CHAPTER ONE 1.0 NATURE AND BACKGROUND OF THE STUDY

1.1 Background of the study

Consumers demand for vegetables the world over have recorded a remarkable increase partly due to urbanization. This can be attributed partly to the important part vegetables play in the healthy diet and if sufficiently consumed in daily amounts could help prevent major diseases such as coronary heart diseases and cancers (Renaud *et al*., 1995). Vegetable production is typified by urban and peri-urban agriculture with the use of wastewater which is found to have microbial pathogens (Oboubie *et al*., 2006). Wastewater has become a resource of global importance (Bruechler *et al*., 2002) and its use in urban and peri-urban Agriculture (UPA) has increased because of the increasing scarcity of freshwater resources in arid and semi-arid countries (Van der Hoek, 2003). However, it is assumed that, the use of wastewater in urban and peri-urban Agriculture (UPA) will result in marginal increase in cost of production and consequently low profit margins and/or negative margins for many producers. This is attributed to concerns related to vegetable safety and /or environmental quality by vegetable consumers'.

These factors have led to the development and testing of safer alternatives of using wastewater. In order to improve on the quality of vegetables produced by using wastewater, two projects were supported in Ghana by Challenge Project on Water and Food (CPWF) to assess and test some of the non-treatment options of wastewater use in urban vegetable production. The assessment and the test were carried out at the farms, markets and the consumer kitchen level and the preliminary results showed that, safer wastewater application techniques such as the use of drip irrigation, cessation of irrigation for few days (3-5days) before harvest and other post-harvest measures such as sanitary

washing of vegetables showed a significantly reduced microbiological contamination of wastewater irrigated vegetables. In addition, results from studies on the general perception of wastewater use in vegetable production indicates that, there is divergence in the knowledge, attitudes and behavior exhibited by farmers, vegetable sellers and street food vendors with associated health risk. Ghanaian vegetable consumers are at higher risk of getting contaminated by wastewater related infections since their knowledge and perception about risk-reduction technologies seem to be inadequate and hence, their inability to differentiate the attributes of the vegetables in the market.

Economic theory suggests that a non-disturbing incentive requires the eco-incentive to be set equal to the marginal value of negative externalities associated with pesticide (Travisi and Nijkamp, 2004). This theory can be likened to the usage of wastewater in Urban and peri-urban Agriculture. In this perspective, a proper incentive program requires a precise estimation of consumers willingness to pay (WTP) for health risk reduction of wastewater use in vegetable production in Ghana. Economic variables associated with health risk reduction and environmental safety is therefore seem to be difficult to measure. The study used choice experiment (CE) to estimate the value of reducing multiple negative impacts on wastewater use in urban and peri-urban areas of Ghana by measuring consumers' willingness to pay (WTP) for safer vegetables (Hanley *et al*., 1997).

1.2 Statement of the problem

There is increased awareness of the health promoting and protecting properties of vegetables because, it provides significant amounts of beta carotene and mineral salts such as iron, calcium and zinc in daily diets. For a good health and vitality, a minimum amount

of daily vegetable intake of 400g is recommended (WHO, 1990). In Africa, vegetables are part of the daily diets in the form of soups and sauces accompanied by carbohydrate staples (Smith and Pablo, 2007). Based on World Health Organization's initiative on fruit and vegetable consumption, a frame work that proposes ways to promote increased production, availability and access, and adequate consumption of vegetables was developed. The framework is to guide in the development of a costefficient and effective intervention for the promotion of adequate consumption of vegetables at the national and sub-regional levels (WHO 1989, 2006). Vegetables in sub-Saharan Africa especially Ghana, are produced in the urban and peri-urban cities mainly by using wastewater from streams and drains.

Studies carried out in Accra, Kumasi and Tamale show that, both faecal coliforms and helminthes contamination of vegetables (lettuce, cabbage and spring onions) produced and marketed in the various cities using wastewater, exceeded the WHO recommended levels (Obuobie *et al*., 2006). Many consumers cannot differentiate consumable vegetable produce and are therefore vulnerable to the health risks associated with the wastewater use in urban and peri-urban agriculture. Some management practices (nontreatment options of wastewater use) have been developed and tried based on the new WHO guidelines on wastewater use to help reduce health risks associated with vegetables produced from using wastewater in urban and peri-urban Ghana.

Vegetables produced by using non-treatment options of wastewater use in urban and peri-urban Agriculture (UPA) are found to be "safer" and have advantages such as; reduced

pathogen and faecal content on vegetables to consumers and producers and also, minimal environmental hazards. The assumption is that, safer vegetable production cost will significantly increase if these non-treatment options are adopted. However, none of the benefits will be realized unless consumers are willing to pay a little above their household income to be able to enjoy such benefits.

1.3 Research Questions

These management practices (non-treatment options of wastewater use) when implemented and adopted by the urban and peri-urban farmers and sellers will result in "safer" vegetables with reduced health risk (pathogen) to consumers in Ghana, but are urban and peri-urban consumers:

1) Aware of the health risks associated with vegetables produced with wastewater and on the stage along the food chain where vegetables get contaminated?

2) Willing to pay for improved environmental quality and safer vegetables produced from the non-treatment options of wastewater use in vegetable production?

3) Does socio-economic/attitudinal characteristics have impact on their willingness to pay (WTP) for "safer vegetables"?

1.4 Objectives of the study

1.4.1 Main objective

The main objective of the study is to estimate consumers' willingness to pay for "safer'' vegetables and environmental improvement in urban and peri-urban vegetable production in Ghana

1.4.2 Specific objectives

The specific objectives of the study are to:

i. Assess consumers' health concerns about vegetable consumption and their perceptions about the level on the food chain where vegetables get contaminated.
ii. Analyze consumers' willingness to pay for safer vegetables and improved environmental quality.
iii. Assess the relationship between consumers WTP and their socioeconomic/attitudinal characteristics.

1.5 Justification of the study

The widespread use of wastewater in urban agriculture, especially in vegetable production provides a complex multidimensional negative effects for human health risk (microbial contamination) and environmental contamination. The empirical findings of this proposed study is therefore to provide quantitative WTP estimates and the availability of this detailed monetary estimates on individuals WTP for safer vegetables to help form the pivot in the design and implementation of appropriate non-treatment options of wastewater use in urban vegetable production and to plan a national incentive programme for the dissemination of more environmentally friendly agricultural practices.

The results on consumers willingness to pay for safer vegetables are also important for all stakeholders in the vegetable food chain; producers, retailers, and food vendors to help build consumer confidence in general. The WTP results together with the financial analysis will help give an informed decision on the viability and sustainability or

otherwise of the various non-treatment options of wastewater use in UPA. This will help in targeting urban and peri-urban health policies and the design and implementation of programmes aiming to reduce the negative effects of wastewater use in vegetable production. It will also help to improve the long term productivity and diversity of vegetable production in the urban and peri-urban poor who are mostly involved in urban agriculture

1.6 Working or research hypothesis

Based on literature reviewed, the following hypotheses are formulated and will be verified:

i. Consumers are concerned about the safety of the vegetables they consume

ii. Consumers have no knowledge regarding the stage on the food chain where vegetables get contaminated. iii. Consumers' are not willing to pay for safer vegetables from the different nontreatment options of wastewater use.

iv. Consumers' incomes, educational level and experience with vegetable borne disease are positively related to their individual WTP

v. Consumers' age, household size, marital status, major occupation and gender are negatively related to their individual WTP.

CHAPTER TWO REVIEW OF LITERATURE

2.0 Introduction

This chapter reviews the relevant literature obtained from studies to provide the context within which this study can be properly understood. The theoretical framework that has been applied for the analysis is also highlighted in this chapter. The topics covered include: theory of consumer choice (the consumer utility theory, consumer behaviour, empirical studies on consumers' WTP, socio-economic variables affecting WTP), and urban/peri-urban agriculture, (wastewater use in UPA, sources and composition of wastewater, benefits of wastewater use in UPA, risks associated with wastewater use in UPA, risks management in wastewater use, the non-treatment options of wastewater use in UPA).

2.1 Theory of consumer choice

2.1.1 The consumer utility theory

The basic economic framework of individual preferences is the standard microeconomic consumer theory of maximizing utility. An individual consumer chooses a consumption bundle faced with his budget restriction. That is;

$$\max(\text{).....} \; imizeUUXindifferencecurve = \; _{i}$$

$$subjecttopxMbudgetconstra \; \text{.....} \; \text{int}\sum_{ii} =$$

Where;

U = Utility
X_i is the vector of quantities

M is the money income for the consumer

P_i is the price of the quantity x_i

The consumers best choice is given where an indifference curve is tangent to the budget constraint.

It is assumed that the consumer will exhibit a rational behavior; choosing the bundle which is at least as good as any other among all the bundles. The individual is assumed to have a set of preferences over goods and services that can be ordered in a logical and consistent manner (Hanley and Splash, 1993). This preference ordering restricts an individual's demand for different consumption bundles. Utility function therefore serves as an index for the preference ordering. This allows us to express the most preferred consumption bundle by the highest level of utility. Changes in consumption bundles which lead to increase in utility are measured by economists as consumer surplus. The consumer surplus therefore is the consumers WTP for the improved quality (Hanley *et al*., 1997). Health risk in this case, can be classified as risk of illness (morbidity) and risk of death (mortality). Hence, the study is to estimate an individual's WTP for health reduced risk of illness.

Economic variables associated with health benefits and environmental qualities are challenging because environmental and health benefits are usually not traded in the market. (Hanley *et al*., 1997). Economists have therefore taken two fundamental routes in

the development of non-market, environmental valuation techniques: the revealed preference technique and the stated preference technique.

