generating Activities

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The use of urban low quality water for agricultural irrigation is a growing practice worldwide especially in low-income countries where it is popularly used for vegetable cultivation (WHO, 2012). Many of the 200 million farmers specialized in market gardening depend on irrigation (UNDP, 1996). Urban agriculture is a widespread reality due to the rate of urbanization in developing countries, and it is also as old as the cities themselves. The rate of urban growth comes with the associated challenges especially the demand for food and employment (Cofie and Drechsel, 2006). The use of wastewater in agriculture started in the 19th century when cities in Europe and North America introduced the water carriage system for domestic wastewater (Ensink *et al*., 2004a). Large sewage farms, as they were called, were established in the United Kingdom (UK), United States of America (USA), France, China and Germany, followed by India, Australia and Mexico (Mara and Cairncross, 1989). The main purpose of establishing these farms was to prevent the contamination of rivers and to improve soil fertility (Mara and Cairncross, 1989). Most of these sewage farms were abandoned at the beginning of the 20th century for a number of reasons, notably the need for more land for expanding cities, increased awareness of the adverse human health impacts, the introduction of chemical fertilizers and development of wastewater treatment technologies (Ensink *et al*., 2004a).

According to the World Health Organization (WHO) (2006), Low Quality Water (LQW) refers to the liquid waste with mainly human excreta and used water discharged from homes and commercial premises. FAO (1992) defined Low Quality Water as water that

possesses certain characteristics which have the potential to cause problems when it is used for unintended purpose. In developing countries the urban farmers rely on raw or diluted low quality water when the good quality sources are unavailable. In many regions, as fresh water sources become scarce; the use of low quality water has become an attractive option for conserving and expanding the available water supplies. Urban low quality water comprises of domestic effluent that consists of black water (excreta, urine, and associated sludge), grey water (kitchen, bathroom wastewater) and effluent from commercial establishments and institutions, including hospitals, industrial effluent where present, storm water and other urban run-off. In principle, low quality water can be used for all purposes for which freshwater is used. If given appropriate treatment such water could be used for irrigation, aquaculture, urban and industrial uses, recreational and environmental use (WHO, 2006a). Low quality water that is used for agricultural irrigation covers the low quality water of different qualities, ranging from raw to diluted, generated by various urban activities (Raschid-Sally and Jayakody, 2008).

In many parts of the world, freshwater is already scarce and the value of freshwater will further increase in regions which experience water scarcity and high population growth (Pereira *et al*., 2002; WHO, 2006a, b, c). The growing water scarcity is a result of increasing multi-sectoral demands of the rapidly growing population (URT, 2002a; WHO, 2006b). In terms of utilization, agriculture is the single largest user of freshwater in the world, accounting for nearly 70% of all extractions worldwide (FAO, 2002; Pereira *et al*., 2002). As freshwater becomes increasingly scarce due to population growth, urbanization and climate change, the use of wastewater is becoming more important (Ensink *et al*., 2004a; WHO, 2006b, d). Basically, Low Quality Water is an important source of water for many farmers in arid and semi-arid climates and sometimes it is the only water source available for agriculture especially during dry season (Buechler *et al*.,

2006; WHO, 2006a, b, c). LQW use for irrigation generates livelihoods for farmers, agricultural labourers, produce transporters, and produce vendors (Buechler *et al*., 2006; Rashid-Sally and Jayakod, 2008). More use of LQW occurs in urban and peri-urban agriculture because this is where large amount of wastewater are generated and the demand of food is high (WHO, 2006a).

During the past three decade or more Tanzania has witnessed the emergence of urban agriculture. If we exclude the Asian and Arabic Tanzanian communities as well as foreigners, about 80 percent of the Tanzania urban population is in one way or another engage in raising crops such as maize, beans, bananas and various types of vegetables (Mvena *et al.*, 1999). As a result, the urban LQW is maximally used.

In Tanzania, low quality water is used in a number of ways including agricultural activities. Low quality water is recognized as a resource, particularly in water-scarce areas because it is free or has only a low cost, its supply is reliable all year round and the produce are close to reliable urban markets. In addition, there are direct benefits to farmers who would otherwise have little or no water for irrigation, the use of Low Quality Water improves soil fertility and reduces water contamination downstream.

1.2 Problem Statement and Justification of the Study

Tanzania faces a water stress situation in some parts of the country, as water demands exceed the available resources thereby raising concerns on its use, quantity and quality (URT, 2008). Due to climate change and insufficient water supply system in urban and peri-urban areas, low quality water is the most reliable or affordable source of irrigation for vegetable growing. Vegetable growers who cannot afford to purchase supplemental fertilizer appreciate the nutrient content of low quality water (Mojid *et al.*, 2010).

Similarly, poverty also motivates many farmers to use any available water for irrigation, regardless of its quality.

Previous studies in Tanzania by Mlozi (1999); Mdegela *et al.* (2009); and Kilobe (2012) show the importance of utilizing domestic waste water in irrigating vegetables in urban and peri urban areas. This is also the case with Morogoro Urban, however, little is known about the knowledge of consumers on the safety of vegetables irrigated with low quality water in Morogoro urban areas. Studies on safe use of low quality water by Mlozi (1999); Mdegela *et al.* (2009); and Kilobe (2012) did not consider the level of understanding of consumers on the status of vegetables. Equally, the studies didn't indicate clearly if the consumers are aware on the source of water used for irrigation and their perceptions towards those vegetables.

Understanding consumers' knowledge on the status of the consumed vegetables grown using low quality water is an important aspect for informing policy makers. The findings of the study, therefore form a base for recommendations to policy makers on the safety of vegetables produced with LQW. The results of this study also help the extension agents and health officers to have a clear understanding of the knowledge level of vegetable growers, sellers and consumers about the safety of vegetables irrigated with LQW in Morogoro Urban.

1.3 Objectives of the Study

1.3.1 Main objective

The main objective of this study was to establish the safety status of vegetables produced in urban Morogoro using low quality water.

1.3.2 Specific objectives

The specific objectives of this study were to:

1. Determine the knowledge of consumers and other stake holders (farmers, transporter and vendors) about the safety of vegetables produced in Morogoro Urban using low quality water.
2. Assess consumers' preferences of vegetables produced in Morogoro Urban using low quality water.
3. Examine consumers' perceptions about the safety of vegetables produced in Morogoro Urban using low quality water.

1.4Hypotheses

1. Ho_1: There is no statistically significant difference in the knowledge of consumers and other stakeholders on the safety of vegetables produced in Morogoro Urban using low quality water.
2. Ho_2: There is no statistically significant difference on consumers' preferences of vegetables produced in Morogoro Urban using low quality water.
3. Ho_3: There is no statistically significant difference on consumers' perceptions about the safety of vegetables produced in Morogoro Urban using low quality water.

1.5 Theoretical Framework

This study adopted the causal theory of knowledge by Alvin Goldman (1967), which states that in order for knowledge to exist, one must have a belief about something true, and that belief must have a causal relation with the truth. The study also adopted the induced innovation theory of Hayami and Ruttan (1984) which states that the technological innovation and institutional change take place to economise on scarce

resources. This theory is based on the assumption that scarcity of resources and economic opportunities lead to search for new innovation. They argued that the search for new innovations is an economic activity that is significantly affected by economic conditions. Probably, this is the reason pushing people to cultivate vegetables using low quality water for economic gains.

1.6 Conceptual Framework

A conceptual framework Fig. 1, represents the study on knowledge of consumers about the safety of vegetables irrigated with low quality water. The conceptual framework is a narrative outline presentation of variables to be studied and the relationship between and among those variables. It is worth to note that consumers' knowledge about the safety of vegetables which is the dependent variable of this study was assumed to be influenced by a set of independent variables. The independent variables assumed in this study included source of water, source of vegetables, types of vegetables, season of growing vegetables and the site of selling vegetables. The independent variables for this study have been divided into three levels of vegetable farmers, vegetable vendors as well as vegetable consumers and in each level the intention was to find how the source of water, source of vegetables, the types of vegetables, the season of growing vegetables and the site of selling vegetables influenced the knowledge of consumers on the safety of vegetables irrigated with low quality water in Morogoro Urban area.

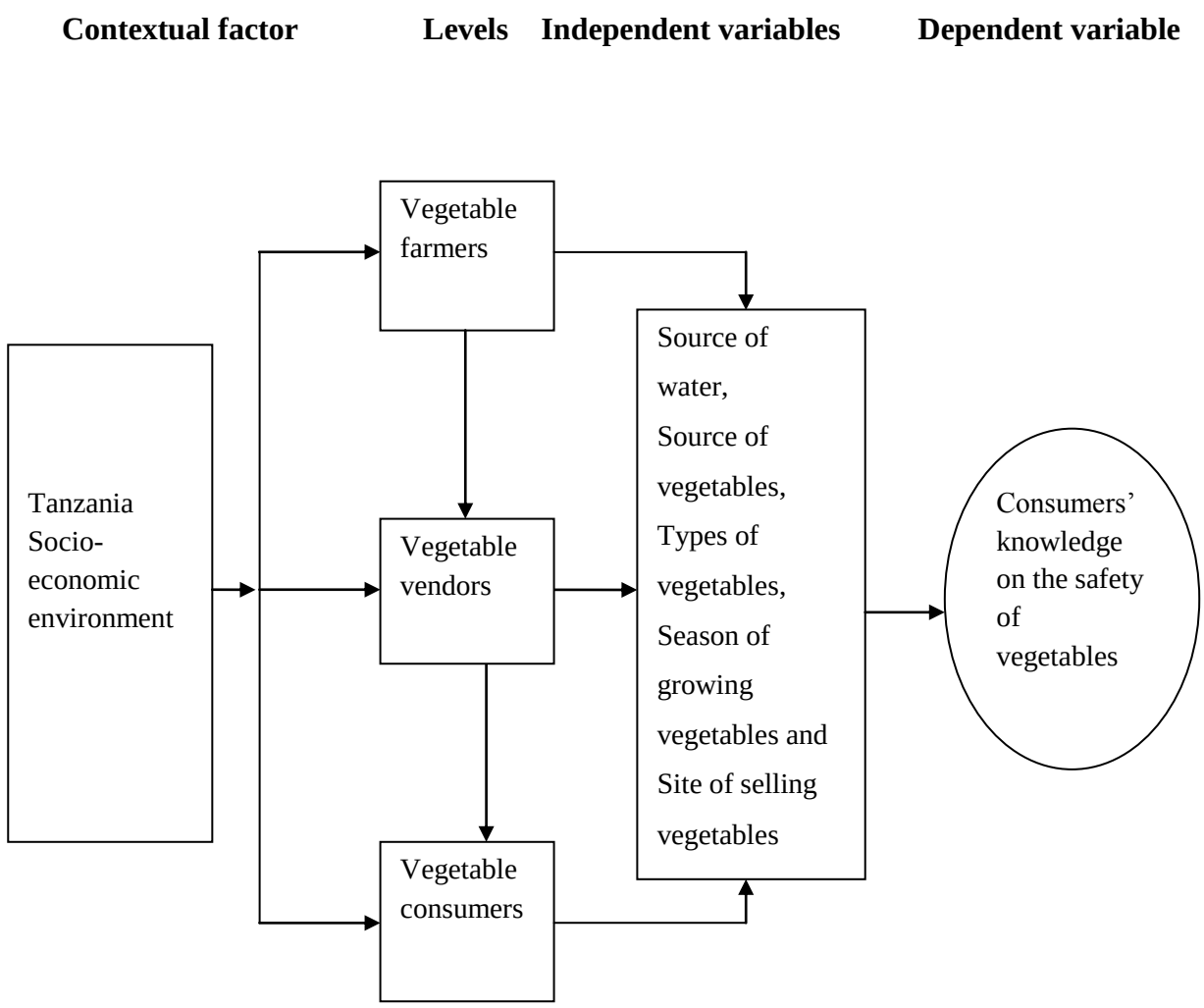

Figure 1: A conceptual Framework for Assessing Consumers' Knowledge on Safety of Vegetables Produced in Morogoro Urban Using Low Quality Water.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Consumers' Knowledge

Knowledge can be defined as the facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject that is all the facts that someone knows about a particular subject (Oxford Dictionaries visited on 6th May, 2013). Declarative knowledge helps consumers to be aware of things and processes thus consumers' knowledge on food safety have positive benefits such as; reduction in food borne diseases/illness, reduction in time spent in the house/hospital due to the illness, reduction in cost of treatment, and eventually preventing death due to food borne illness (Jatib, 2003).

2.2 Food Safety

Food safety is defined as the assurance that the food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use (FAO/WHO, 1997). A vegetable is said to be safe when it is free of chemical residues such as pesticides used in conventional vegetable production and the use of polluted water on vegetables which is known to cause contamination. Food safety information helps in quantifying consumers' response to food safety events, predicting market impacts and developing appropriate risk communication strategies. Also, for competitiveness, food safety and quality assurance is a key driver (Jatib, 2003).

2.3 Low Quality Water

Low Quality Water (LQW) refers to water whose quality might pose a threat to sustainable agriculture and/or human health, but which can be used safely for irrigation provided that certain precautions are taken. Low quality water use in agriculture is a

growing practices worldwide (WHO, 2012). Traditionally, most food is grown on rain fed lands, but as food demand rises, the soil moisture in arable land must be increasingly supplemented by irrigation systems using water drawn from the lakes, rivers, and underground aquifers. The use of low quality water in agriculture is gaining tremendous popularity because of the wide range of benefits that accompany it. These benefits include conservation of water, provision of reliable water supply and recycling of nutrients, thereby reducing the need for farmers to invest in chemical fertilizers (Mojid *et al.*, 2010).

2.4 Use of LQW for Irrigation

Freshwater is a finite and a vulnerable resource which its sustainability is threatened by human induced activities (URT, 2002a). The increase in population and concurrent growth of economic activities requiring water as an input such as in hydropower generation, irrigated agriculture, industries, domestic, livestock, fisheries and forestry activities have exerted pressure on this finite resource (URT, 2002b). Unreliable rainfall in some areas especially in arid and semi-arid areas, multiplicity of competing uses, degradation of sources and water catchments areas have threatened food security, energy production and water use conflicts between sectors of the economy (URT, 2002a;WHO, 2006b). It has been shown in the previous studies that in many parts of the world there is a gradual decline in availability of fresh water to be used for irrigation (Ensink *et al*., 2004a; Mapanda *et al*., 2005; Buechler *et al*., 2006 and Ensink and Van der Hoek, 2008). The use of urban wastewater in agriculture is seen by many as a vital component of integrated water management to overcome regional and global water scarcity (Scott *et al*., 2004). In places where wastewater is used for irrigation, community gains value from the crops produced and the improvement in livelihoods. Thus, use of wastewater and other industrial effluents for irrigating agricultural lands is on the rise particularly in peri-urban areas of developing countries (Rattan *et al*., 2005; WHO, 2006b). The study conducted by

Ensink *et al*. (2004b) indicated that untreated wastewater was used for irrigation in over 80% of all Pakistani communities. WHO (2006a) indicated that more than 10% of the world's population consumes various crops irrigated with wastewater.

Irrigation with wastewater occurs either formally or informally depending on the intervention of government or donor agency (Cornish and Kielen, 2004). Cornish *et al*. (1999) explained that formal irrigation occurs when farmers rely on some form of fixed irrigation infrastructure that is designed and operated by the government or a donor agency. Informal irrigation usually is practiced by individuals or groups of farmers without reliance on irrigation infrastructure that is planned, constructed or operated through intervention of a government or donor agency (Cornish *et al*., 1999).

2.5 Urban Agriculture

Tanzania is a low-income country in East Africa, and heavily dependent on agriculture. Urban agriculture (UA) provides urban dwellers with extra income, food and offers employment to family members and youths (Mlozi, 2005). It is one of the most important informal activities that urban dwellers in many towns and cities undertake. It involves raising crops and livestock but sometimes it may include agro-forestry. It is practiced both within the urban boundary and in its periphery. The majority of people involved in urban and peri urban agriculture are from different social economic status including urban poor (Mlozi, 1995). In this context, urban and peri-urban agriculture is viewed as an activity which involves growing, processing and distribution of food and other products through intensive plant cultivation and animal husbandry in and around cities (UNDP, 1996; Mlozi, 1999).The presence of vegetable production activities in urban areas is due to the nearness or proximity to the market and market information (Obuobie *et al.*, 2006). This is also true for Morogoro Municipal. Common vegetables produced in Morogoro

Urban are amaranths Chinese cabbage, sweet potato leaves, okra, pumpkin leaves, egg plants, cowpeas, night shade, and cassava leaves. In Morogoro Urban the production of vegetable is done by both men and women, but the selling is mostly dominated by women.

2.6 Source of Vegetables

Consumers and vendors have different mechanisms for sourcing their produce. Some of them select their crops on the field and even harvest themselves, while others buy at distribution points where the source may not be known (Obuobie *et al*., 2006). Basically, in Morogoro, Urban vegetables sold in urban markets are produced from within the urban and peri urban areas, and they are a mixture of those irrigated using low quality water and those from normal water.

2.7 Vegetable Contamination

Food is believed to be essential to life but if contaminated can cause illness or even death (Griffith, 2006). There is the problem of food contamination in Kumasi due to poor agricultural practices, residual chemicals such as pesticides on harvested crops, poor handling, haulage and storage. These preventable hazards have been attributed to causing contamination of vegetables (Obuobie *et al.,* 2006). Vegetables irrigated using low quality water are prone to being contaminated by heavy metals like iron, manganese, copper and zinc (Arora *et al*., 2008). Leafy vegetables have been shown to accumulate relatively high concentrations of heavy metals as compared to fruit vegetables. Heavy metals are easily accumulated in the edible parts of leafy vegetables, than it is with grain or fruit crops (Mapanda *et al.,* 2005). In Morogoro Urban, leafy vegetables are commonly consumed due to their availability in the market all year round.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

This study was conducted in two Districts of Morogoro Region these were Mvomero and Morogoro. The region lies within Longitude 31°41'E and Latitude 6°51'S. The total rainfall amount for meteorological stations in Morogoro varies from year to year with more than 600 mm in lowlands and 1200 mm in highlands whereas temperatures range from 30 °C in lowlands and 18 °C in highlands. The northern part of the region experience bimodal rainfall regime that includes March-May and October-December while the southern part experience unimodal rainfall regime starting from November to April (Magehema *et al.*, 2014).The average annual temperature varies between 180C on the mountains to 300C in river valleys. In most parts of the region, the average temperatures are almost uniform at 250C. In general the hot season runs from July to September. Three wards of Morogoro Urban (Mafisa, Mazimbu and Mwembesongo) and one ward of Morogoro peri urban areas that was Mzumbe ward were selected because of the presence of vegetable gardens irrigated with low quality water from waste water. According to the 2012 Tanzania population and housing census, Morogoro Urban had 315 866 people among them 151 700 were males and 164 166 were females, while the household size was 4.1.Mzumbe ward had 19056 people among them males were 9264, females were 9792 and the household size was 4.0 (NBS, 2013). The major vegetables that are grown in Morogoro Urban include amaranth, Chinese cabbage, sweet potato leaves, okra, pumpkin leaves, egg plants, cowpeas, night shade, and cassava for its leaves. This study was assessed the knowledge of consumers of amaranths, Chinese cabbage, sweet potato leaves, okra and pumpkin leaves vegetables that were commonly produced using low quality water and were sold all the year round in the study area.

3.2 Research Design

A cross - sectional study design was applied which involved collecting data at one point in time from a sample selected to describe some larger population in that time. Also, this design was used to determine the relationship between variables at the time of study (Babbie, 1990). In addition, a direct observation was used to assess the knowledge of consumers and various key informants along the food chain such as vegetable cultivators, vegetable vendors, and transporters.

3.3 Sampling Techniques

Multiple sampling techniques such as simple random sampling, purposive sampling and snow ball sampling were used in this study to get respondents who were categorised into four groups: Vegetable farmers; vegetable consumers; vegetable transporters as well as vegetable vendors. These are explained below.

3.4 Consumers

3.4.1 Vegetable consumers at household level

Purposive sampling was used to select four wards among the twenty nine wards. Then simple random sampling was used to select seven households from each ward where a purposive sampling technique was used to obtain two consumers in each household.

3.4.2 Vegetable Consumers in Restaurants and Mama lishe

Simple random sampling was used to select three *mama lishe* from each ward where a snow ball sampling technique was employed to get two customers from each *mama lishe*. The same procedure was employed to get consumers from restaurants.

3.4.3 Vegetable Farmers

A simple random sampling technique was used to select ten vegetable farmers who were using Low Quality Water for irrigation within the two wards selected purposively.

3.4.4 Vegetable Vendors

A purposive sampling was also used to select two markets and within those two markets a simple random sampling was used to select four sellers from each market. Again a snow ball sampling was used to get twelve street vendors, four from each ward.

3.4.5 Vegetable Transporters

Eight vegetable transporters were selected using a snow ball sampling technique. A purposive sampling technique was used to select ten key informants (Ward Executive Officers, Extension agents, and those who were producing or selling vegetables produced using low quality water in large quantities as influential people). Respondents for Focus Group Discussion were selected based on age, sex and gender.

3.5 Sample Size

According to Bailey (1994), a sample or sub-sample of 30 respondents is a bare minimum for a study in which statistical data analysis is to be done regardless of the population size. Decisions about sample size represent a compromise between the constraints of time and cost, the need for precision, and a variety of further considerations that will now be addressed (Bryman, 2008). For that matter then, a total sample size of 130 was selected for this study comprising of the following:

Ninety two vegetable consumers: (56) from the households (7 households x 2 members x 4 wards), 24 form the *mama lishe* (3 *mama lishe* x 2 customers x 4 wards) and 12 from restaurants (6 restaurants x 2 customers). Ten vegetable growers in two vegetable

growing sites: 5 growers per each site (5 growers x 2 wards = 10 growers), eight vegetable transporters and 20 vegetable sellers in market places and street vendors (2 markets x 4 sellers = 8, and 3 street vendors x 4 wards = 12 vendors).

3.6 Pre-test of the Instruments

The instruments were pre-tested to vegetable consumers, vegetable farmers and vegetable vendors outside the selected four wards. This helped to determine the validity and practicability of the prepared instrument (Kothari, 2004).The instrument was revised to accommodate changes according to response got in the field.

3.7 Data Collection

Data collection methods included using semi structured interviews for objective 1, 2 and 3, Focus Group Discussions (FGDs) for objective 1 and 3, and direct observation for objective 2. Secondary data were collected through reading documents at Sokoine National Agricultural Library (SNAL), Safe Water for Food Project (SAWAFO), websites, published materials, theses, and journal articles.

3.8 Data Processing and Analysis

Kothari (1990) defined data analysis as the computation of certain indices or measures along with the searching for patterns of relations that exist among the data. In this study, data collected from the respondents using questionnaires were coded, entered and statistically analysed using computer software programs, Statistical Package for Social Sciences (SPSS 17.0). Descriptive statistics was done to get frequencies, means and percentages. Cross tabulations and Chi-square helped to establish the nature of relationship between variables.

Table 1: Summary for Data Analysis

Hypothesis	Independent variables	Dependent variable	Methods of Data Analysis
Ho_1: There is no statistically significant difference in consumers' knowledge and other stakeholders on the safety of vegetables produced in Morogoro urban using low quality water	Knowledge	Knowledge on the safety of vegetables irrigated with LQW	Frequencies, Percentages, Mean
Ho_2: There is no statistically significant difference in consumers' knowledge and their preferences on the safety of vegetables produced in Morogoro urban using LQW	Preferences Knowledge	Knowledge on the safety of vegetables irrigated with LQW	Frequencies, Percentages, Chi-square
Ho_3: There is no statistically significant difference in consumer's knowledge and their perception on the vegetables produced in Morogoro Urban using low quality water	Perception, Knowledge	Knowledge on the safety of vegetables irrigated with LQW	Frequencies, Percentages, Chi-square

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-Demographic Characteristics of Respondents

Of the 130 respondents, 75% were females, while 35% were males. Of the 130 respondents, 58% were adults aged between 21-40years old, 27% were also adults aged between 41- 60 years old, while 8% aged 61years and above. Only 6% were young people aged below 20 years old implying that, over half of the respondents were aged 21 – 40 years old.