The demands for non-market valuation have not been satisfied by the use of the revealed preference techniques; the travel cost method and the hedonic pricing technique. This is because preference revealed in the past may be of little interest where new circumstances are expected to emerge (in this case safer vegetables from the nontreatment options of wastewater use). More so, there are only limited number of cases where non-market values exhibit a quantifiable relationship with a marketed good. Hence, the focus now is on the estimation of the 'total economic value' of the environmental impact which include not only the use value but the non-use value and hence the development of stated preference technique (Bennet and Blamey, 2001).

The stated preference technique includes the use of choice experiment (CE), contingent valuation (CV) and contingent ranking and rating methods to elicit consumers' willingness to pay (WTP) for reduced health risk and an improved environmental quality (Hanley and Splash, 1993). The CV applications have concerns raised against it regarding validity of the results based on numerous biases. The contingent ranking and rating method also have their shortcoming including are; difficulty in making interpersonal comparisons of ranking or rating data, the difficulty of respondents to rank large numbers of alternatives and the rating tasks in particular involve a departure from the context of choice actually faced by consumers. This study will employ the use of choice modeling (experiments) which is consistent with random utility theory in economics (Bennet and Blamey, 2001).

2.1.2 The Random Utility Theory

Choice experiment which belongs to the family of stated preference elicitation methods that provide information on preference ordering for all or a subset of choice options should be consistent with Random utility theory (RUT). The theory postulates that, an individual's utility (U) is a latent construct that exists in the mind of the consumer but that can be decomposed into a systematic or deterministic component (V) and unobserved or stochastic component (ε) (Louviere *et al*., 2000). That is for consumer *i* faced with *j* scenarios, the utility of scenario *j* can be expressed as in equation (1) below;

$$UV_{ijijij} = + \varepsilon \qquad (1)$$

Where;

U_{ij} = individual's utility of scenario *j*.

V_{ij} = systematic/deterministic component of utility

ε_{ij} = unobserved/stochastic component which is assumed to be independently and identically distributed.

$iN = 1,...,$
$JJ = 1,...,$

An individual consumer chooses option *J* when;

$$U_j > U_k, \forall \neq jk \quad (2)$$

The systematic component V_{ij} can be expressed as a linear function of the explanatory variables as in equation (3) below;

$$Vx_{ijij} = \beta' \quad (3)$$

From equations (1) and (2) above, it will be realized that a scenario j is selected if and only if;

$$()()VV_{ijijikik} + > + \varepsilon\varepsilon \quad (4)$$

Hence,

$$()()VV_{ijikikij} - > - \varepsilon\varepsilon \quad (5)$$

(Bannet and Blamey, 2001)

But since $()\varepsilon\varepsilon_{ikij} -$ cannot be observed, it is not possible to assess $()()VV_{ijikikij} - > - \varepsilon\varepsilon$ exactly and therefore, the probability that $()()VV_{ijikikij} - > - \varepsilon\varepsilon$ will be calculated as in equation (6) below;

$$(/)\{()()\}xAPVV^{ijikijijik} = - < - \varepsilon\varepsilon \quad (6)$$

$$\forall \in \neq jkAjk, ,$$

Where;

A= the choice set β = vector of coefficients to be estimated x_{ij} = vector of the characteristics of consumer *i* and attribute of scenario/option j .

For choice probabilities to be calculated, it is assumed that, the random variable is independently and identically distributed with Gumbel random variables. This leads to the familiar logit model (Bennet and Blamey, 2001) as in equation (7) below;

$$PjA(/) = \frac{\exp V_{ij}}{\Sigma_{j\neq 1}^{j} \exp V} \quad \ldots\ldots\ldots\ldots (7)$$

Equation (7) above implies that the probability of choosing option j depends on the utility of that option relative to the utility of the other options. The model above can be estimated using the maximum likelihood estimation method. According to Bannet and Blamey, 2001, the significance of the individual β coefficients can be assessed using their corresponding t-statistics (with a t-statistic of 1.96 indicating that, the attribute coefficient is statistically different from zero at 5% level). The overall explanatory power of the model is assessed using the log-likelihood statistic and the McFadden/pseudo R^2 statistic (for R^2, values between 0.2 and 0.4 are considered adequate).

The information collected from the field survey with the questionnaire can be modeled into a data matrix, each choice set will have five lines of code that will combine each ASCs, and socio-economic variables (Bennet and Blamey, 2001). For example using the variable for this study as shown in equation (8) below;

$$OPTIONAVASCHHEXPSECSDSE;\%_{1\%} = + + + \ \beta\beta\beta_{HHEXPSECSDSE}$$

$$OPTIONBVASCHHEXPSECSDSE;\%\ldots\ldots\ldots\ldots\ldots\ldots(8)_{21\%} = + + + \ \beta\beta\beta_{HHEXPSECSDSE}$$

$OPTIONCVASCHHEXPSECSDSE;\%_{32\%} = + + +$
$\beta\beta\beta_{HHEXPSECSDSE}$

$SDSE_{SE}$

$OPTIONDVASCHHEXPSEC;\%_{43\%} = + + +$
$\beta\beta\beta_{HHEXPSECSD}$
$OPTIONEVASCHHEXPSECSDSE;\%_{54\%} = + + + \beta\beta\beta_{HHEXPSECSDSE}$

Where;

V = Latent utility derived from the alternatives

SEC = Socio-economic variables

$\%HHEXP$= % of household expenditure spent on vegetables

$SDSE$ = Experience of vegetable borne disease

B_{SEC} =Coefficient of socio-economic variables

$B_{\%HHEXP}$= Coefficient of % household expenditure spent on vegetables

B_{SDSE} = Coefficient of experience of vegetable borne disease ASC

= Alternative specific constant.

The significance of the individual β (coefficients) is assessed using their corresponding t-statistics (with a t-statistic of 1.96 indicating that, the attribute coefficient is statistically different from zero at 5% level). The overall explanatory power of the model is assessed using the log-likelihood statistic and the McFadden/pseudo R^2 statistic (for R^2, values between 0.2 and 0.4 are considered adequate).

2.1.3 The choice experiment

Choice experiments are samples of choice sets or choice scenarios drawn from the universe of all possible choice sets. This is done according to statistical design principles such that, the overall choice experiment consists of a set that satisfy certain estimation requirements. It enables the probability of an alternative being chosen to be modeled in terms of the attributes used to describe the alternatives. Hence, it is expected that, the higher the level of a desirable attribute in an alternative, "*ceteris pari bus*" the higher the Utility associated with that option and more likely for a respondent to choose it (Bennet and Blamey, 2001).The assumption in the assessment of economic value for non-treatment options of wastewater use in urban Agriculture to bring about a change in human health risk reduction and environmental impact (soil and ground water contamination levels) is that its monetary value would reflect in consumers' behavior. Hence, this study seeks to analyze consumers' preferences regarding the choice of alternative scenarios of non-treatment options of wastewater use at both the market and the farm levels.

There are two kinds of choice data: Stated Preference (SP) and Revealed Preference (RP). The SP data are generated from the decision experiment (survey), while the RP data are from consumers' actual observed choice decisions. There are some major advantages of a stated preference method compared with revealed preference studies: for example, the SP method allows researchers to estimate and predict the demand for new products with new attributes; in the marketplace, the explanatory variables have little variability and they are usually highly correlated, which makes it difficult to obtain significant estimation

results, usually, SP data is less costly to collect and less time consuming than gathering RP data. Clearly, a challenge of stated preference surveys is their hypothetical nature; consumers may provide unrealistic answers if there is no cost to overstating their willingness to pay (Bennet and Blamey, 2001).

2.1.4 Consumer behaviour

According to Padberg et al. (1997), consumers' are described as social beings and based on theory; their behaviour is a complex, multidisciplinary approach with contributions from different social sciences such as; economics, psychology, anthropology, geography, nutrition and medicinal sciences. Consumer behaviour is driven by three factors: emotions, motive and attitude

That is, a higher emotion about produce leads to a stronger motivation which leads to change in attitude towards the product and hence the probability of behaviour changes (purchase). The evolvement of vegetable consumption can be described as follows; the stronger the health concern, the stronger the health motive in nutrition and more positive the health image of vegetables and hence the higher the probability of purchase.
Ghanaian consumers' are not left out since they are also social beings.

2.1.5 Empirical studies on food buying behaviour

Consumer buying behaviour according to Lancaster, 2001, consists of activities involved in the buying and using of product or service for personal and household use. The value consumers put on food depends not only on their income but several other influencing factors:

Extrinsic attributes are used by consumers' to perceive a product quality. Hence such attributes are described to have influence on consumers' purchasing motive. A study conducted in Ghana by Oboubie *et al*., 2006 found that characteristics such as freshness, colour and spotless leaves were considered by consumers' when buying vegetables. In Croatia, vegetable buyers consider freshness as the most important characteristic when buying vegetables (Kovacic *et al*., 2002).Vietnamese demand for products from modern supply chains especially modern retailers and non-traditional imports is highly income elastic and that supermarkets expansion had impact on consumers' demand for fruits and vegetables (Mergenthaler *et al*., 2007).

Sensory intrinsic attributes such as taste influences consumer buying behaviour. Combris *et al*., 2007, in trying to find answers to whether taste beats food safety, found that food safety instantly influenced consumers' willingness to pay whiles taste was preferred to the guarantee of food safety in driving buying behaviour. Through socialization, individuals' values are developed and these differ depending on one's cultural background. Hence culture-specific values can result in specific consumer behaviour (Reuters *et al*., 2006).

Consumers' awareness 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. Food safety information helps in quantifying consumers' response to food safety events, predicting market impacts and developing appropriate risk communication strategies (Beach *et al.*, 2008). Also, for competitiveness, food safety and quality assurance is a key driver (Jatib, 2003).