Also, of the 130 respondents, 65% were married, 26% were single, 5% were widows while 3% were divorced, implying that over two third of the respondents were married. Moreover, of the 130 respondents, 81% reported to have attained primary school education, 11% had attained secondary school education, 7% had no formal education while 2% had university/college level of education. The implication was that, most of the respondents had attained primary school education (Table 2). Previous study by Tham-Agyekum and Ansah (2010) found that, sex of respondents, consumers' educational status and age have influence on the food safety awareness among consumers interviewed.

Table 2: Socio-demographic Characteristics of Respondents by Ward (N = 130)

Variable	Frequency and Percent by Ward									
	Mafisa		Mazimbu		Mwembesongo		Mzumbe		Overall	
	n	%	n	%	n	%	n	%	n	%
Sex										
Male	13	40.6	8	25	9	28.1	3	8.8	33	25.4
Female	19	59.4	24	75	23	71.9	31	91.2	97	74.6
Age										
<20 years	0	0	2	6.3	5	15.6	1	2.9	8	6.2
21 – 40	18	56.3	19	59.4	18	56.3	21	61.8	76	58.5
41 – 60	10	31.3	10	31.3	6	18.8	9	26.5	35	26.9
61 and above	4	12.5	1	3.1	3	9.4	3	8.8	11	8.5
Marital status										
Single	5	15.6	8	25	11	34.4	10	29.4	34	26.2
Married	24	75	22	68.8	17	53.1	22	64.7	85	65.4
Divorced	0	0	1	3.1	3	9.4	0	0	4	3.1
Widow/widower	3	9.4	1	3.1	1	3.1	2	5.9	7	5.4
Education										
No formal education	2	6.3	2	6.3	3	9.4	2	5.9	9	6.9
Primary school education	25	78.1	26	81.3	25	78.1	29	85.3	105	80.8
Sec. school education	4	12.5	4	12.5	4	12.5	2	5.9	14	10.8
College/Univ.	1	3.1	0	0	0	0	1	2.9	2	1.5

4.2 Respondents Family Size, Occupation and Monthly Income

Of the 130 respondents, 74% reported that they were self- employed while 12% had no formal jobs and 9% were temporarily employed. This implied that, over two thirds of the respondents were involved in self-employment and most were from the wards of Mzumbe79% followed by Mafisa 78% (Table 3). Similarly, of the 130 respondents, 55%, said that their family size were between three to five members per household while, 28% had six to ten and 17% had one to two persons per household. Further, among the 130 respondents 68.5% reported that they were engaged in petty business as their main economic activity, 22% dealt with farming activities and 10% were students attending schools/college.

In addition, this study revealed that over two thirds of the respondents dealt with petty businesses as their main economic activity. Moreover, of the 130 respondents, 34% indicated that they had monthly incomes of less than Tshs 100000, 33% had Tshs 100 001 -500 000 while 18% were not aware of their monthly earnings. This implies that, monthly incomes of most of respondents were less than Tshs 100 000 or US$ 2 per day.

Table 3: Respondents' Family Size, Main Economic Activity and Monthly Income (N = 130)

Variable	Mafisa		Mazimbu		Mwembesongo		Mzumbe		Wards Overall	
	n	%	n	%	n	%	n	%	n	%
Occupation										
Permanent employed	2	6.3	0	0	1	3.1	1	2.9	4	3.1
Temp. employment	1	3.1	2	6.3	5	15.6	4	11.8	12	9.2
Self employed	25	78.1	24	75	20	62.5	27	79.4	96	73.8
No job	4	12.5	5	15.6	5	15.6	1	2.9	15	11.5
Student	0	0	1	3.1	1	3.1	1	2.9	3	2.3
Family size										
1 – 2	5	15.6	9	28.1	4	12.5	4	11.8	22	16.9
3 – 5	17	53.1	17	53.1	18	56.3	19	55.9	71	54.6
6 – 10	10	31.3	6	18.8	10	31.3	11	32.4	37	28.5
Main economic activity										
Farming	5	15.6	10	31.3	4	12.5	9	26.5	28	21.5
Business	24	75	17	53.1	25	78.1	23	67.6	89	68.5
Attending school/Coll.	3	9.4	5	15.6	3	9.4	2	5.9	13	10
Monthly income										
< 100,000	12	37.5	11	34.4	8	25	13	38.2	44	33.8
100,000 - 250,000	10	31.3	10	31.3	12	37.5	11	32.4	43	33.1
251,000 - 500,000	2	6.3	1	3.1	2	6.3	3	8.8	8	6.2
above 500,000	1	3.1	0	0	0	0	1	2.9	2	1.5
Don't know	7	21.9	11	30.1	10	31.2	6	16.1	33	24.14

4.3 Number of Livestock Kept by Respondents

Different Income Generating Activities (IGAs) like farming, petty business and livestock keeping were performed by the respondents. The study revealed that, livestock keeping was performed by almost all the respondents and of the 130 respondents, 11% kept 1-10 chicken while 5% kept 11-20 chicken and 2% kept 21-30 chicken. In addition, respondents in the study are reported to keep goats 2%, pigs 2% and sheep 2% (Table 4). The implication was that, most of the respondents kept local chicken on small- scale and Mzumbe and Mafisa wards had most respondents keeping chicken (Table 4).

Table 4: Number of Livestock Kept by Respondents per Ward (N = 130)

Variable	Wards									
	Mafisa		Mazimbu		Mwembesongo		Mzumbe		Overall	
	n	%	n	%	n	%	n	%	n	%
Number of goats kept										
1 – 10	0	0	0	0	0	0	2	5.9	2	1.5
Number of pigs kept										
1 – 10	0	0	1	3.1	0	0	1	2.9	2	1.5
Number of chicken kept										
1 – 10	4	12.5	2	6.3	3	9.4	5	14.7	14	10.8
11 – 20	3	9.4	1	3.1	0	0	2	5.9	6	4.6
21 – 30	1	3.1	0	0	0	0	1	2.9	2	1.5
Above 31	0	0	0	0	1	3.1	0	0	1	0.8
Number of sheep kept										
1 – 10	0	0	0	0	0	0	2	5.9	2	1.5

4.4 Farmers Knowledge about Sources of Water Used for Irrigation

Of the 130 respondents, 10 were vegetable farmers from the two vegetable growing sites of Mafisa and Mzumbe wards. Of the five respondents from Mzumbe ward, all respondents mentioned that they irrigated their vegetables with LQW from Mzumbe waste water stabilisation ponds (*MtoTiba*) (Table 5). This supports the previous study by

Cornish *et al*. (1999) on formal utilization of LQW in irrigation. He explained that formal irrigation occurs when farmers rely on some form of fixed irrigation infrastructure that is designed and operated by the government or a donor agency. The study found that, all farmer respondents from Mzumbe ward irrigated their vegetables using LQW. During FGD, Mzumbe farmers said that, they had been using *MtoTiba* for more than 20 years, and that they had not experienced any health problems. Also, of the five farmer respondents from Mzumbe ward, 80% of the respondents reported that water used for irrigation was safe (Table 5). In addition to that, of the five farmer respondents from Mzumbe ward, all reported that they used LQW for irrigation. These results are contrary to the findings of previous study by Obuobie*et al.*, (2006) who reported that most of the LQW water used in the irrigation of vegetables contains high levels of faecal caliform.

Table 5: Farmers Knowledge about the Sources of Water and its Safety (N = 5)

Variable	Ward involved					
	Mafisa		Mzumbe		Total	
	n	%	n	%	n	%
Source of water						
Morogoro river	2	40	0	0	2	20
Shallow wells	3	60	0	0	3	30
Mzumbe (mtotiba) LQW	0	0	5	100	5	50
Total	**5**	**100**	**5**	**100**	**10**	**100**
Farmers Knowledge about safety of irrigation water						
Safe	4	80	4	80	8	80
Not safe	1	20	1	20	2	20
Total	**5**	**100**	**5**	**100**	**10**	**100**
Does the farmer use LQW for irrigation						
Yes	3	60	5	100	8	80
No	2	40	0	0	2	20
Total	**5**	**100**	**5**	**100**	**10**	**100**

Among the five farmer respondents from Mafisa ward, 40% indicated that they irrigated their vegetables using water from the Morogoro river and 60% reported that they irrigated vegetables using water from shallow wells (*Mafisa kwa Mambi*) to irrigate vegetables. Of the five farmer respondents from Mafisa ward, 80% reported that water used to irrigate

the vegetables was safe while 20% said that water used for irrigation was not safe. Of the five farmer respondents from Mafisa ward, 60% reported that they used LQW to irrigate vegetables, while 40% said that they did not used LQW for irrigation. Generally 80% of the farmers' respondents reported using LQW in irrigating vegetables (Table 5).

4.5 Sources of Vegetables that Transporters Sold

The study interviewed eight vegetable transporters, and of these, 75% reported that their sources of vegetables were farmers while 25% said markets. Also, 87.5% of the eight transporters respondents said that they had permanent customers while, 12.5% had not. Of the 87.5% transporters respondents who had permanent customers, 50% reported that market sellers were their main customers followed by 37.5% mentioning *mama lishe* and 12.5% mentioning restaurants (Table 6).

Table 6: Sources of Vegetables and permanent customers for transporters (n = 8)

Variable	Frequency	Percent
Sources of vegetables		
From farmers	6	75.0
Market	2	25.0
Total	**8**	**100.0**
Does the transporters have permanent customers		
Yes	7	87.5
No	1	12.5
Total	**8**	**100.0**
Mention the permanent customers		
Mama lishe	3	37.5
Vendors	1	12.5
Market sellers	4	50.0
Total	**8**	**100.0**

Figure 2: Transportation of LQW Irrigated Vegetables to be sold in Morogoro Urban

4.6 Vendors' Sources of Vegetables and where Sold

In this study, vegetable vendors were also interviewed to know their vegetable sources and where they sold them. Of the 20 vendors, 95% reported that they got vegetables from farmers, while 5%said from their own gardens. Of the 20 vendors, 70% mentioned that they sold vegetables to individual customers, 25% said to *mama lishe*, while only few (5%) reported that they sold vegetables to restaurants. Reasons for having permanent vegetable customers were varied. One half (50%) of the vendors said because of the availability of vegetables, slightly more than one third (35%) of them said because of the distance from the vendor to the consumers, 10% mentioned of the stable prices while 5% reported that it was because of the relationship that existed between the vendors and the consumers (Table 7).

Table 7: Vendors Sources of Vegetables and where Sold (n = 20)

	Wards involved									
	Mafisa		Mazimbu		Mwembesongo		Mzumbe		Overall	
	n	%	n	%	n	%	n	%	n	%
Sources of vegetables										
From farmers	5	100	5	100	5	100	4	80	19	95
Own garden	0	0	0	0	0	0	1	20	1	5
Total	**5**	**100**	**5**	**100**	**5**	**100**	**5**	**100**	**20**	**100**
Permanent customers										
Households	4	80	3	60	3	60	4	80	14	70
Restaurants	0	0	0	0	1	20	0	0	1	5
Mama lishe	1	20	2	40	1	20	1	20	5	25
Total	**5**	**100**	**5**	**100**	**5**	**100**	**5**	**100**	**20**	**100**
Reasons for having permanent customers										
Distance	1	20	4	80	2	40	3	60	10	50
Price	1	20	0	0	0	0	1	20	2	10
Availability	3	60	1	20	2	40	1	20	7	35
Relationship	0	0	0	0	1	20	0	0	1	5

Figure 3: Vegetables Irrigated with LQW that Vendors Sold in Morogoro Urban

4.7 Water that Vendors used to Wash Vegetables before Selling

About 20 vendors who sold vegetables, 70%said that they used tape water to wash vegetables before selling, while 30% washed them using LQW. The reasons for using tape water were because it was available as mentioned by 50% of the respondents.

Of the 20 respondents 40%indicated that they vegetables with tape water. On the contrary, 10% said that there were no differences between washing vegetables using LQW or tape water. The results are in line with Ensink *et al.* (2007) who suggested that unhygienic post-harvest handling was the major source of produce contamination. Reasons given by respondents as to why it was important to wash vegetables before selling was to remove sand and dust which was mentioned by 85%, while 15% said they washed to remove pests (Table 8).