2.1.6 Empirical studies on WTP

In applied economics literature, empirical studies on consumers' willingness to pay have taken different approaches. In measuring quantitative willingness to pay in monetary estimates, several authors have used the traditional contingent valuation method. This method is a direct elicitation method by questioning an individual consumer what he/she would be willing to pay contingent on there being a product or service. For example; Boccaletti and Nardella, 2000, used contingent valuation method to assess willingness to pay for pesticides-free fresh fruit and vegetables in Italy and Garming *et al*., 2006, a case study of Nicaragua, also used contingent valuation method to assess willingness to pay to avoid health risks from pesticides.

Also, economists have used discrete choice, stated choice experiments and a host of other elicitation methods to elicit direct monetary estimates of willingness to pay for a product. For example; Goldberg *et al*., 2005, used both the choice experiments and contingent valuation methods to measure consumers willingness to pay for a health risk reduction of *Salmonellosis* and *Campylobateriosis* in Germany whilst Travisi and Nijkamp, 2004,

used the stated choice experiment approach to measure Italians willingness to pay for Agricultural environmental safety. Other approaches used to estimate willingness to pay include; conjoint analysis (as in Ara, 2003); survey rankings and ratings (as in Quagrainie, 2006); travel cost method (as in Gonzalez and Loomis, 2006) and experimental auction method (Yue *et al*., 2006; Groote *et al.*, 2006). Generally, results of consumers' willingness to pay have been shown to be positive and modest ranging between five to twenty percentage.

Even though willingness to pay techniques have been used extensively in Agriculture to assess several risks factors. None of such studies have been carried out in relation to wastewater use in urban/peri-urban agriculture. Hence this study used the stated choice experiment approach to estimate in monetary terms, Ghanaian consumers' willingness to pay for "safer" vegetables produced from the non-treatment options of wastewater use in urban and peri-urban vegetable production.

2.1.7 Socio-economic variables affecting consumers' WTP

A broad range of factors have been found to influence/ affect consumers' willingness to pay. Numerous studies have examined the effects of socioeconomic variables on consumers' willingness to pay for safer vegetables. Boccaletti and Nardella, 2000, used contingent valuation method to measure Italian consumers' willingness to pay for pesticide-free fresh fruit and vegetables and they found that consumers' willingness to pay is positively related to income and risk concern but negatively related to education.

In measuring consumers willingness to pay for health risk reduction of *Salmonellosis* and *Campylbacteriosis*, Goldberg and Roosen, 2005, used both contingent valuation method and choice experiment and found that household net income and age were positively related to willingness to pay whiles experience of food borne disease, gender and presence of children (<18 years) in the household were negatively related to willingness to pay.

Garming and Waibel, 2006, also used the contingent valuation method to measure farmers' willingness to pay to avoid health risk of pesticides in Nicaragua and they found that, willingness to pay depended on farmers' experience with poisoning, income variables and pesticide exposure. Income, education, risk index, presence of children in the household and females had a positive relation to consumers' willingness to pay when Buzby *et al*., 1998, used contingent valuation method to measure consumer benefit of food safety risk reductions in the USA. I shall be making comparison with the findings of these empirical results and that of theory to see the effects of Ghanaian consumers' socio-economic variables on their willingness to pay to be able to make a policy recommendation for stakeholders in the vegetable industry in Ghana.

2.2 Agro-food marketing

In Ghana, vegetable production is mostly done by men whiles the women are mostly involved in the marketing of the produce (Oboubie *et al*., 2006). Along the vegetable value chain, neither grading nor quality information is available for consumers to be able to make better choices. A study conducted along the coast of West Africa showed that women handle over 60-90% of domestic produce from the point of origin to consumption. The vegetable industry is constrained by efficient transportation system, storage facilities,

improper handling and grading. This makes the industry unattractive and can be a source of diseases since consumers' cannot differentiate the produce.

2.2.1 Marketing information

The prime focus of market information systems is to support market analysis for policy development. limited focus was justified by the traditionally strong influence of policy regulations on markets in the agro-food sector and, to a lesser extent, by the limited capacity of traditional information collection and delivery technology to provide information appropriate for business and consumer decision support' (Scheifer in Padberg *et al.*,1997). Adequate information on the demand, supply, price and safety conditions of vegetables are necessary traders, farmers, and consumers' and for an efficient vegetable industry in Ghana.

2.2.2 Vegetable pricing

Generally, because of the perishability of vegetables, it is accepted that, demand and supply are the principal factors in pricing. However, a retailer considers the wholesale cost of buying vegetables and expected profit to influence selling prices (Newman, 1977). Sometimes cost of transportation can influence selling price of vegetables. However, quality and safety assurance can also in a way have some marginal increases in prices of vegetables. But the urban vegetable producers are at the mercy of the market retailer because of the small-scale nature of their farms.

2.3 Importance of vegetables

Vegetables are part of the daily diets in the form of soups and sauces accompanied by carbohydrate staples (Smith and Pablo, 2007). This is due to the increased awareness of the health promoting and protecting properties of vegetables because, it provides significant amount of beta carotene, iron, calcium and zinc in daily diets, for a good health and vitality. Vegetables add flavor to the food and also provide considerable quantities of protein, vitamins and roughage which promotes digestion and prevents constipation (Dittoh, 1992). Vegetables are considered to be an important part of a healthy diet and if sufficiently consumed in daily amounts, could help in the prevention of major diseases such as coronary heart diseases and cancers (Renaud *et al*., 1995).

Vegetables can also help in the prevention and alleviation of several micronutrient deficiency diseases especially in the less developed countries which leads to hunger and malnutrition (WHO/FAO, 2004). Low vegetable intake is identified as a major contributor to mortality and that, adequate consumption could help prevent major chronic non-communicable diseases. Based on epidemiological findings, diets rich in vegetables have been found to significantly reduce the risk of ischemic heart disease, stroke and type two (2) diabetes (Bazzano *et al*., 2004). WHO, (1990) recommended that, a minimum of 400g/day of vegetable/fruit is required by an individual; however, the consumption is very low in sub-Saharan Africa (27-114kg/capita/year). The is far below the WHO/FAO recommended level of 146kg/capita/year (WHO/FAO, 2004).

Apart from improvement in the quality of the diets and health, the production and marketing of vegetables provides employment to many people especially in the dry season (Obuobie *et al.,* 2006).

2.4 Urban/Peri-Urban Agriculture (UPA)

Urban agriculture is a wide spread reality due to the rate of urbanization in developing countries, it is also as old as the cities themselves. The rate of urban growth comes with associated challenges especially the demand for food and employment (Cofie and Drechsel., 2006). About 20 million West Africans are estimated to currently live on some kind of urban agriculture (Drechsel *et al.,* 2006). Urban/peri-urban agriculture is specialized in the production of perishable products such as vegetables, milk and eggs. For example in Kumasi, all year-round open-space vegetable production is common in bottomlands and along rivers and streams (Avila *et al*., 2002).

The major vegetables cultivated by Urban farmers include: Lettuce (9-11 harvests per year), Cabbage (2-3 harvests per year) and Spring onions (8-9 harvests per year), others include; "Ayoyo" (*Corchorus sp.)*, "Alefi" (*Amaranthus sp*.), Carrots and Radish (Avila and van Veenhuizen, 2002). The production of these perishable produce increases the food supply by producing niche products for the nation (Avila and van Veenhuizen., 2002; Cofie and Drechsel, 2006). UPA can be market-oriented (as a source of income) or subsistence-oriented (as a supplement of household food requirements) or may serve both purposes. The persistence of UPA is due to the nearness to market and market information, demand for perishable products and productive resources (wastewater,

organic wastes, etc.) (Obuobie *et al*., 2006). Men are involved in open-space urban vegetable cultivation and women dominate in the marketing sector of the vegetables.

Financial analysis carried in Kumasi show that urban farmers with access to irrigation water earn twice the income they would have earned in the rural area. An average farm size of 0.05-0.2 ha, yields net revenue of about US$ 400-800/year (Obuobie *et al*., 2006).

2.4.1 Economic impact of UPA

Urban and Peri-urban Agriculture (UPA) contribution to the Gross Domestic Product (GDP) might be insignificant (Avila and van Veenhuizen, 2002) but it's important in: employment generation, livelihoods, poverty alleviation and complementing urban food security situation in African cities, especially, Ghana (Cofie and Drechsel, 2006; Obuobie *et al*., 2006).

Beyond provision of employment, livelihood and poverty alleviation, Obuoie *et al.*, 2006 also reported that urban agriculture contributes to: flood control, urban greening and biodiversity, land reclamation, resource protection, land protection and saving households expenditure on food for other household expenditures such as paying school fees and purchasing of school uniforms.

2.4.2 Wastewater use in UPA

Wastewater is the main source of water during the dry season for urban agriculture in developing countries especially in Africa. The increasing use of wastewater is due to population increase and related increase in demand for food in the growing urban cities. The increasing urbanization in developing countries results in the generation of high volumes of wastewater (IWMI, 2004). The wastewater generated in these urban cities especially in arid and semi-arid countries is available all year-round, inexpensive and a good source of nutrients for urban and peri-urban vegetable producers (Buechler *et al.*, 2002; Van der Hoek, 2003). This resulted in wastewater becoming a resource of global importance especially in urban and peri-urban agriculture (Buechler *et al.*, 2002).

An estimated total area of between 10,000 and 30,000 ha was reported by IWMI (2004) to have been under cultivation using undiluted wastewater in Vietnam and Pakistan. In Ghana, Agodzo *et al*., 2003 also reported that in 2000, an estimated 46,000 ha with an average farm size of 0.5 ha could have been irrigated using 10% of the estimated 2.78×10^8 m^3 of wastewater generated in the urban areas whose irrigation requirements is estimated to be 600mm/annum. In Kumasi alone, about 12,000 ha are cultivated using polluted water (IWMI, 2004).

Waste use in urban and peri-urban agriculture can be in several ways according to van der Hoek, 2003:

- Direct use of untreated wastewater; this is an irrigation source of wastewater taken directly from the sewerage systems and/or drains that carry large sewage flows.

- Direct use of treated wastewater also referred to as reclaimed water; this refers to wastewater that is treated and conveyed through a controlled exit from the point of treatment works to a controlled area where it is used for irrigation purposes.
- Indirect use of wastewater; this is where industrial and domestic wastewater is discharged without any form of treatment or monitoring into water bodies in urban cities. An example is found in Kumasi, where because of lack of sewerage system, a river which is polluted by diffuse urban runoff is used by many users along the river. Figure 2.1 below shows the basic uses of wastewater;

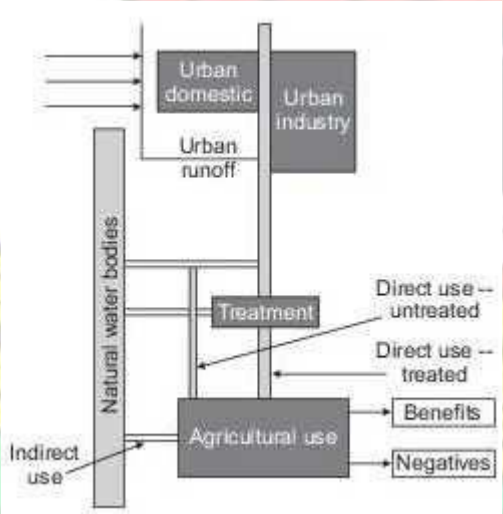

Fig. 2.1: Basic uses of wastewater (Source; van der Hoek, 2003).

2.4.3 Composition of wastewater.

Wastewater sources are reported by Buechler *et al*., 2002 to include: rivers, spouts from city sewage channels, urban streams, urban drains, shallow wells and ponds.

It is also reported by IWMI (2002), that, in Kumasi mostly hand dug wells and streams are used whiles in Accra, urban farmers mostly use water from drains and polluted streams.

Wastewater composition is based on the origin of the water. These include:

- Storm water, urban run-off and grey water; it is composed of domestic wastewater without urine and faeces.
- Black water; it is wastewater composed of urine and faeces
- Industrial wastewater; which is composed of a wide range of pollutants including heavy metals.
- Hospital and other institutional establishment.

(Buechler *et al.*, 2002; van der Hoek, 2003). Figure 2.2 below shows the components of wastewater in urban an peri-urban areas;

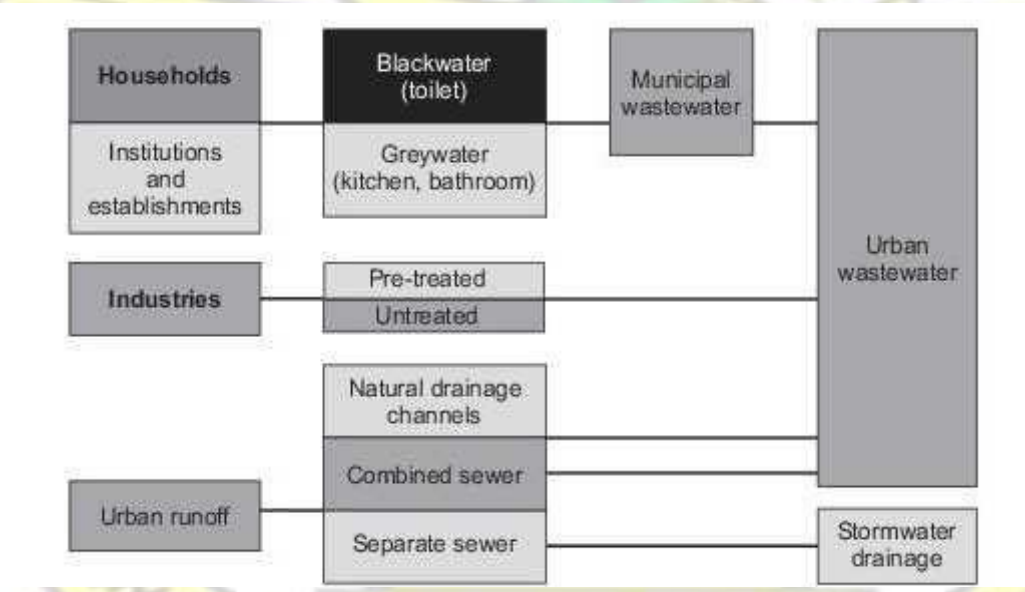

*Fig. **2.2: Components of urban wastewater (Source: van der Hoek, 2003).***

It is reported that, in urban Accra and Kumasi, wastewater is lifted by using buckets and watering cans whiles in peri-urban Kumasi, treadle and motor pumps are used. Overhead irrigation using watering cans or hand hose is also reported as the application method

commonly employed and that, furrow and sprinkler irrigation methods are seldom used due to tenure and land security issues (Buechler *et al*., 2002).

2.4.4 Benefits of Wastewater use in UPA

Wastewater use in urban/peri-urban agriculture reduces the use of artificial fertilizers and hence the environmental impact associated with mining Phosphorus and the production of artificial fertilizers. A treated municipal wastewater is found to supply 225kg of Nitrogen and 45kg of Phosphorus per hectare per year at an irrigation rate of 1.5m per year (WHO, 2006). This complements the farmer's effort by reducing the cost of farming as artificial fertilizers will not be bought and hence allows farmers income to rise. In Ghana, revenue generated from urban irrigated vegetable farming using wastewater is estimated to be about US$ 400-800 per year (Oboubie et al., 2006).

This, however, is an indication that, irrigation with wastewater is more productive than irrigation with fresh water, even when artificial fertilizers are used. Hence higher yields of crops imply availability of food and therefore lower prices as the economics of demand and supply indicates.

2.4.5 Risks of Wastewater use in UPA

Table 2.1: Summary of health effects of wastewater and excreta use in Agriculture.

	HEALTH RISKS		
GROUP EXPOSED	***Helminth infection***	***Bacterial/Viral infection***	***Protozoal infections***

CONSUMERS	*Significant risk of helminth infection for both adults and children with untreated wastewater*	*Cholera, typhoid and shigellosis outbreaks reported from use of untreated wastewater; seropositive responses for Helicobacter pylori(untreated); increase in non-specific diarrhea when water quality exceeds 10^4 thermotolerant coliforms/100ml*	*Evidence of parasitic protozoa found on wastewater-irrigated vegetable surfaces, but no direct evidence of disease transmission.*
FARM WORKERS AND THEIR FAMILIES	*Significant risk of helminth infection for both adults and children in contact with untreated wastewater; increased risk of hookworm infection for workers who do not wear shoes; risk for helminth infection remains, especially for children, even when wastewater is treated to <1 helminth egg per litre; adults are not at increased risk at this helminth concentration.*	*Increased risk of diarrhoeal disease in young children with wastewater contact if water quality exceeds 10^4 thermotolerant coliform/100ml; elevated risk of salmonella infection in children exposed to untreated wastewater; elevated seroresponse to norovirus in adults exposed to partially treated wastewater.*	*Risk of Giardia intestinalis infection reported to be insignificant for contact with both untreated and treated wastewater; however, another study in Pakistanhas estimated a threefold increase in Giardia infection for farmers using raw wastewaster compared with fresh water; increased risk of amoebiasis observed with contact with untreated wastewater.*
NEARBY COMMUNITIES	*Transmission of helminth infections not studied for sprinkler irrigation, but same as above for flood or furrow irrigation with heavy contact*	*Sprinkler irrigation with poor water quality ($10^6$$10^8$ thermotolerant coliformss/100ml) and high aerosol exposure associated with increased rates of infection; use of partially treated water (10^4-10^5 thermotolerant coliforms/100ml or less) in sprinkler irrigation is not associated with increased viral infection rates.*	*No data on transmission of protozoan infections during sprinkler irrigation with wastewater.*

Source: Blumenthal and Peasey, 2002.

Potentially, Agricultural workers and their farm families, crop handlers, consumers and people living around irrigated fields face the risks associated with wastewater use in urban and peri-urban Agriculture (RUAF, 2002). Epidemiological evidence from wastewater

use in Agriculture, suggests a high risks of transmission of intestinal nematodes and bacterial infections to consumers and farm workers. However, there was limited evidence that, the health of people living near wastewater-irrigated fields were affected (Shuval *et al*., 1986). Table 2.1 below shows a summary of epidemiological evidence of health effects of wastewater and excreta use in Agriculture.

In Ghana, microbiological studies conducted in three cites; Accra, Kumasi and Tamale by Amoah *et al*., 2006, showed that, faecal coliform level exceeded the WHO recommended level of 1×10^3 faecal coliform g^{-1} fresh weight. Lettuce, Cabbage and Spring onions were the vegetables purchased from the markets of the three cities. Lettuce recorded the highest level of faecal coliform contamination with a geometric mean of 1.1×10^7 g^{-1} wet weight whiles that of Cabbage and Spring onion were 3.3×10^6 and 1.1×10^6 g^{-1} wet weight respectively. They also reported on the mean helminthes egg populations of the Lettuce Cabbage and Spring onions as 1.1 g^{-1}, 0.4 g^{-1}, and 2.7 g^{-1} wet weight respectively. The helminthes eggs identified included; *Ascaris lumbricoides, Ancylostoma duodenale, Schistoma haematobium, and Trihirus trichiura.*
However, the dominant was the *Ascaris lumbricoides.*

Other hazards associated with wastewater include; bacteria (e.g. *E. coli, Vibrio cholerae, Salmonella spp., and Shigella spp*.), Schistosomes (e.g. trematode bloodflukes), Protozoa (e.g. *Giardia intestinalis, Cryptosporidium, Entamoeba spp*.), and Viruses (e.g.hepatitis A virus, hepatitis E virus, adenovirus, rotavirus, and norovirus). These pathogens are capable of survival in the environment; water, plants and soils, for long periods to allow

transmission to humans. The pathways of transmission of or exposure to pathogens or contaminants associated with wastewater use in agriculture include;

- Human contact with wastewater or contaminated crops before, during or after irrigation especially farmers, their families, vegetable vendors and local communities.
- Inhalation of wastewater aerosols especially, farm workers and local communities.
- Consumption of contaminated wastewater- irrigated products especially consumers and their farm families
- Consumption of drinking-water contaminated as a result of wastewater use activities (e.g. chemical or pathogen contamination of aquifers or surface waters).
- Consumption of animals or animal products that have been contaminated through exposure to wastewater.
- Vector-borne disease transmission as a result of development and management of wastewater irrigation schemes and wastewater stabilization ponds (WHO, 2006).