Table 8: Water Used by Vendors to Wash Vegetables before Selling and the Types of Vegetable Contaminants in the Study Area (n = 20)

	Wards involved									
Variable	**Mafisa**		**Mazimbu**		**Mwembesongo**		**Mzumbe**		**Overall**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Water that vendors used to wash vegetables										
LQW	0	0	1	20	3	60	2	40	6	30
Tape water	5	100	4	80	2	40	3	60	14	70
Total	**5**	**100**	**5**	**100**	**5**	**100**	**5**	**100**	**20**	**100**
Perceived quality of water used to wash vegetables										
LQW is good only for irrigation	3	60	0	0	2	40	3	60	8	40
No difference between LQW and tape water	0	0	1	20	0	0	1	20	2	10
Availability	2	40	4	80	3	60	1	20	10	50
Total	**5**	**100**	**5**	**100**	**5**	**100**	**5**	**100**	**20**	**100**
Reasons for washing vegetables										
To remove sand and dust	5	100	3	60	5	100	4	80	17	85
To remove pest	0	0	2	40	0	0	1	20	3	15
Total	**5**	**100**	**5**	**100**	**5**	**100**	**5**	**100**	**20**	**100**
Types of vegetable contaminants										
Chemical	1	20	0	0	1	20	0	0	2	10
Biological	0	0	0	0	0	0	1	20	1	5
Physical	4	80	1	20	1	20	0	0	6	30
Don't know	0	0	4	80	3	60	4	80	11	55
Total	**5**	**100**	**5**	**100**	**5**	**100**	**5**	**100**	**20**	**100**

Among the 20 vendor respondents, more than half, 55% reported that they were not aware of vegetable contaminants, 30% said they were aware of physical contaminants such as sand and glasses, 10% knew about chemical contaminants like water flowing from

industries and hospitals while the other 5% knew about biological contaminants such as urine. With these results, about half of the respondents, 55% were not aware of vegetable contaminants associated with washing the vegetables using LQW.

4.8 Vegetables Frequently Consumed and Knowledge about their Sources

The study findings show the five types of vegetables that respondents reported to consuming frequently in the study area. These included Chinese cabbage, *amaranthus*, pumpkin leaves, sweet potato leaves and okra. Of the 130 respondents, 24.6%, 24.6%, 24.6%, and 26.1% were surveyed from Mafisa, Mazimbu, Mwembesongo and Mzumbe wards, respectively. Of these, 32 respondents came from Mafisa ward and 78% indicated that they consumed Chinese cabbages. Also, 76%of the respondents from Mzumbe ward reported that they consumed Chinese cabbages. Moreover, 69% of the 32 respondents from Mazimbu ward mentioned that they consumed Chinese cabbages, while 59% from Mwembesongo ward said so. Generally, most respondents, 78% and 76% from Mafisa and Mzumbe wards indicated to consume more Chinese cabbages than their counterparts in two wards of Mazimbu 69% and Mwembesongo 59% (Table 9).

For the case of *Amaranths*, of the 32 respondents from Mazimbu ward, 88% reported that they consumed *Amaranths*, 79% of the 34 respondents from Mzumbe ward mentioned that they consumed *Amaranths*. Also, of the 32 respondents from Mafisa ward, 78% reported that they consumed *Amaranths*, while 72% of the 32 respondents from Mwembesongo said so. The study found that *Amaranth* was mostly consumed in Mazimbuas mentioned by 88% and Mzumbe by 79% wards than in other two wards of Mafisa78% and Mwembesongo 72%, (Table 9).

Table 9: Vegetables frequently consumed and knowledge about their sources (N= 130)

Variable	Mafisa		Mazimbu		Mwembesongo		Mzumbe		Overall	
	n	%	n	%	n	%	n	%	n	%
	32	24.6	32	24.6	32	24.6	34	26.2	130	100
Vegetables frequently consumed										
Chinese cabbage	25	78	22	69	19	59	26	76	92	71
Amaranth	25	78	28	88	23	72	27	79	103	79
Pumpkin leaves	24	75	22	69	24	75	24	71	94	72
Sweet potato leaves	23	72	30	94	25	78	28	82	106	82
Okra	9	28	19	59	14	44	20	59	62	48
Average	21.2	66.2	24.2	75.8	21	65.6	25	73.4	91.4	70.4
Source of vegetables										
Market	5	16	8	25	12	38	21	62	46	35
From the farmers	15	47	8	25	5	16	9	26	37	28
Own garden	1	3	6	19	2	6	2	6	11	8
Street vendors	11	34	10	31	13	41	2	6	36	28
Total	32	100	32	100	32	100	34	100	130	100
Knowledge about places of production										
Yes	24	75	26	81	23	72	28	82	101	78
No	8	25	6	19	9	28	6	18	29	22
Where vegetables were produced										
Mafisa kwa mambi	13	41	1	3	9	28	1	3	24	18
Morogoro river	9	28	1	3	7	22	0	0	17	13
Ngerengere river	1	3	12	38	2	6	0	0	15	12
Mzumbe (mtotiba)	0	0	0	0	0	0	23	68	23	18
Tangeni river	1	3	1	3	0	0	0	0	2	2
Mlali/kipera	0	0	0	0	0	0	4	12	4	3
Mazimbu campus	0	0	11	34	0	0	0	0	11	8
Mwembesongo	0	0	0	0	5	16	0	0	5	4

Moreover, of the 130 respondents from the four wards, 79% mentioned that they consumed pumpkin leaves. Of the 32 respondents from Mwembesongo, 75%said that they consumed pumpkin leaves, and of the 32 respondents from Mafisa ward, 75%said so. Also, of the 34 respondents from Mzumbe ward, 71% reported that they consumed pumpkin leaves, while 69% of the 32 respondents from Mazimbu ward said so. Generally, Mwembesongo and Mafisa wards had most respondents who indicated to consume pumpkin leaves as 75% of the respondents said so than their counterparts from Mzumbe, 71% and Mazimbu 69% wards (Table 9).

Furthermore, sweet potato leaves were also consumed by respondents from the four wards. Of the 32 respondents from Mazimbu ward, 94% reported that they consumed sweet potato leaves, while of the 34 respondents from Mzumbe ward, 82% said so. Also, of the 32 respondents from Mwembesongo ward, 78% reported that they consumed sweet potato leaves, and 72% of the 32 respondents from Mafisa ward said so. Mazimbu ward had the most respondents who reported to consume sweet potato leaves94% followed by Mzumbe 82%, Mwembesongo78% and Mafisa72% (Table 9).

Additionally, okra was among the vegetables that respondents consumed frequently in the study area. Of the 34 respondents from Mzumbe ward, 59% said that they consumed okra, while of the 32 respondents from Mazimbu ward, 59% mentioned that they consumed okra (Table 8). Yet of the 32 respondents from Mwembesongo ward, 44% mentioned that they consumed okra, while of the 32 respondents from Mafisa ward it was only 28%who said so. These results show that most respondents from Mzumbe and Mazimbu wards consumed more okra than others; perhaps this was because okra was abundantly produced in these wards.

Generally, the study results show that, of all the five types of vegetables consumed, sweet potato leaves were the leading mostly consumed by 94% of the respondents from Mazimbu ward while okra was the least consumed mentioned by 59% of the respondents. On the overall, most consumers of all the five types of vegetables were from Mazimbu ward with an average of 75.8% and Mzumbe ward had an average of 73.4%, Mafisa ward had an average of 66.2%, while the last was Mwembesongo ward with an average of 65.6% (Table 9).

Basically, all the five types of vegetables that respondents consumed frequently were sourced from different areas. Of the 130 respondents, 35% reported that they sourced vegetables from the markets, 28% indicated that they brought vegetables from farmers, yet, 28% said conversely, that they got them from street vendors, while 8% mentioned to have been getting the vegetables from their own gardens. In terms of wards, of the 32 consumers from Mwembesongo, 41% reported to have been getting vegetables from street vendors, 38% from markets, 16% from farmers, while, 6%got form their own gardens. Among the 32 respondents from Mafisa ward, 47% indicated that they sourced vegetables from farmers, 34% from street vendors, 16% from markets, while 3% sourced from own gardens.

Furthermore, of the 32 respondents from Mazimbu ward, 31% reported that they got vegetables from street vendors, 25% from markets and farmers, while 19%obtained from their own gardens. Also, of the 34 respondents from Mzumbe ward, 62% mentioned that they sourced vegetables from the markets, 26% from farmers, 6% from street vendors, and 6% from their own gardens (Table 9). Overall, the study found that one third of the respondents, 35% reported that they sourced vegetables they consumed from markets. This showed the importance of markets for selling vegetables to various consumers in urban areas.

Of the 130 respondents, most, 78% indicated that they had knowledge about places where vegetables they consumed were produced. Of the 32 respondents from Mzumbe ward, 68% mentioned that they had knowledge that the vegetables they ate were irrigated with water flowing from Mzumbe waste water stabilisation ponds called *Mto Tiba*. Similarly, 32 respondents from Mafisa and Mwembesongo wards, 41% and 28% reported that they ate vegetables irrigated with water from *Mafisa kwa Mambi* water from the Morogoro

river when gets floods respectively. Equally, of the 32 respondents from Mazimbu ward, 38%reported that they ate vegetables that were irrigated with water from Ngerengere river. Also, 28% and 22% of the respondents from Mafisa and Mwembesongo wards said that they had knowledge that they consumed vegetables irrigated with water from the Morogoro river respectively.

4.9 Vegetables Bought and Consumed per Day and their Cost

Among the 130 respondents, 33.8% reported that they bought and ate two bundles of Chinese cabbages per day which was equal to 0.6kgat a cost of Tshs300 per bundle. In addition, 14.6%of the respondents mentioned that they bought one bundle (0.3kg), while 10.0% bought three bundles per day (Table 10). Furthermore, 6.9%of the respondents indicated that they bought four bundles (1.2kg), while 3.1% bought five bundles of Chinese cabbage (1.5 kg) per day. The study results showed that majority of respondents bought two bundles (0.6kg) of Chinese cabbage per day. Probably, this was influenced by their family sizes since about half of the respondents, 54.6% had family sizes between 3-5 people. Of the 130 respondents, 40% mentioned that they bought two bundles of *Amaranths* each weighing 0.28 kg, while14.6% and 14.6% reported that they bought three and one bundle of *Amaranths* per day, respectively. Few respondents, 4.6% and 3.8% mentioned that they bought four and five bundles of amaranths per day respectively. Also, for *Amaranths*, most respondents bought two bundles (0.5 kg) per day. Moreover, of the130 respondents, 36.2% reported that they bought and ate two bundles of pumpkin leaves each weighing 0.3 kg, and20.0%of the respondents mentioned that they bought and ate one bundle of pumpkin leaves. On one hand, 6.2%, of the respondents mentioned that they bought and ate one bundle. On the other hand, 4.6% of the respondents said three bundles, and 2.3% said five bundles of pumpkin leaves per day.

Table 10: Data of the Five Vegetables Consumed per Household per Day (N = 130)

Bundles	Weight (KG)	Cost (Tshs)	Frequency	Percent
Chinese cabbage				
1	0.3	300.00	19	14.6
2	0.6	600.00	44	33.8
3	0.9	900.00	13	10.0
4	1.2	1,200.00	9	6.9
5	1.5	1,500.00	4	3.1
0	0	0	41	31.5
Amaranths				
1	0.2	300.00	19	14.6
2	0.5	600.00	52	40.0
3	0.8	900.00	19	14.6
4	1.1	1,200.00	6	4.6
5	1.4	1,500.00	5	3.8
0	0	0	29	21.5
Pumpkin leaves				
1	0.3	300.00	26	20.0
2	0.6	600.00	47	36.2
3	0.9	900.00	8	6.2
4	1.2	1,200.00	6	4.6
5	1.5	1,500.00	3	2.3
0	0	0	40	30.8
Sweet potato leaves				
1	0.3	300.00	22	16.9
2	0.6	600.00	54	41.5
3	0.9	900.00	17	13.1
4	1.2	1,200.00	7	5.4
5	1.5	1,500.00	2	1.5
0	0	0	28	21.5
Okra				
1	0.4	500.00	23	17.7
2	0.7	1,000.00	35	26.9
3	1.1	1,500.00	7	5.4
4	1.4	2,000.00	2	1.5
5	1.8	2,500.00	2	1.5
0	0.0	0	61	46.2

Furthermore, of the130 respondents, 41.5% indicated that they bought two bundles of sweet potato leaves per day each weighing 0.3kg and each was sold for Tshs 300. Also, 16.9% and 13.1% mentioned that they bought one and three bundles of sweet potato leaves per day respectively and then, 5.4% and 1.5% respondents mentioned that they bought four and five bundles of sweet potato leaves, respectively. Also, of the 130 respondents, 26.9% reported that they bought two bundles of okra per day each weighing 0.4kg and each was sold for Tsh 500 per bundle. Besides, 17.7%of the respondents

indicated that they consumed one (0.4kg) bundle, while 5.4% mentioned to buying three (1.1kg) bundles per day. Further, 1.5% of the respondents mentioned that they bought four (1.4kg) and five (1.8kg) bundles of okra per day. The study results show that less than half, 46.2% of the respondents didn't buy okra per day (Table 10) above.