2.4.6 Risk management of wastewater use in UPA

Based on the risk associated with wastewater use in UPA, an expert meeting in Stockholm, Sweden in 1999, the International Water Association (IWA) on behalf of the World Health Organization (WHO) published *Water Quality: Guidelines, Standards and Health: Assessment of Risk and Risk Management for Water-related Infectious Disease*. This publication outlines a harmonized framework for the development of guidelines and standards for water-related microbiological hazards (Bartram *et al.*, 2001). The

framework involves the assessment of health risks prior to the setting of the health-based targets and the development of guideline values, defining basic control approaches and evaluating the impact of these combined approaches to public health as shown in figure 2.3 below.

Effective guidelines for health protection should be: feasible to implement; adaptable to local social, economic, and environmental factors; and include the following elements:

- Evidence-based health risk assessment
- Guidance for managing risk (including options other than wastewater treatment).
- Strategies for guideline implementation (including progressive implementation where necessary) (Carr *et al*., 2003)

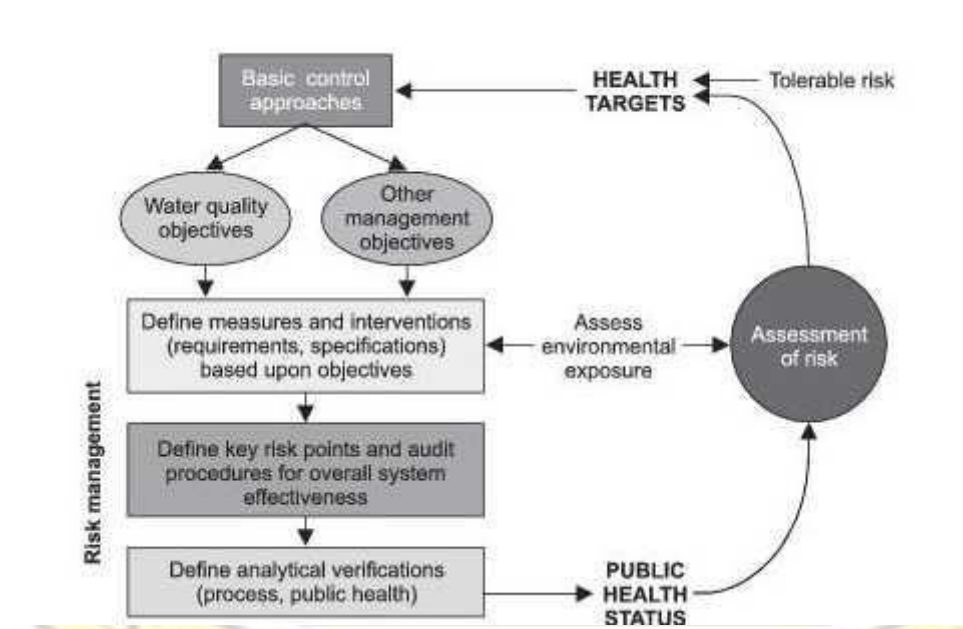

Fig. 2.3: Stockholm Framework for management of water-related diseases (source: Bartram *et al.*, 2001. cf. Carr *et al*., 2003).

2.5 The non-treatment options of wastewater use in UPA

Based on WHO recommendation for developing countries to try to use low-cost irrigation methods of wastewater use in urban/peri-urban agriculture due to high cost of treating the wastewater, Several management practices (non-treatment options of wastewater use) have been developed and tried based on the new WHO guidelines on wastewater use to help reduce health risks associated with vegetables produced from using wastewater in Ghana.

Keraita *et al*., 2007(a), tested the effectiveness of the use of drip irrigation kits and found that, the method gave a lowest contamination level of 4log units/100g of lettuce thermotolerant coliforms. They also found that, the use of watering cans with caps on the outlets and from a height <0.5m reduced thermotolerant coliforms by 2.5log units and helminths by 2.3log units/100g of lettuce compared with using watering cans without caps and a height >1m. Keraita *et al*., 2007(b), also assessed the effectiveness of cessation of irrigation before harvest in reducing microbial contamination of lettuce irrigated with wastewater in UPA. They found that, an average of 0.65log units for indicator thermotolerant coliforms and 0.4 helminth eggs/100g of lettuce were removed on each non-irrigated day from lettuce in the dry season. However, the cessation method was said not to be suitable for the rainy season due to unfavourable conditions for pathogen die-off.

Effectiveness of common indigenous washing method for the reduction of faecal coliform populations on the surface of wastewater irrigated vegetables was analyzed. It was found

that, households and restaurants in the sub-region are aware of vegetable related health risks and wash vegetables before consumption. They realised that, several of the most common methods do not reduce the contamination to any desirable levels. Significant log reductions could be achieved depending on the temperature of the water, the washing method employed, and the contact time. It was also found that, the use of relatively expensive vinegar with the apparent ineffective methods made improved strides. Also, up to 3log units reductions was found to be possible with the use of a much lower price household bleach ("Eau de javel") commonly used in Francophone West Africa (Amoah *et al*.,2007)

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter describes in detail the study area, the theoretical framework, where the theoretical definitions of willingness to pay concepts will be discussed. The analytical framework which examines the analytical model, the sampling techniques and sampling methods used, sources of data and method of data collection and analysis will also be discussed in this chapter.

3.1 The Study Area

The study was conducted in peri-urban and urban Accra and Kumasi.

3.1.1. Accra

Accra is the capital city of Ghana and covers an area of about 170 km^2. It has an estimated population of 1.8 million with an active population estimated to be 823,327. (GSS, 2002). The major economic activities in the Accra metropolis are grouped into three sectors, the primary sector (urban agriculture, fishing, mining and quarrying), the secondary sector (manufacturing, electricity, gas, water, and construction) and the tertiary sector (wholesale trade, retail trade, hotel, restaurant, transportation, storage, communication, financial intermediaries, public administration, education, health and other social services). The major employer of the labour force is the tertiary sector which employs about 64.58%, the secondary sector is the second major employer of the labour force employing about 22.34% of the labour force and the primary sector employs about 13.08% of the labour force with urban agriculture and fishing as the predominant activities in that sector.

Farming in Accra is typically urban farming system where varieties of vegetables are grown by families. Vegetables grown by these families include cabbage, lettuce, okro, garden eggs, carrots etc. Accra lies within the coastal-savanna zone with low annual rainfall averaging 810mm distributed over less than 80 days. The rainfall pattern of the city is bimodal with the major season falling between the months of March and June, and the minor season around October. Mean temperatures vary from 24°C in August to 28°C in March.

3.1.2 Kumasi

Kumasi is the second largest and one of the fastest growing urban cities in Ghana with an estimated population of 1.2 million. The economic activities in the metropolis can also be grouped into three: the agricultural sector, the industrial sector and the services sector. The agricultural sector contributes about 10% of the metropolis gross domestic product (GDP) with the industrial sector contributing about 30% of the gross domestic product (GDP) and 60% of the gross domestic product (GDP) is contributed by the services sector. Wood and wood related industries employs about 50% of the labour force in the metropolis. Kumasi is a major market for vegetables produced within urban and the peri-urban areas of the city.

It covers an area of 157 km^2 and the topography of the region varies from gently undulating to distinctly hilly and mountainous. The region has two major seasons, the rainy and dry seasons. The city experiences major rains between March and July and minor rains between September and November with an annual rainfall of about 1300mm.

3.2 Conceptual Framework

3.2.1 The concept of consumer Utility theory As mentioned earlier in page 8.

3.3 The choice experiment method

Choice experiments are samples of choice sets or choice scenarios drawn from the universe of all possible choice sets. This is done according to statistical design principles such that, the overall choice experiment consists of a set that satisfies a certain estimation

requirements. It enables the probability of an alternative being chosen to be modeled in terms of the attributes used to describe the alternatives. Hence, it is expected that, the higher the level of a desirable attribute in an alternative, "*ceteris paribus*" the higher the Utility associated with that option and more likely for a respondent to choose it (Bennet and Blamey, 2001).

The assumption in the assessment of economic value for non-treatment options of wastewater use in urban Agriculture to bring about a change in human health risk reduction and environmental impact (soil and ground water contamination levels) is that, its monetary value would reflect in consumers' behavior (Hanley *et al*., 1997).

Hence, this study seeks to analyze consumers' preferences regarding the choice of alternative scenarios of non-treatment options of wastewater use at both the market and the farm levels.

The choice experiment approach is used in this study because it allows a wide array of different possible choice scenarios (in this case different non-treatment options of wastewater use) to be estimated.

3.3.1 The choice scenarios used in the choice experiment

Table 3.1 below shows the choice scenarios and the description of each choice set as used in the choice experiment.