4.10 Consumers' Knowledge about Safety of Water Used for Irrigating Vegetables

The results of this study indicated that, of the 92 consumer respondents from four wards of Mafisa, Mazimbu, Mwembesongo and Mzumbe, each comprised of 23 consumer respondents. Of these 23 consumer respondents from Mafisa ward, 48% said that, water used in irrigating vegetables was not safe, and 39% said that they did not know if water was safe, while 13% reported that water used to irrigate vegetables in Morogoro Urban was safe. In Mazimbu ward, of the 23 consumer respondents, 39% reported that water used to irrigate vegetables in Morogoro Urban was safe, and 39% of the 23 consumer respondents from Mazimbu reported that they did not know if water used for irrigating vegetables was safe, while five (22%) of the 23 consumer respondents reported that water used for irrigating vegetables was safe.

Also, of the23consumer respondents from Mwembesongo ward, 57% reported that water used in irrigating vegetables was not safe, 35% said that they did not know if water used in irrigating vegetables was safe, while only 9% mentioned that water used to irrigate vegetables in Morogoro Urban was safe. Moreover, of the 23 consumer respondents from Mzumbe ward, 43% reported that water used in irrigation was not safe, 35% mentioned that water used for irrigating vegetables was safe, while 22% said that they did not know if water was safe or not. Generally, consumer respondents had knowledge that water used to irrigate vegetables in Morogoro Urban was not safe (Table 11).There is therefore a shared responsibility between farmers and consumers to ensure the safety of food

consumers purchase (Griffith, 2000). This entire scenario raises the question of whether farmers are really aware of the effect of their activities on the quality of vegetables produced as well as on the health of the consumer.

Table 11: Knowledge of Consumers about the Safety of Water used for Irrigation and if they Consumed Vegetables from LQW (n=92)

Variable	Ward involved									
	Mafisa		Mazimbu		Mwembesongo		Mzumbe		Overall	
	n	%	n	%	n	%	n	%	n	%
Consumers know the safety of irrigation water										
Safe	3	13	9	39	2	9	8	35	22	24
Not safe	11	48	5	22	13	57	10	43	39	42
Don't know	9	39	9	39	8	35	5	22	31	34
Consumers know that some vegetables were irrigated with LQW										
Yes	16	70	20	87	13	57	19	83	68	74
No	7	30	3	13	10	43	4	17	24	26
Knowledge that vegetables consumed were irrigated with LQW										
Yes	11	48	15	65	7	30	15	65	48	52
No	12	52	8	35	16	70	8	35	44	48

Of the 23 consumer respondents from Mafisa ward, 70% reported that they knew some vegetables in Morogoro Urban were irrigated with LQW, and 87% of the 23 consumer respondents from Mazimbu ward said so. Further, 57% and 83% of the23 consumer respondents from Mwembesongo and Mzumbe ward reported having knowledge that some vegetables in Morogoro Urban were irrigated with LQW. Again, of the 23 consumer respondents from Mafisa ward, 48% mentioned that they knew that the vegetables they ate were irrigated with LQW, 65% of the 23 consumer respondents from Mazimbu ward, reported having such knowledge, 30%of those from Mwembesongo ward and they were 65% from Mzumbe ward. Generally, more than half, 52% of the respondents were aware that the vegetables they consumed were irrigated with LQW (Table 11).

4.11 Vegetables that Consumers Preferred

Table 12shows frequencies and percentages of different types of vegetables that consumers preferred to eat in the four study wards. Of the 92 consumer respondents, 79% mentioned that they preferred sweet potato leaves, 68% said *Amaranths*, and 62%preferred Chinese cabbage. Also, 60% reported that they preferred pumpkin leaves and 38% said okra. The study results showed that sweet potato leaves were mostly preferred by more than half of the consumer respondents and respondents from Mazimbu ward leading in preference (Table 12).

Table 12: Consumer Respondents' Preference of Vegetables (n = 92)

Variable	Mafisa		Mazimbu		Mwembesongo		Mzumbe		Wards involved Overall	
	n	%	n	%	n	%	n	%	n	%
Chinese cabbage	14	61	12	52	16	70	15	65	57	62
Amaranth	16	70	18	78	15	65	14	61	63	68
Pumpkin leaves	15	65	10	43	14	61	16	70	55	60
Sweet potato leaves	19	83	22	96	17	74	15	65	73	79
Okra	12	52	5	22	7	30	11	48	35	38

4.12 Relationship between Consumers' Knowledge about Safety of Vegetables and their Preference

Of the 130 consumer respondents, 66.6% reported that they preferred to eat vegetables even when they knew that they were irrigated with LQW, and of these 66.6%, 52% mentioned that they preferred Chinese cabbages even when they were aware that they were irrigated with LQW. A chi-square test revealed that there was a statistically significant difference between means of consumers' awareness on Chinese cabbages that were irrigated with LQW at $p \leq 0.028$. However, a chi-square test showed that there were no statistically significant differences of means between knowledge about the type of water used in irrigating vegetables and the consumer's preference of Amaranths at $p \leq 0.800$ (Table 13).

Table 13: Respondents Preference on Types of Vegetables in Relation to their Knowledge Level (N = 130)

Variable	Knowledge that the vegetables they ate were irrigated with LQW						Chi-square test	
	Yes		No		Overall		χ^2-Value	P - value
	n	%	n	%	n	%		
Preference in consuming Chinese cabbage								
Yes	34	52	45	70	79	61	23.412	0.028*
No	32	48	19	30	51	39		
Amaranths								
Yes	44	67	44	69	88	68		
No	22	33	20	31	42	32	4.865	0.800ns
Pumpkin leaves								
Yes	39	59	43	68	82	64		
No	27	41	20	32	47	36	23.413	0.028*
Sweet potatoes leaves								
Yes	52	79	51	80	103	79		
No	14	21	13	20	27	21	0.355	0.899ns
Okra								
Yes	22	33	29	45	51	39		
No	44	67	35	55	79	61	29.32	0.046*

Note: *= statistically significant ($p \leq 0.05$) ns =statistically not significant ($p \geq 0.05$)

Moreover, of the 130 consumer respondents, 66.6% reported that they preferred to eat vegetables even when they knew that they were irrigated with LQW and of these, 59% reported that they preferred to eat pumpkin leaves. A chi-square test indicated statistically significant differences of means between knowledge of the consumer respondents and preferences on pumpkin leaves at $p \leq 0.028$ (Table 13).Also, of the 130 consumer respondents, 79% reported that they preferred sweet potato leaves. A chi-square test revealed that there were no statistically significant differences of means between knowledge and the consumers' preferences on sweet potato leaves at $p \leq 0.899$.Furthermore, of the 130consumer respondents,66% reported to be knowledgeable that they ate vegetables irrigated with LQW and of these, 22% mentioned that they preferred okra. A chi-square test showed that there were statistically significant differences of means between knowledge and consumers' preference on okra at $p \leq 0.046$ (Table 13).

Results in Table 13 show the consumers' preferences on various types of vegetables in relation to their knowledge that they ate vegetables irrigated with LQW. Preferences in consuming Chinese cabbages $p \leq 0.028$, sweet potato leaves $p \leq 0.028$ and okra $p \leq 0.046$ were statistically significant at $p \leq 0.05$. This means that, the Null Hypothesis Ho_2 which states that: There is no statistically significant difference on consumers' preferences of vegetables produced in Morogoro Urban using low quality water is rejected for Chinese cabbage, pumpkin leaves and okra, but upheld for Amaranths ($p \leq 0.800$) and sweet potato leaves ($p \leq 0.899$).

4.13 Consumers' Reasons for Preferring a Certain Type of Vegetable

Table 14 presents preference results for eating five types of vegetables. Of the 130 respondents, 66.6% indicated that they were aware that they were eating vegetables irrigated with LQW. Of these, 3.08% preferred Chinese cabbages because they believed that they were nutritious, while 2.31% and 1.54% preferred Chinese cabbages because they were familiar to them and they were of good quality, respectively. A Chi-square test revealed that, there was statistically significant differences between knowledge of consumers and their reasons for preferences of Chinese cabbages at $\chi^2 = 23.416$ and atp≤ 0.023. Among the 130 consumer respondents, 66.6% mentioned that they preferred eating vegetables even when they knew that they were irrigated with LQW and of these, 10% preferred *Amaranths* because they believed that they were nutritious, 3.08% and 1.54% reported to prefer because they were familiar with them and they were of good quality respectively. A Chi-square test revealed that there was no statistical significant differences between the reasons for preference of *Amaranths* irrigated with LQW and the knowledge of consumers at $\chi^2 = 21.971$ and at $p \leq 0.076$ (Table 14).

Moreover, of the 130 consumer respondents, 66.6% mentioned that they preferred eating vegetables even when they knew that they were irrigated with LQW. Likewise, 6.92% mentioned to prefer pumpkin leaves because they were nutritious, while 1.54% preferred them because they were common vegetables. A chi-square test showed that they were statistically significant at $\chi^2 = 23.419$ and at $p \leq 0.023$ implying that the consumers knowledge influenced their preferences to eat pumpkin leaves (Table 14).

Also, of the 130 consumer respondents, 15.38% reported that they preferred sweet potato leaves because they were nutritious, while 3.08% said they preferred them because they were familiar to them. A chi-square test revealed that there was statistically significance differences at $\chi^2 = 28.352$ and at $p \leq 0.003$ between consumers' knowledge about sweet potato leaves being irrigated with LQW. In addition, of all the consumer respondents, 4.62% reported that they preferred okra because it was nutritious, while 2.81% preferred it because they were familiar. A chi-square test revealed that it was statistically significant at $\chi^2 = 29.333$ and at $p \leq 0.001$ (Table 14).

Moreover, during FGDs respondents were asked to give reasons for their preferences on the studied vegetables although they knew that they were irrigated with LQW. Their views were as follows:

> *"I prefer eating vegetables because they are available in this area throughout the year although I know that they are irrigated with LQW (Consumer FGD from Changarawe – Mzumbe ward)."*
>
> *On the same, another participant said: "I prefer these vegetables because I buy them direct from the field while they are fresh and normally they are sold at affordable prices (Consumer FGD from Mafisa ward)."*
>
> *Yet, another participant commented: "People in this area prefer eating vegetables irrigated with LQW because they look fresh and green due to the nutrients from LQW, also farmers do not apply industrial fertilizers (Key Informantf rom Mafisa ward)."*

These FGDs responses are in line with those given by consumers during face-to-face questionnaire interviews.

Table 14: Reasons for Consumers' Preference on Different Types of Vegetables (N = 130)

Reasons for preferring	Knowledge about vegetables irrigated with LQW				Chi-Square Test	
	Yes		No		χ^2-Value	P-Valu
	n	%	n	%		
Chinese cabbages						
Nutritious	4	3.08	11	8.46	23.416	0.023*
Good quality	2	1.54	0	0		
Familiar with	3	2.31	2	1.54		
Low cost	0	0	2	1.54		
No reason	57	43.85	49	37.69		
Amaranths						
Nutritious	13	10	9	6.92	21.971	0.076ns
Good quality	2	1.54	3	2.31		
Familiar with	4	3.08	2	1.54		
Low cost	0	0	2	1.54		
Easy to prepare	3	2.31	5	3.85		
No reason	44	33.85	43	33.08		
Pumpkin leaves						
Nutritious	9	6.92	10	7.69	23.419	0.023*
Good quality	1	0.77	4	3.08		
Familiar	2	1.54	2	1.54		
Low cost	1	0.77	3	2.31		
No reason	53	40.77	45	34.62		
Sweet potato leaves						
Nutritious	20	15.38	17	13.08	28.352	0.003*
Good quality	1	0.77	5	3.85		
Familiar with	4	3.08	3	2.31		
Low cost	0	0	1	0.77		
No reason	41	31.54	38	29.23		
Okra						
Nutritious	6	4.62	6	4.62	29.333	0.001*
Good quality	0	0	4	3.08		
Familiar	3	2.31	0	0		
Easy to prepare	0	0	1	0.77		
No reason	57	43.85	53	40.77		

Note: * = statistically significant ($p \leq 0.05$) ns = statistically not significant ($p \geq 0.05$)

4.14 Consumers' Perceptions about the Safety of Vegetables Irrigated with LQW

Among the 130 respondents, 56.9 reported that they perceived that Chinese cabbages irrigated with LQW were not safe to eat, 30.8% said that they were safe to eat, while 12.3% were not sure if they were safe to eat or not safe. Also, of the130 respondents, 53.8% perceived that *Amaranthus* that were irrigated with LQW were not safe to eat, while 30.8% said they were safe and 15.4% said that they did not know. Moreover, of the 130 respondents, 53.1% mentioned that the pumpkin leaves that were irrigated with LQW were not safe to eat, 31.5% reported that they were safe to eat, while 15.3% said they did not know anything. Also, of the 130 respondents, 54.6% reported that they perceived, sweet potato leaves that were irrigated with LQW were not safe to eat, and 30.0% perceived that they were safe to eat, while 15.3% reported that they do not know anything (Table 15).

Table 15: Respondents Perception about Safety of Vegetables Irrigated with LQW (N = 130)

Perception about safety of vegetables irrigated with LQW	Frequency	Percent
Chinese cabbages		
Safe	40	30.8
Not safe	74	56.9
Don't know	16	12.3
Amaranths		
Safe	40	30.8
Not safe	70	53.8
Don't know	20	15.4
Pumpkin leaves		
Safe	41	31.5
Not safe	69	53.1
Don't know	20	15.3
Sweet potato leaves		
Safe	39	30.0
Not safe	71	54.6
Don't know	20	15.3
Okra		
Safe	55	42.3
Not safe	58	44.6
Don't know	17	13.1

In addition, of the 130 respondents, 44.6%perceived okra that was irrigated with LQW, and thus, not safe to eat, 42.3% reported that they perceived them as safe to eat, while 13.1%said that they were not sure about their safety status. Generally, the study found that less than half of the respondents (42.3%) perceived okra irrigated with LQW as safe to eat. Probably, this was because the edible part of okra is not touched with water during irrigation. This made consumers to believe that they were safe, compared to other vegetables they consumed.

4.18 Consumers Perceived Reasons about the Safety of Vegetables Irrigated with LQW

Table 16 shows that, of the 66 consumer respondents who perceived that Chinese cabbages irrigated with LQW were safe to eat, 30.30% perceived them as safe because they cooked them well. However, 19.18% reported that there was no difference between Chinese cabbages irrigated with LQW and those from good quality water. Yet, 12.12% mentioned that these Chinese cabbages had no health effects to consumers. Further, 31.82% perceived that *Amaranths* irrigated with LQW were safe to eat because they were cooked thoroughly, and15.15% perceived them as safe to eat. Also, 12.12% perceived that *Amaranths* were safe to eat even when they were irrigated with LQW. Moreover, 31.82% of the consumer respondents perceived *Amaranths* as safe to eat because they were cooked well, while 12.12% perceived them as not having any health effects to consumers (Table 16).

Furthermore, of the 66 consumer respondents, 31.82% perceived sweet potato leaves irrigated with LQW as safe to eat because they were well cooked. Equally, 15.15% perceived them as safe because there was no difference between LQW irrigated sweet potato leaves and those irrigated with good quality water, and 12.12% perceived sweet

potato leaves as not having any health effects to consumers. Also, of the 66 consumer respondents, 22.73% perceived that okra irrigated with LQW were safe to eat because they were well cooked. Again, 21.21% perceived them as safe because there was no direct contact of the fruit with water used for irrigation. Moreover, 13.64% reported that there were no differences in safety between okra irrigated with LQW and those irrigated with good quality water, while 10.61% perceived them as safe because they know that there were no health effects to consumers (Table 16).

Further, during FGDs with consumers, most reported that, LQW used in irrigation was not safe, but the vegetables were safe because they cooked them before eating. This was reported by participants in different FGDs as illustrated by the following quotes:

> *"I do not trust the safety of this water because it combines with household water and sewer, it has a green colour, but when I cook vegetables they become safe. This water is not safe, but vegetables are safe. (Consumer FGD participant from Mafisaward)."*
>
> *Another one said: "I know that the vegetables irrigated by Mto Tiba are safe because I get them directly from the field, and I never experience any health problems even when I eat fish from this water" (Consumer FGD participant from Changarawe–Mzumbe ward).*
>
> *Yet, another participant commented: "Just by looking, the vegetables we eat are not safe but because we have been eating even carrots and cucumber when raw and we have never died since 1977. The vegetables look green and no industrial fertilizers are used."(Consumer FGD participant from Changarawe–Mzumbe ward).*

These responses support consumers' perceived reasons given during face-to-face questionnaire interviews.

Table 16: Consumers' Perceived Reasons for Eating Vegetables Irrigated with LQW (n = 66)

Variable	Mafisa		Mazimbu		Mwembesongo		Mzumbe		Overall	
	n	%	n	%	n	%	n	%	n	%
Chinese cabbage										
Cooked vegetables are safe	2	3.03	13	19.7	2	3.03	2	3.03	20	30.3
No health effects to consumers	2	3.03	0	0	0	0	6	9.09	8	12.12
No differences between LQW and good quality water	1	1.52	3	4.55	5	7.58	3	4.55	14	19.18
No comments	6	9.09	6	9.09	7	10.61	5	7.58	24	36.36
Amaranth										
Cooked vegetables are safe	3	4.55	13	19.7	2	3.03	4	6.06	22	33.33
No health effects to consumers	2	3.03	0	0	0	0	6	9.09	8	12.12
No differences between LQW and good quality water	1	1.52	3	4.55	5	7.58	1	1.52	10	15.15
No comments	5	7.58	6	9.09	9	13.64	6	9.09	26	39.39
Pumpkin leaves										
Cooked vegetables are safe	3	4.55	13	19.7	1	1.52	4	6.06	21	31.82
No health effects to consumers	2	3.03	0	0	0	0	6	9.09	8	12.12
No differences between LQW and good quality water	1	1.52	3	4.55	5	7.58	2	3.03	11	16.67
No comments	6	9.09	6	9.09	8	12.12	6	9.09	26	39.39
Sweet potato leaves										
Cooked vegetables are safe	3	4.55	13	19.7	1	1.52	4	6.06	21	31.82
No health effects to consumers	2	3.03	0	0	0	0	6	9.09	8	12.12
No differences between LQW and good quality water	1	1.52	3	4.55	5	7.58	1	1.52	10	15.15
No comments	7	10.61	6	9.09	8	12.12	7	10.61	27	41.42
Okra										
Cooked vegetables are safe	2	3.03	9	13.64	1	1.52	3	4.55	15	22.73
No health effects to consumers	1	1.52	0	0	0	0	6	9.09	7	10.61
No differences between LQW and good quality water	1	1.52	2	3.03	4	6.06	2	3.03	9	13.64
No direct contact with water used for irrigation	6	9.09	3	4.55	3	4.55	2	3.03	14	21.21

4.19 Consumers' Actions for Maintaining Safety of Vegetables

Table 17 shows the respondents' actions to maintain vegetable safety. The study results show that consumers used various ways to ensure that they consume safe vegetables. Among the ways were like washing vegetables before cooking as reported by all respondents. Respondents gave reasons as to why they washed vegetables before cooking. Of the 130 respondents, 76.2% reported that it was to remove sand and dust, and 15.4% said to remove pests (Table 17). Other 5.4% reported that it was routine to wash vegetables before cooking, while 3.1% indicated that they washed vegetables because they did not know where they came from and type of water used in irrigation. Previous studies found that home is the location for many cases of food-borne diseases (Redmond and Griffith, 2003) so consumers must handle food hygienically.

With regards to respondents' level of knowledge, 52.3% of the respondents reported that they knew that vegetables were contaminated. Of the 52.3% respondents, 30.8% reported that it was due to biological contaminants such as faecal and urine present in sewerage water. Yet, 12.3% of them mentioned of physical contaminants like presence of sand, glasses, iron and other metal/plastic containers in vegetable gardens. Nevertheless, 8.5% respondents indicated to have knowledge about chemical contaminants such as water flowing from industries carrying chemicals (Table 17).

Moreover, of the 130 respondents, 40% reported that they were aware of health problems due to eating vegetables irrigated with LQW, while 60% said that they did not know. Of the 40% with knowledge, 26.9% mentioned health problem as diarrhoea, typhoid 7.5%, worms 4.6% and cholera 3.1%. Generally, over half of the respondents were not aware of the health problems associated with eating vegetables irrigated with LQW (Table 17). This collaborates with Ndunda and Mungatana (2013) study who found that, diarrhoeal infection, stomach-ache, intestinal worm's infection, and skin infections were some of the health problems associated with eating vegetables irrigated with waste water.

Table 17: Respondents Actions to Maintain Vegetables Safety, possible vegetable Contaminants and the Perceived Health Problems (N=130).

Variable	Frequency	Percent
Wash vegetables before cooking		
Yes	130	100.0
No	0	.0
Reasons for washing vegetables before cooking		
To remove sand and dust	99	76.2
To remove pests	20	15.4
As a routine	7	5.4
Don't know where it was cultivated	4	3.1
Knowledge on vegetable contaminants		
Yes	68	52.3
No	62	47.7
Possible vegetable contaminants		
Chemical contaminants	11	8.5
Biological contaminants	40	30.8
Physical contaminants	16	12.3
Don't know	63	48.5
Knowledge of health problems related to LQW		
Yes	52	40.0
No	78	60.0
Perceived health problems		
Diarrhoea	35	26.9
Cholera	4	3.1
Typhoid	10	7.7
Don't know	75	57.7
Worms	6	4.6

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study found that, most consumers had knowledge on the sources of water used in irrigation and they knew that some vegetables in Morogoro Urban were irrigated with LQW. More than half of the consumer respondents had no knowledge about vegetable contaminants associated with irrigating vegetables with LQW. Farmer respondents reported that, water used for irrigation was safe, while over half of the consumer respondents reported that it was not safe.

One type of vegetable that was sweet potato leaves was the most preferred by respondents among the five types of vegetables which were frequently consumed in the study area; these were Chinese cabbage, pumpkin leaves, amaranth and okra. Given that consumers were aware that the vegetables consumed were irrigated with LQW, they still preferred consuming those vegetables especially sweet potato leaves because they recognised them as nutritious and good for their health regardless of the kind of water used in irrigation.

Moreover, the study results showed that large percent of consumers' perceived vegetables irrigated with LQW to be not safe. Among the five most consumed vegetables in the study area, only one type (okra) was perceived as safe by most of the respondents with the reason that although it was irrigated with LQW, the consumable part of okra was not touched by water used for irrigation. Vegetable consumers showed a need that vegetable farmers should be relocated to areas with good quality water. The knowledge that vegetables were irrigated with LQW influenced consumers to engage in several practices like washing and cooking vegetables before eating in order to maintain its safety.

5.2 Recommendations

Based on the conclusions made above, the study would recommend the following:

(i) Morogoro Municipal Council (MMC) through Morogoro Rural and Urban Water Supply Authority (MORUWASA) should test LQW to know its level of contamination and its suitability for irrigation of vegetables. If possible the test results should be communicated to vegetable farmers, vendors, consumers so that they can use it with cautions. Vegetables irrigated with LQW should also be tested so as to assure the consumers' safety.

(ii) MMC Environmental Health Officers should provide education to the communities on how to maintain hygiene for reducing contamination due to use of LQW for irrigation of vegetables.

(iii) MMC agricultural extension agents should educate vegetable farmers on how to safely irrigate their vegetables using LQW to reduce contaminations of vegetables to consumers.