Table 3.1: Choice scenarios used in the choice experiment

OPTION A	*Status quo; the normal watering by*

	using open buckets without any conscious effort to reduce pathogen levels	***Choice scenario Description***
OPTION B	*Improved use of watering cans; using watering with the cap on and at a height <1m*	
OPTION C	*Cessation of irrigation allowing pathogen die-off; stopping the normal watering by the use of open buckets for between 2-5 days before harvest*	
OPTION D	*Use of drip kits; this is a home garden micro-irrigation kit fitted with micro-tube emitters*	
OPTION E	*Market washing with clean water; normal irrigation practice with the use of open buckets for watering and washing each vegetable produced with clean water*	

Source: Author's construct, 2008

3.3.2 The attribute and attribute level used in choice experiment

Table 3.2 below shows the attributes and attribute levels for each choice set used in the choice scenarios.

Table 3.2: The attributes used in the c

hoice experiment

Attribute	***Description***	***Level***
Percentage(%) of HH expenditure on vegetables	*The % of HH expenditure on vegetables the consumer is willing to add to get the Benefits*	*None in OPT A* *5% in OPT B* *7% in OPT C* *9% in OPT D* *6% in OPT E*
Health risk (Pathogen) reduction	*Reduction of faecal coliform and helminths contamination on vegetables*	*None in OPT A* *Low in OPT B* *High in OPT C* *Very high in OPTD* *Medium in OPTE*
Reduction in soil and ground water contamination	*Pathogen reduction levels In soil and ground water*	*None in OPT A* *Low in OPT B* *High in OPT C* *Very high in OPTD* *Very low in OPTE*

Source: GLSS 4, Oboubie et al., 2006, WHO, 2006

3.4 Estimation of WTP

The estimated coefficients of the attributes are assumed to be linear parameters and hence can be used to estimate the tradeoffs between the attribute that respondents would be willing to make. The price attribute together with the other attributes are used to determine the willingness to pay by respondents for gains or losses of the attribute levels. The monetary value is called the part-worth or the "implicit price" of the attribute (Bennet and Blamey, 2001).

That is, $partworth - = -(/).....(9)\beta\beta_{nonmarketattributemonetaryattribute-}$

Hence the results will show the amounts consumers' are willing to pay to move from the "status quo" to the specified improved health risk and environmental quality attributes levels of the non-treatment options of wastewater use in urban vegetable production. The willingness to pay estimates will be used to demonstrate the trade-off between individual attributes. This enables the analysis of the composition of potential alternative allocations of resources.

Another method for eliciting the consumer's utility is by the use of the economic surplus method. The method arises because it specifically investigates trade-offs between attributes. In theory, the economic welfare measures;

a. The amount of money given or taken away that makes a person well off as they would be before a change.
b. The amount of money given or taken away that makes a person as well off as they would be after a change.

In algebra, welfare measure can be expressed as;

$$VMVMCS(,0)(,1).....(10) = -$$

Where;

V is the utility
M is the income

CS is the compensating surplus which is the amount of money that is taken away from the person to make the utility with the environmental improvement or health improvement equal to the utility before the change.

0 represents the base situation and 1 represents the changed situation.

The welfare measures can be categorized into two; the 'state of the world' models and the market shares approach. The 'state of the world' models involve the assessment of economic welfare by using the difference between the well-being achieved by the individual consumer under the status quo and some other alternatives. That is, the marginal value of change away from the status quo is considered. In other words,

$$economicsurplusVV\ (1/)().....(11)=--\ \beta_{monetary} \quad 12$$

Where;

V_1 is the value associated with the status quo. V_2 is

the value associated with the changed situation

$B_{monetary}$ is the estimate of the monetary attribute.

For multiple alternatives, the expected value of the base case is compared to the expected value of the changed case and the linear model is multiplied by 1 over the marginal utility of income to convert the difference into monetary values. The formula in this case is;

$$economicsurplusVV\ (1/)(\ln\exp()\ln\exp()).....(12)=--\ \beta_{monetaryii}\sum\sum \quad 12$$

Where;

V_i is the conditional indirect utility associated with alternative *i*, the superscript 1 indicates the base case and 2 indicates the changed case.

The market share approach, estimates the support each alternative will generate when the relative values for each of the utilities at different levels of the attributes are included. For instance , each alternative related to a changed situation and the status quo, the percentage of the total contribution to the changed situation by each individual would represent the percentage support that alternative will generate. In behavioral models such as 'measuring consumers' willingness to pay for "safer" vegetables in Ghana', market share would predict the number of people who will choose each alternative under different conditions or attribute levels (Bennet and Blamey, 2001).

This study therefore used the market share approach to estimate Ghanaian consumers' willingness to pay for "safer" vegetables and environmental quality improvement in urban/peri-urban vegetable production using wastewater.

3.5 Empirical Estimation of mean WTP

The market share procedure was used to estimate the consumers' willingness to pay for safer vegetables. The procedure considered the number of consumers who chose to support an option based on the attributes of that option. The percentage of the total number who would support that option was calculated with the inbuilt household expenditure and the willingness to pay by each individual consumer was calculated by using the formula as follows in equation (13);

$$WTPofhhonfoodavmntmonth_i = \times\% \ \exp \ / \quad \ldots\ldots\ldots\ldots\ldots\ldots \ (13)$$

Where;

WTP_i= individual willingness to pay *hhexp*= household expenditure on food per month *avmnt*= household expenditure on vegetable per month.

Hence, for each option, *j*, the individual WTP was estimated as in equation (14) below;

$$WTPofhhavmntmonth_{ijij} = \times \% \ \exp / \quad \ldots\ldots\ldots\ldots\ldots\ldots \ (14)$$

Where *j* can be options A, B, C, D or E.

The average WTP for each option is then calculated as in equation (15) below;

$$WTPWTPoptionN = = [(1)] \sum / \quad _{ijijij} \ \ldots\ldots\ldots\ldots \ (15)$$

Where;

$Option_{ij}$= individuals who responded yes to option *j*

WTP_{ij} = an individual's WTP for option *j*

The direct effects of the consumers' socio-economic/attitudinal characteristics and their choice of the non-treatment options on individual willingness to pay was analyzed using Ordinary Least Squares (OLS) estimation method as in equation (16) below;

$$WTPGenderAgeHhEduMaristatMajoccupincomeS_i = ++++++++\alpha\beta\beta\beta\beta\beta\beta\beta\beta_{12345678} \quad dse$$

$$++++++\beta\beta\beta\beta\beta\varepsilon_{910111213} optAoptBoptCoptDoptE_i \ldots\ldots\ldots\ldots\ldots\ldots (16)$$

Where;

Age = age of respondent

income = income of the household/month

Gender = male or female respondent

Hh = household size

SDSE = experience of suffering from vegetable borne disease.

Edu = educational level of respondent

Maristat= marital status

Majoccup = major occupation of the household head

OptA = choice option A

OptB = choice option B

OptC = choice option C

OptD = choice option D

OptE = choice option E

The relationship between the explained variable (WTP) and the explanatory variables in the model was tested using the R^2 and the t-statistic of the coefficients of the individual variables in the model was used to test the significance of the variables.

3.6 Sampling technique and sample method

The target population of interest for this study is all households in both Accra and Kumasi metropolises. The sampling unit was the household, defined for this study as- a group of people who eat from the same "pot" and share common resources. In order to increase precision and to minimize sampling bias, a total of 650 households were stratified into three income groups based on the characteristics of the housing structures; low income, middle income and high income. A proportionate sampling method was

employed to get representative sample for the various income groups from the two metropolises. The formula for the proportionate sampling is given as:

$\{PopulationAKUMASIsumpopAandpopBTotalsamp\ ()/(.\ .)*\ (650)\}$ *lesize*

where;

PopulationAHouseholdpopulationofKumasi =

PopulationBHouseholdpopulationofAccra =

The study employed the multistage sampling method in order to achieve the objectives set out above.

The areas that constitute these income zones in both Accra and Kumasi were randomly sampled and the within houses (which might contain several households), systematic random sampling method was employed. A household which was sampled and it happens not consume vegetables was replaced by the next household immediately after that household. The sampled areas for this study are as in the table 3.3 below;

City	***Community***	***Income category***	***No. of households in Sample***
	Bomso	*high income*	*40*
	Nhyieso	*high income*	*41*

	Amakom	*middle income*	*41*	
KUMASI	*Pankrono*	*middle income*	*53*	
(415)	*Ashanti New Town*	*middle income*	*41*	
	Asawasi	*low income*	*53*	
	New Tafo	*low income*	*42*	
	Gyinyasi	*low income*	*52*	
	Asuoyeboa	*low income*	*43*	
	North Kaneshie	*high income*	*23*	
	Achimota	*middle income*	*43*	
ACCRA	*Labadi*	*middle income*	*43*	
(235)	*Jametown*	*low income*	*42*	
	Chorkor	*low income*	*42*	
	Sukura	*low income*		

Table 3.3 Communities sampled.

Source: Author, 2008

3.7 Sources of data and data collection method

In other to achieve the objectives set out, primary data was collected from household members in charge of food purchasing and preparation in the household. Data collection was done between 10th and 24th January, 2008 in the morning in both Accra and Kumasi. The face-to-face interview technique was employed using a structured questionnaire. The questionnaire comprised of three sections: the first section included questions on

consumers socio-demographic characteristics such as age, income, gender, household size and educational level, the second section included questions on consumers food safety concerns and the third section included questions on consumers WTP. The survey instrument was pre-tested in 20 households at Ayigya Zongo, a suburb of Kumasi.

3.8 Definition of variables

Table 3.4 below gives the variables used in the study, the working definition, measure and the working hypothesis of each variable used.