(iv) MMC should look for places with good quality water and relocate vegetable farmers. Also, MMC should dig wells so that vegetable farmers can access good quality water and stop using LQW.

(v) The present study collected information on consumers' knowledge about the safety of vegetables irrigated with LQW. It also examined consumers' perceptions and preferences on variety of vegetables irrigated with LQW in Morogoro Urban. However, the study did not capture in-depth information on the health risks of the consumers associated with eating vegetables irrigated with LQW. Neither did it look on the interventions to reduce health risks associated with eating vegetables irrigated with LQW. It is therefore recommended that, further research on those areas be conducted.

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APPENDICES

Appendix 1: Questionnaire for vegetable consumers

Interviewee Consent

Participation in this interview is voluntary. Your name and the information collected from you will be treated confidential. The Researcher will use this information to understand consumers' level of knowledge, perception and preference on vegetables irrigated with low quality water in the urban areas of Morogoro.

A: General Information

Respondent name ……..

Questionnaire number…….....Region…….District……...Ward……...

Name of interviewer……..Date ……..

B: Socio – economic and Demographic Characteristics

1) Sex of the respondent
   (a) Male (b) Female

2) What is your age in years?
   (a) Below 20 years (b) 21 - 40 years (c) 41 - 60 years (d) Above 60 years

3) Where were you born? Region…….. District…….
4) In which year did you came to Morogoro for the first time……
5) How many years have you lived in Morogoro Urban? …….
6) What is your marital status
   (a) Single (b) Married (c) Divorced (d) Widowed

7) Do you have children? Yes / No

8) If you have children, how many are there?

(1) Male…… (2) Female……

9) Do you live with other relatives? (extended family) Yes / No

10) If you live with relatives, how many are there?

(1) Male…… (2) Female……

11) What is the total number of people living in your house? ……

12) Do you stay in your own house? Yes, / No

13) If not owning a house, do you rent one? Yes / No

14) If you rent a house, how much do you pay per month? ……..…Tshs

15) If you rent a room, how much do you pay per month? ……..…Tshs

16) What is your level of education

(a)No formal education (b) Primary school education (c) Secondary school education (d) College/University

17) What is your occupation?

(a)Permanent employment (b) Temporary employed (b) Self-employed (c) Jobless (d) Others, specify……..

18) Do you keep livestock Yes / No

19) If you keep livestock, what types of livestock and how many do you keep?

Livestock **Number of livestock**

1. ……. ……
2. ……. ……
3. ……. ……
4. ……. ……

20) What is your main economic activity?

.....

21) What is your monthly income from your main economic activity?.....Tshs/month

22) What was your average income per month (from January to August 2013) from other economic activities apart from your main economic activity mentioned above?

Activity	**Income per month**
1. ……..	…….
2. ……..	……..
3. ……..	…….
4. ……..	…….

23) Mention the types of vegetables that you normally eat

(a)…….

(b)…….

(c)…….

(d)…….

(e)…….

24) Where do you get the vegetables that you eat?

(a)At the market

(b) Direct from the farmers

(c) From my own garden

(d) Others, specify……

25) What is the peak season of the year for the availability of vegetables

(a)Rainy season

(b) Dry season

(c)Both seasons

(d) All year round

26) How many bundles of each of the following vegetables do you buy for eating per day?

Vegetable type	**5. Bundles**	**6. Price per bundle (Tshs)**
Chinese cabbage	7.	8.
Amaranths	10.	11.
. Pumpkin leaves	13.	14.
. Sweet potato leaves	16.	17.
. Okra	19.	20.

*Determine the average size of one bundle …….. (kg)

C: Knowledge Questions

27) Do you know the place where these vegetables are cultivated? Yes / No

28) If the answer in question 27 above is Yes, mention the places (wards)

……

29) Do you know the source of water used for irrigating vegetables? Yes / No

30) Do you know the status of water used to irrigate the vegetables just by looking at it? Safe / Not safe

31) Are you aware that some vegetables in the urban areas of Morogoro are irrigated with Low Quality Water? Yes / No

32) What is the % of your level of awareness from question 31 above?.....%

33) Do you know that the vegetables that you eat are irrigated with Low Quality Water? Yes / No

34) Give the percentage of your level of understanding about this…….%

35) Do you have permanent place for buying the vegetables that you eat? Yes / No

36) Give reasons for your decision of having permanent place for buying vegetables

……

……

37) Do you know any health problem/disease that is caused by eating vegetables irrigated with low quality water? Yes / No.

38) If you know the health problems caused by consuming vegetables irrigated with low quality water, mention them.……...……

……

39) Do you know any member of your family who fell sick because of eating vegetables irrigated with low quality water?

Yes / No

40) Do you wash vegetables before you eat them? Yes / No

41) If you wash vegetables, for what reasons do you think that it is important to wash them before cooking?

……

……

42) Do you have a tendency of asking where the vegetables came from before you eat? (if you are not the one who prepared the food)

Yes / No

43) If the answer in 42 above is Yes, why do you want to know the source of vegetables?

……

……

44) Do you know any vegetable contamination that is associated with using Low Quality Water for irrigation

Yes / No

45) If Yes, mention those contaminations

……

……

E: Perception Questions

46) If you eat vegetables irrigated with low quality water, do you perceive them as safe to eat? Yes / No

47) Give the percentage for perceiving this way……..%

48) Which type of the following vegetables irrigated with low quality water do you perceive them as safe or not safe to eat? What is the reason behind this perception?

Type of vegetable	**Perceive them as safe / not safe**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

49) Have you ever refused to eat/buy some vegetables because you perceive them as being irrigated with low quality water? Yes / No

50) Give the % for the response of question 49 above ……%

51) Do you perceive that some vegetables are safe to eat in its raw form? Yes / No

52) Give the reasons and percentage for perceiving this way.

Type of vegetable	**Perceive them as safe / not safe**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

53) Do you also eat the vegetables irrigated with low quality water? Yes / No

54) What is your perception with regard to the safety of these vegetables you eat? Safe / Not safe.

D: Preference Questions

55) Mention the top five vegetables that you most prefer to eat

1. …… 2. ……. 3. ……

4. …… 5……

56) Indicate the most preferred vegetables (by your family/customers) and the reasons for the preference.

Consumer	Most preferred vegetable	Reasons for preference
Households		
Hotels		
Restaurants		
Mama lishe		

57) If you become aware that the vegetables you eat are irrigated with Low Quality Water, do you think that you would still prefer to eat them? Prefer / Do not prefer

58) If you had a chance of eating vegetables irrigated with clean water would you still prefer to eat vegetables irrigated with low quality water? Prefer / Do not prefer

59) Give reasons as to why you prefer to eat vegetables irrigated with low quality water…….

60) When buying vegetables, is there a price difference between vegetables irrigated with low quality water and with clean water?

Yes / No

61) If there is any price difference, give reason as to why? ……

……

62) Do you have any comments/suggestions about using low quality water for vegetable irrigation?

.....

.....

Thank you for your cooperation

Appendix 2: Questionnaire for vegetable growers

Interviewee Consent

Participation in this interview is voluntary. Your name and the information collected from you will be treated confidential. The Researcher will use this information to understand consumers' level of knowledge, perception and preference on vegetables irrigated with low quality water in the urban areas of Morogoro.

A: General Information

Respondent name ……

Questionnaire number…..Region…….District……..…...Ward……

Name of interviewer…….…….Date ……..

B: Socio – economic and Demographic Characteristics

1) Sex of the respondent
   a. Male (b) Female

2) What is your age in years?
   a. Below 20 years (b) 21 - 40 years (c) 41 - 60 years (d) Above 60 years
3) Where were you born? Region…….. District…….
4) In which year did you came to Morogoro for the first time……
5) How many years have you lived in Morogoro Urban? …….
6) What is your marital status
   a. Single (b)Married (c)Divorced (d) Widowed
7) Do you have children? Yes / No
8) If you have children, how many are there?
   (2) Male…… (2) Female……
9) Do you live with other relatives? (extended family) Yes / No
10) If you live with relatives, how many are there?
   (2) Male…… (2) Female……

11) What is the total number of people living in your house? ……

12) Do you stay in your own house? Yes, / No

13) If not owning a house, do you rent one? Yes / No

14) If you rent a house, how much do you pay per month? ……..…Tshs

15) If you rent a room, how much do you pay per month? ……..…Tshs

16) What is your level of education

(a)No formal education (b) Primary school education (c) Secondary school education (d) College/University

17) What is your occupation?

(a)Permanent employment (b) Temporary employed (b) Self-employed (c) Jobless

d) Others, specify……..

18) Do you keep livestock Yes / No

19) If you keep livestock, what types of livestock and how many do you keep?

Livestock	**Number of livestock**
5. …….	……
6. …….	……
7. …….	……
8. …….	……

20) What is your main economic activity? .....

21) What is your monthly income from your main economic activity?.....Tshs/month

22) What was your average income per month (from January to August 2013) from other economic activities apart from your main economic activity mentioned above?

Activity	**Income per month**
a. ……..	……
b. ……..	……..
c. ……..	…….
d. ……..	…….

23) What type of vegetables do you grow?

(a)…….

(b)…….

(c)…….

(d)…….

(e)…….

24) What is the peak season of the year for the availability of vegetables?

(a)Rainy season

(b) Dry season

(c)Both seasons

(d) All year round

25) How many bundles of each of the following vegetables do you sell per day?

Vegetable type	**Bundles**	**Price per bundle (tshs)**
Chinese cabbage		
Amaranths		
Pumpkin leaves		
Sweet potato leaves		
Okra		

*Determine the average size of one bundle …….. (kg)

26) Of these, who are your permanent customers?

a. Individual customers at household
b. Hotels
c. Restaurants
d. Mama lishe
e. Others, specify……..

C: Knowledge Questions

27) Mention the sources of water that you use to irrigate the vegetables

1)……

2)……

3)……

4)……

28) Do you know the status of water used to irrigate the vegetables just by looking at it? Safe / Not safe

29) Are you aware that some vegetables in the urban areas of Morogoro are irrigated with Low Quality Water? Yes / No

30) What is the % of your level of awareness from question 29 above?.....%

31) Do you also irrigate the vegetables with Low Quality Water? Yes / No

32) Do you have permanent customers to whom you sell vegetables? Yes / No

33) Do your customers know the source of water used to irrigate the vegetable they buy from you? Yes / No

34) Give the percentage of those who know about this ……%

35) Do you think that individual customers in households know that they eat vegetables irrigated with low quality water?
Yes / No

36) Give the percentage of those who know about this ……..%

37) Do you think that consumers in hotels know that they eat vegetables irrigated with low quality water? Yes / No

38) Give the percentage of those who know about this ……..%

39) Do you think that consumers in restaurants know that they eat vegetables irrigated with low quality water? Yes / No

40) Give the percentage of those who know about this ……..%

41) Do you think that consumers at *mama lishe* know that they eat vegetables irrigated with low quality water? Yes / No

42) Give the percentage of those who know about this ……..%

43) Do you know any health problem/disease that is caused by eating vegetables irrigated with low quality water? Yes / No

44) If you know the health problems caused by eating vegetables irrigated with low quality water, mention them.

……

45) Do you know any member of your family who fell sick because of eating vegetables irrigated with low quality water?

Yes / No

46) Do you wash vegetables before selling them? Yes / No

47) If you wash the vegetables, with what kind of water do you wash them?

Fresh water / Low quality water

48) If you wash vegetables using fresh water, give reasons for selecting this kind of water.

……

……

If you wash vegetables using low quality water, have you experienced any health problems? Yes / No

49) If the answer in question 49 above is Yes, mention the health problems that you experienced…….

……

50) Do you know any vegetable contamination that is associated with using Low Quality Water for irrigation

Yes / No

51) If Yes, mention those contaminations

……

……

E: Perception Questions

52) Do customers that you sell vegetables to, perceive them as safe to eat? Yes / No

53) Give the percentage of those who perceive this way ……%

54) Which type of the following vegetables irrigated with low quality water do individual customers at household level perceive them as safe or not safe to eat? What is the reason behind this perception

55)

Type of vegetable	**Perceive them as safe / not safe**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

56) Which type of the following vegetables irrigated with low quality water do customers in hotels perceive them as safe or not safe to eat? What is the reason behind this perception?