Table 3.4 Definition of variables and hypothesis

WTP	*The extra amount a consumer is ready to add to enjoy the pathogen reduction and environmental improvement.*	*Ghana cedis (GH¢)*	*Consumers in urban and periuban Kumasi and Accra are not willing to pay for pathogen reduction and environmental improvement.*
INCOME	*Total household income per month*	*Ghana cedis (GH¢)*	*Positively related to WTP*
EDU	*Educational level of respondent*	*Years of education*	*Positively related to WTP*
SDSE	*Experience with vegetable borne disease*	*1. Yes* *0. No*	*Positively related to WTP*
AGE	*Age of respondent*	*Years*	*Negatively related to WTP*
HH	*Household size*	*Number of members*	*Negatively related to WTP*
MARISTAT	*Marital status of respondent*	*1. Married* *0. Otherwise*	*Negatively related to WTP*

Variables	***Definition***	***Measure***	***Hypothesis***
MAJOCCUP	*Occupation of the household head.*	*1. Salary worker* *0. Other wise*	*Negatively related to WTP*
GENDER	*The sex of respondent*	*1. Male* *0. Otherwise*	*Negatively related to WTP*
OPTION A	*Status quo*	*1. Yes* *0. No*	*Negatively related to WTP*

OPTION B	*Improved use of watering cans*	*1. Yes* *0. No*	*Positively related to WTP*
OPTION C	*Cessation of irrigation*	*1.Yes* *0. No*	*Positively related to WTP*
OPTION D	*Use of drip kits*	*1.Yes* *0. No*	*Positively related to WTP*
OPTION E	*market washing of vegetables with clean water*	*1.Yes* *0. No*	*Positively related to WTP*
Avmnt	*Average amount of HH income spent on vegetables per month.*	*Ghana cedis* (GH¢)	*Ghanaian consumers' spend some portion of their income on vegetables per month.*

Source: Author, 2008.

CHAPTER FOUR RESULTS AND DISCUSSIONS

4.0 Introduction

The chapter presents discussion of the results for the study. These include results of socio-demographic characteristics, vegetable consumption behaviour, health concerns on vegetables, stage vegetables get contaminated along the vegetable food chain, choice of non-treatment options and WTP and factors affecting their WTP.

4.1 Consumers' socio-demographic characteristics

The results of the socio-demographic characteristics of vegetables consumers sampled are as shown in *Table 4.1* below. The results are based on a sample of 650 completed questionnaires administered in January 2008. This is based on 415 households in Kumasi and 235 households in Accra. The sample is made up 572 females and 78 males. The high percentage of females is due to the fact that, the target respondent for the study was the person in charge of either food purchasing or preparation in the household. This confirms that, more females are involved in food purchasing and preparation; an observation consistent with the Ghanaian culture. The average age of respondents for the sample is 33.7 years with a minimum age of 13 years and a maximum age of 76 years.

Table 4.1: Results of socio-demographic characteristics

Variable	*Options*	*Frequency*	*Percentages (%)*

Educational level of respondent (EDU)	*1. Primary*	*72*	*11.1*
	2. JHS/Middle sch.	*295*	*45.3*
	3. SHS	*149*	*22.9*
	4. Tertiary	*78*	*12*
	5. No education	*52*	*8*
	6. Vocational educ.	*4*	*0.6*
Gender of respondent	*1. Male*	*78*	*12.1*
	2. Female	*572*	*87.9*
Marital status	*1. Married*	*361*	*55.6ss*
	2. Single	*236*	*36.3*
	3. Divorce	*32*	*4.9*
	4. Widowed	*21*	*3.2*
Occupation of HHH	*1.Salaried worker*	*213*	*32.7*
	2. Non salary worker	*437*	*67.3*

Source: Field survey. January, 2008

In education, 45.0% of the respondents had junior high school/middle school education, about 23.0% of the respondents had senior high school education, about 12.0% had tertiary education, 11.0% of respondents had primary education, whiles 8.0% of the respondents had no education and 0.6% of the respondents had vocational training. The results on educational levels with majority attaining the junior high school with an average of 6.5 years is comparable to the National average in Ghana of 5 years of education with a standard deviation of 5.4 as in the Ghana living standard survey 4. The results as shown in *Table 4.2* below show that, the sample average household size is 5.7 members/household with a minimum of 1member and a maximum of 20 members. The household size is comparable with the national average of 5.5 members per household (calculated from 5.1 members per household with an annual growth rate of 1.24%), (GSS,

2000). The average household income per month is 262.90 ($257.64) with a minimum of GH¢9.00 ($8.82) and a maximum of GH¢2650.00 ($2597.00). This high variation in income levels shows the disparity between the rich and poor. The Gini index for income distribution in Ghana according to World Bank (2004) is 30.0. This indicates disparity in Ghana as suggested by the study.

Table 4.2: Sample averages

Variable	***Sample average (Mean)***	***Standard deviation***
AGE	*33.7*	*4.99*
INCOME	*GH¢ 262.90*	*299*
Household size (HH)	*5.7*	*2.8*
WTP	*GH¢ 4.70*	*4.99*
Average amnt. On vegetables/ month (Avmnt/mnth)	*GH¢ 4.8*	*4.97*

Source: Field survey. January, 2008

4.2 Consumers' vegetable consumption behaviour

The target group for the sample was households who consume vegetables known as the green salads; Cabbage, Lettuce and Spring onion. *Table 4.3* shows the results of the households who eat one or more of the green salads mentioned above. Consumers were asked where they usually eat vegetables and most of the respondents, about 599 said they ate the salads at home. This represents about 92.2% of the sample. Few (74) consumers said they ate vegetables from roadside food vendors and only 4 consumers said they ate vegetables at the restaurants. These represent about 7.2% and 0.6% respectively. Most consumers, about 479, said they usually cook their vegetables before eating and this represents about 76.3% of the sample while 154 consumers said they usually ate the vegetables raw.

Table 4.3: Vegetable consumption behavior.

Statement	*Options*	*Frequency*	*Percentages (%)*
Where vegetables are mostly eaten	*1. Home 2. Restaurant*	*599 4*	*92.2 0.6*
	3. Food vendors	*47*	*7.2*
Form in which vegetables are usually eaten	*1. Raw*	*154*	*23.7*
	2. Cooked	*496*	*76.3*
Characteristics of a good quality vegetable	*1. Greenish leaves*	*155*	*23.8*
	2. Cleanliness	*172*	*26.5*
	3. Freshness	*249*	*38.3*
	4. No spots on leaves	*74*	*11.4*
Sources of vegetables	*1. Farm gate*	*25*	*3.8*
	2.Market vegetable retailer	*530*	*81.5*
	3. Street hawkers	*92*	*14.2*
	4. Supermarkets	*3*	*0.5*

Source; Field survey. January, 2008.

It was found that the most cooked vegetable was Cabbage whiles Lettuce and Spring onion was eaten raw. The cooking can be attributed to the high percentage of consumers who ate vegetables at home. It was found that, consumers are much aware of the quality of vegetables they eat as found by Oboubie *et al*., 2006. The characteristics consumers look for in a good quality vegetable were identified as: freshness of the vegetables (38.3%), greenish leaves (26.5%), cleanliness of vegetables (23.5%) and spotless leaves (11.4%). It was also revealed that, most consumers', 81.5%, get their vegetable sources from market vegetable retailers, 14.2% from street hawkers, 3.8% from farm gate and

0.5% from the supermarket. This is because there are no well established vegetable supermarkets in Ghana. Also, Ghanaians usually buy their fresh vegetables at the satellite vegetable markets within the cities and some times the perception of cost of vegetables in super markets as compared to that in the satellite markets does not allow consumers to patronise the supermarkets.

The average amount a consumer spent on vegetables per month was found to be GH¢ 4.80 which represent about 1.8% of the average household income per month as in *Table 4.2* above. The variation of the amount is as result of high disparity in income levels as shown above.

4.3 Consumers health concerns on vegetables

Table 4.4 shows consumers health concerns on vegetables. The study revealed that, majority of the consumers were very much aware of the health concerns of vegetables sold in our markets. When they were asked as to whether they heard/knew about diseases caused by vegetables, about 52.2 % of consumers responded positively while the remainder, about 47.8% respondents answered negatively. The results indicate Ghanaian consumers' awareness of their health concerns when it comes to the food they consume, especially vegetables. This result is comparable to studies conducted by Combris et al., 2007 who found that, consumers were concerned with food safety as their WTP was affected by food safety concerns.

Consumers were asked how they heard or read about diseases caused by contaminated vegetables and they said they heard through the radio, television, news papers through

friends and family members. The study showed that, 42.2% of consumers who responded positively said they heard it through the radio, while 35.4% said they heard about the diseases through friends and family.

Table 4.4: Consumers health concerns on vegetables/vegetable safety issues

Statement	*Options*	*Frequency*	*Percentages (%)*
Heard/know of diseases caused by contaminated vegetables	*1. Yes*	*339*	*52.2*
	2. No	*311*	*47.8*
Where/how they heard about the diseases caused by contaminated vegetables	*1. Radio*	*143*	*42.2*
	2. News paper	*14*	*4.1*
	3. Television	*20*	*5.9*
	4.Family/friends	*120*	*35.4*
	5. Schools	*42*	*12.4*
Experience of HH member suffering from vegetable borne diseases	*1. Yes*	*44*	*6.8*
	2. No	*606*	*93.2*

Source; Field survey. January, 2008.

Schools, television and newspapers representing 12.4%, 5.9% and 4.1% respectively of consumers' who responded positively were other sources indicated. However, only few consumers, about 6.8% of the sample attributed the source of disease they suffered from or their household members had suffered from to the consumption of contaminated vegetables.