Type of vegetable	**Perception**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

57) Which type of the following vegetables irrigated with low quality water do customers in restaurants perceive them as safe or not safe to eat? What is the reason behind this perception?

Type of vegetable	**Perception**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

58) Which type of the following vegetables irrigated with low quality water do customers in *mama lishe* perceive them as safe or not safe to eat? What is the reason behind this perception

Type of vegetable	**Perception**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

59) Do you have consumers who do not buy the vegetables because they perceive them as being irrigated with low quality water? Yes / No

60) Give the % for the response of question 60 above ……%

61) Do you also eat the vegetables irrigated with low quality water? Yes / No

62) What is your perception with regard to the safety of these vegetables you grow and eat? Safe / Not safe.

D: Preference Questions

63) Mention the top five vegetables that most consumers prefer to buy from your garden

2. …… 2. …….. 3. ……

4. …… 5……

64) Of the four groups of your main customers, indicate the most preferred vegetables and the reasons for their preference.

Customer	**Most preferred vegetable**	**Reasons for preference**
Households		
Hotels		
Restaurants		
Mama lishe		

65) If consumers become aware that the vegetables they eat are irrigated with Low Quality Water, do you think that they would still prefer to buy them? Prefer / Do not prefer

66) If you had a chance of selling vegetables irrigated with clean water would you still prefer to sell vegetables irrigated with low quality water? Prefer / Do not prefer

67) Give reasons as to why you prefer to sell vegetables irrigated with low quality water?

……

……

68) When selling vegetables to your customers, is there a price difference between vegetables irrigated with low quality water and with clean water? Yes/ No

69) If there is any price difference, give reason as to why? ……

70) Do you have any comments/suggestions about using low quality water for vegetable production?

.....

.....

Thank you for your cooperation

Appendix 3: Questionnaire for vegetable street vendor

Interviewee Consent

Participation in this interview is voluntary. Your name and the information collected from you will be treated confidential. The Researcher will use this information to understand consumers' level of knowledge, perception and preference on vegetables irrigated with low quality water in the urban areas of Morogoro.

A: General Information

Respondent name

……

Questionnaire

number…….....Region…….District……Ward……

Name of interviewer……Date ……..

B: Socio – economic and Demographic Characteristics

1) Sex of the respondent
   (a) Male (b) Female

2) What is your age in years?
   a. Below 20 years (b) 21 - 40 years (c) 41 - 60 years (d) Above 60 years
3) Where were you born? Region…….. District…….
4) In which year did you came to Morogoro for the first time……
5) How many years have you lived in Morogoro urban? …….
6) What is your marital status
   a. Single (b)Married (c)Divorced (d) Widowed
7) Do you have children? Yes / No
8) If you have children, how many are there?
   (3) Male…… (2) Female……
9) Do you live with other relatives? (extended family) Yes / No
10) If you live with relatives, how many are there?
   (1)Male…… (2) Female……

11) What is the total number of people living in your house? ……

12) Do you stay in your own house? Yes, / No

13) If not owning a house, do you rent one? Yes / No

14) If you rent a house, how much do you pay per month? ……..…Tshs

15) If you rent a room, how much do you pay per month? ……..…Tshs

16) What is your level of education

(a)No formal education (b) Primary school education (c) Secondary school education (d) College/University

17) What is your occupation?

(a)Permanent employment (b) Temporary employed (b) Self-employed (c) Jobless

d) Others, specify……..

18) Do you keep livestock Yes / No

19) If you keep livestock, what types of livestock and how many do you keep?

Livestock	**Number of livestock**
1…….	……
2…….	……
3…….	……
4…….	……

20) What is your main economic activity?

.....

21) What is your monthly income from your main economic activity?.....Tshs/month

22) What was your average income per month (from January to August 2013) from other economic activities apart from your main economic activity mentioned above?

Activity	**Income per month**
1 ……..	…….
2 ……..	……..
3 ……..	…….

23) What type of vegetables do you sell among the following

(a)…….

(b)…….

(c)…….

(d)…….

(e)…….

24) Where do you get the vegetables that you sell?

(a)At the market

(b) Direct from the farmers

(e) From my own garden

(f) Others, specify……

25) What is the peak season of the year for the availability of vegetables

(a)Rainy season

(b) Dry season

(c)Both seasons

(d) All year round

26) How many bundles of each of the following vegetables do you sell per day?

Vegetable type	**Bundles**	**Price per bundle (tshs)**
Chinese cabbage		
Amaranths		
Pumpkin leaves		
Sweet potato leaves		
Okra		

*Determine the average size of one bundle …….. (kg)

27) Of these, who are your permanent customers?

a. Individual customers at household

b. Hotels

c. Restaurants

d. Mama lishe

e. Others, specify……..

C: Knowledge Questions

28) Do you know the source of water used for irrigating vegetables? Yes / No

29) Do you know the status of water used to irrigate the vegetables just by looking at it? Safe / Not safe

30) Are you aware that some vegetables in the urban areas of Morogoro are irrigated with Low Quality Water? Yes / No

31) What is the % of your level of awareness from question 30 above?.....%

32) Do you know that the vegetables that you sell are irrigated with Low Quality Water? Yes / No

33) Do you have permanent customers to whom you sell vegetables? Yes / No

34) Do your customers know the source of water used to irrigate the vegetable they buy from you? Yes / No

35) Give the percentage of those who know about this ……%

36) Do you think that individual customers in households know that they eat vegetables irrigated with low quality water?
Yes / No

37) Give the percentage of those who know about this ……..%

38) Do you think that consumers in hotels know that they eat vegetables irrigated with low quality water? Yes / No

39) Give the percentage of those who know about this ……..%

40) Do you think that consumers in restaurants know that they eat vegetables irrigated with low quality water? Yes / No

41) Give the percentage of those who know about this ……..%

42) Do you think that consumers at *mama lishe* know that they eat vegetables irrigated with low quality water? Yes / No

43) Give the percentage of those who know about this ……..%

44) Do you know any health problem/disease that is caused by consuming vegetables irrigated with low quality water? Yes / No.

45) If you know the health problems caused by consuming vegetables irrigated with low quality water, mention them.……

46) Do you know any member of your family who fell sick because of consuming vegetables irrigated with low quality water? Yes / No

47) Do you wash vegetables before selling them? Yes / No

48) If you wash the vegetables, with what kind of water do you wash them?

Fresh water / Low quality water

49) If you wash vegetables using fresh water, give reasons for doing it.

……

……

50) If you wash vegetables using low quality water, have you experienced any health problems? Yes / No

51) If the answer in question 49 above is Yes, mention the health problems that you experienced…….

……...

52) Do you know any vegetable contamination that is associated with using Low Quality Water for irrigation Yes / No

53) If Yes, mention those contaminations

……

……

E: Perception Questions

54) Do customers that you sell vegetables to perceive them as safe to eat? Yes / No

55) Give the percentage of those who perceive this way ……%

56) Which type of the following vegetables irrigated with low quality water do individual customers at household level perceive them as safe or not safe to eat? What is the reason behind this perception

Type of vegetable	**Perceive them as safe / not safe**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

57) Which type of the following vegetables irrigated with low quality water do customers in hotels perceive them as safe or not safe to eat? What is the reason behind this perception?

Type of vegetable	**Perception**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

58) Which type of the following vegetables irrigated with low quality water do customers in restaurants perceive them as safe or not safe to eat? What is the reason behind this perception

Type of vegetable	**Perception**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

59) Which type of the following vegetables irrigated with low quality water do customers in *mama lishe* perceive them as safe or not safe to eat? What is the reason behind this perception

Type of vegetable	**Perception**	**%**	**Reason**
Chinese cabbage			
Amaranths			
Pumpkin leaves			
Sweet potato leaves			
Okra			

60) Do you have consumers who do not buy the vegetables because they perceive them as being irrigated with low quality water? Yes / No

61) Give the % for the response of question 60 above ……%

62) Do you also eat the vegetables irrigated with low quality water? Yes / No

63) What is your perception with regard to the safety of these vegetables you eat? Safe / Not safe.

D: Preference Questions

64) Mention the top five vegetables that most consumers prefer to buy

3. …… 2. ……. 3. ……

4. …… 5……

65) Of the four groups of your main customers, indicate the most preferred vegetables and the reasons for their preference.

Customer	**Most preferred vegetable**	**Reasons for preference**
Households		
Hotels		
Restaurants		
Mama lishe		

66) If consumers become aware that the vegetables they eat are irrigated with Low Quality Water, do you think that they would still prefer to buy them? Prefer / Not prefer

67) If you had a chance of selling vegetables irrigated with clean water would you still prefer to sell vegetables irrigated with low quality water? Prefer / Not prefer

68) Give reasons as to why you prefer to sell vegetables irrigated with low quality water.

……

……

69) When buying vegetables in bulk for selling, is there a price difference between vegetables irrigated with low quality water and with clean water? Yes / No

70) If there is any price difference, give reason as to why? ……

……

71) Do you have any comments/suggestions about using low quality water for vegetable irrigation?

.....

.....

Thank you for your cooperation

Appendix 4: Checklist for Key Informants

A Checklist for Key Informants

Name of the interviewee…… Career …….....

Sex ……. Date …….…….

Ward …… Street ……

A: Introduction

My name is Shukrani Mdegela, studying at Sokoine University of Agriculture.

I am interested in learning about the knowledge of vegetable consumers on water used for irrigating vegetables. Also I want to know the consumers' preferences of the vegetables irrigated with Low Quality Water. I hope that your response to my questions will make this research a success. This discussion is confidential and the information will only be used for this study.

B: General question:

1. What are your roles and economic responsibilities in this community?

C: Questions about the knowledge on safety of vegetables irrigated with Low Quality Water:

1. What are the sources of water that farmers in this area use to irrigate their vegetables?
2. What are the top five vegetables grown in this area?
3. What are the top five vegetables that are most consumed in this area?
4. Do farmers in this community use Low Quality Water to irrigate their vegetables?
5. Are the community members aware that Low Quality Water is used to irrigate vegetables?
6. Do people here know that the vegetables consumed are irrigated with low quality water?
7. Do people in this community prefer consuming vegetables produced using low quality water?
8. What do the community members say about the safety of these vegetable?
9. Do you think that vegetables irrigated with Low Quality Water are safe for consumption?

10. Do you also consume vegetables irrigated with low quality water?
11. Are there any vegetable contaminations resulting from irrigation with Low Quality Water?
12. Are there any health problems that community members explain from consuming vegetables irrigated with Low Quality Water?

What comments do you offer about vegetables consumed that are produced using low quality water?

Thank you for your cooperation.

Appendix 5: Checklist for Focus Group Discussions

Focus Group Discussion Checklist

Name of group interviewed: ……..... Date: …….

Site: …….. Time discussion started: …… Time ended: ……

Participants' summary: No. of women: …….. No. of men: ……. Total No.……

Name of moderators: …….. Name of record keeper: ……

A: Introduction

My name is Shukrani Mdegela, studying at Sokoine University of Agriculture.

I am interested in learning about the knowledge of vegetable consumers on water used for irrigating vegetables. Also I want to know the consumers' preferences of the vegetables irrigated with Low Quality Water. I hope that your response to my questions will make this research a success. This discussion is confidential and the information will only be used for this study.

B: General questions:

1. What are the social and economic activities in your community?
2. What are the roles of men in this community?
3. What are the roles of women in this community?

C: Questions about the knowledge on safety of vegetables irrigated with Low Quality Water

13. What are the sources of water that farmers in this area use to irrigate their vegetables?
14. What are the top five vegetables grown in this area?
15. What are the top five vegetables that are most consumed in this area?
16. Do farmers in this community use Low Quality Water to irrigate their vegetables?
17. Are the community members aware that Low Quality Water is used to irrigate vegetables?
18. Do people here know that the vegetables consumed are irrigated with low quality water?

19. Do people in this community prefer consuming vegetables produced using low quality water?
20. What do the community members say about the safety of these vegetable?
21. Do you think that vegetables irrigated with Low Quality Water are safe for consumption?
22. Do you also consume vegetables irrigated with low quality water?
23. Are there any vegetable contaminations resulting from irrigation with Low Quality Water?
24. Are there any health problems that community members explain from consuming vegetables irrigated with Low Quality Water?
25. What comments do you offer about vegetables consumed that are produced using low quality water?

Thank you for your cooperation