The results of the awareness and how they heard about this awareness can be attributed to the influx of radio stations across the entire nation and the fact that most of these radio

stations do health education programmes in the local dialect and also due to funerals and other social gatherings in the communities

4.3.1 Diseases caused by contaminated vegetables

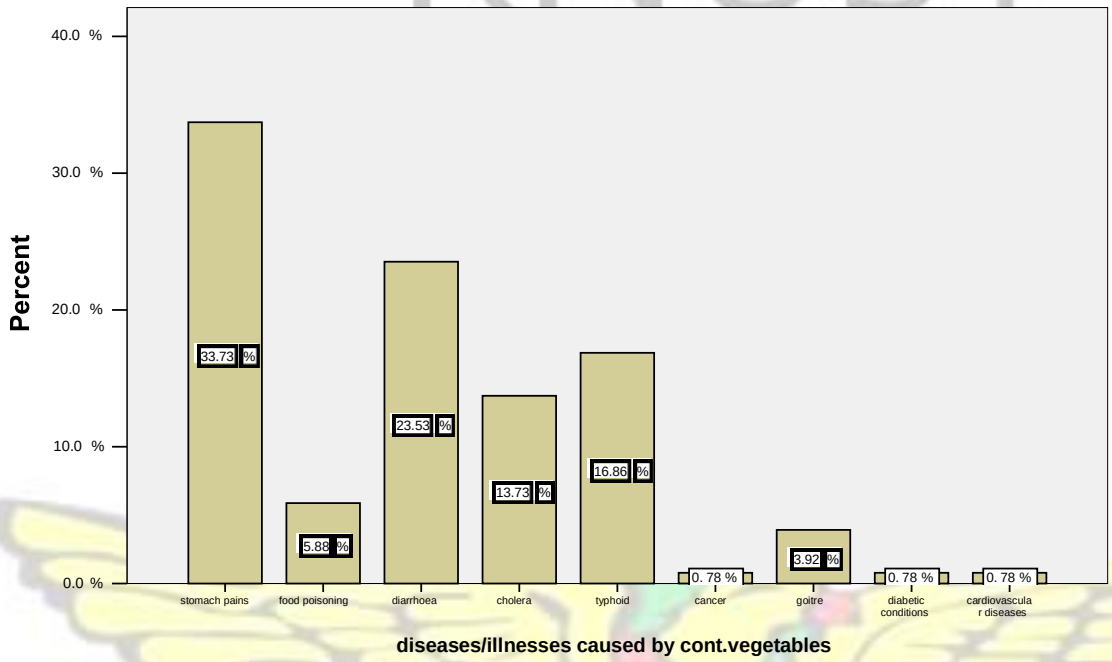

Figure 4.1: Bar graph of diseases/illnesses caused by contaminated vegetables

Figure 4.1 shows the diseases consumers attributed to the consumption of contaminated vegetables. Based on the 339 consumers who have heard or read about diseases caused by contaminated vegetables the following were mentioned; "stomach pains", food poisoning, diarrhoea, cholera, typhoid, cancer, goiter, diabetic conditions and cardiovascular diseases. Some of the consumers who mentioned cancer and cardiovascular diseases were of the view that the chemicals used in the production of the vegetables were the cause of such diseases and majority said the others were caused by germs.

4.3.2 Consumers perceptions on the causes of vegetable borne diseases

Consumers were asked whether in their opinion the wastewater used in watering the vegetables can cause vegetable borne diseases and a majority of them, about 611 representing 94.00% answered in the affirmative, while only 39 consumers representing 6.00% answered in the negative. When they were further asked why they think the wastewater can be the cause of vegetable borne diseases and majority, about 67.6%, said because of the presence of pathogens (germs), 152 consumers attributed the cause to poor water quality but could not tell what they meant by poor water quality. Among others 2.2% attributed it to chemical contamination whiles about 0.9% attributed it to the presence of faecal matter as shown in *Table 4.5*

Table 4.5: Consumers perceptions on the cause of vegetable borne diseases

Statement	*Options*	*Frequency*	*Percentages (%)*
Consumers' opinion on whether wastewater can cause diseases	*1. Yes*	*611*	*94*
	2. No	*39*	*6*
Why can wastewater cause diseases?	*1. Presence of pathogens*	*440*	*67.6*
	2.Presence of faecal matter	*5*	*0.8*
	3. Poor water quality	*152*	*23.4*
	4. Presence of chemicals	*14*	*2.2*
	5. Don't know	*39*	*6*

Source; Field survey. January, 2008.

4.3.3 Perceptions of the stage along the food chain where vegetables get contaminated

Table 4.6 below shows the result on the stage of the vegetable food chain where they get contaminated. The results revealed that, 310 consumers, representing about 47.7% of the sample were of the view that, vegetables are usually contaminated at farm or production level. About 41.4% of the sample were of the view that, they were contaminated at the market level whiles 8.3% and 2.6% respectively thought vegetables were contaminated during transportation and at the consumer kitchen levels.

Table 4.6: Consumers perception of contamination along the vegetable food chain

Statement	*Options*	*Frequency*	*Percentages (%)*
Where vegetables get contaminated along the chain	*1.Farm/production level*	*310*	*47.7*
	2.During transportation	*54*	*8.3*
	3. Market level	*269*	*41.4*
	4.Consumer kitchen level	*17*	*2.6*
Causes of contamination	*1. Water used*	*168*	*25.8*
	2. Pesticides	*23*	*3.5*
	3. Poor handling	*74*	*11.4*
	4.Water/pesticides	*62*	*9.5*
	5.Water/poor handling	*98*	*15.1*
	6. Pesticides/ poor handling	*5*	*0.8*
	7. Don't know	*220*	*33.8*

Source: Field survey. January, 2008.

When consumers were probed as to the cause of contamination, wastewater used, pesticides/weedicides and poor handling were mentioned as the major causes of contamination. At the farm level they attributed the cause of contamination to the water used and the pesticides farmers use while poor handling was attributed to transportation and the consumer kitchen level.

4.4 Consumers perception on pathogen reduction

Effectiveness of water application method at the farm level, market washing of vegetables by sellers and further washing of vegetables at the consumer kitchen level on pathogen reduction was assessed using the five point likert scale; 1 meaning strongly agree and 5 meaning strongly disagree. The results are as shown in *Table 4.7*. A statement was read and explained to consumer's understanding. At the farm level, 44.5% of the consumers sampled strongly agreed to the statement that farm safe water application method reduces pathogen content significantly while 41.5%, 10.0%, 3.5% and 0.5% respectively agreed, somewhat agreed, disagreed and strongly disagreed to the statement. This implies that, consumers from the sample have the firm conviction that wastewater application methods can reduce pathogen content on vegetables significantly.

At the market level, the statement washing each vegetable with clean water at the market reduces pathogen levels further led to the following responses: 38.3% of the consumers said they strongly agreed to the statement, 40.9% of the consumers said they agree whiles 12.6%, 7.7% and 0.5% said the somewhat agreed, disagreed and strongly disagreed respectively with the statement. It is also an indication of consumers awareness that,

washing of vegetables can reduce pathogens. Most consumers sampled, strongly (about 80.8%) agreed and agreed (16.8%) to the statement that further washing and boiling of the vegetables at the consumer kitchen level can further reduce pathogen content significantly. About 1.8%, 0.5% and 0.2% of the consumers respectively said they somewhat agreed, disagreed and strongly disagreed to the statement above.

The results above indicates consumers awareness of the need to wash food very well and for that matter vegetables produced from urban vegetable farms before consumption. This is comparable to findings in Oboubie *et al.*, 2006, where consumers of vegetables said they always washed vegetables very well before consumption.

Table 4.7: Consumers perceptios on pathogen reduction

	Percentage response				
Statement	***Strongly agree***	***Agree***	***Somewhat agree***	***Disagree***	***Strongly disagree***
Farm safe water application method reduces pathogen content significantly	*44.50%*	*41.50%*	*10.00%*	*3.50%*	*0.50%*
Washing each vegetables with clean water at the market reduces pathogen levels further	*38.30%*	*40.90%*	*12.60%*	*7.70%*	*0.50%*
Further washing & boiling at the consumer kitchen level further reduces pathogens	*80.80%*	*16.80%*	*1.80%*	*0.50%*	*0.20%*

Source; Field survey. January, 2008.

4.5 Consumers willingness to pay.

The results of consumers choice and willingness to pay are also based on a random sample of 650 consumers in Accra and Kumasi as in table 4.8. The results revealed that consumers are willing to pay for "safer" vegetables from the non-treatment options of wastewater use in urban and peri-urban vegetable production. It is shown that, consumers in Ghana are willing to pay an average of GH¢4.70 ($4.61) per month to move from the current water application methods.

Table 4.8: Consumers' WTP for their choice options

Choice option	**Frequency**	**Percentage**	**Average WTP/mnth.**
STATUS QUO			
1. Yes	*16*	*2.5*	*GH¢ 0.00*
0. No	*644*	*97.5*	
IMPROVED USE OF WATERING CANS			
1. Yes	*66*	*10.1*	*GH¢ 4.40*
0. No	*584*	*89.9*	
CESSATION OF IRRIGATION			
1. Yes	*60*	*9.2*	*GH¢4.70*
0. No	*590*	*90.8*	
USE OF DRIP KITS			
1. Yes	*485*	*74.6*	*GH¢ 4.90*
0. No	*165*	*25.4*	
MARKET WASHING WITH CLEAN WATER			
1. Yes	*26*	*4*	*GH¢ 4.40*
0. No	*624*	*96*	

Source; Field survey, January 2008.

The results showed that, 16 consumers representing about 2.5% of the sample are not willing to pay any extra to enjoy the health benefit and the environmental improvement

of the non-treatment options of wastewater use. This category of consumers are not ready to pay any extra on the average amount of GH¢4.8 ($4.70) on vegetables per month. They prefer to maintain the status quo. These consumers' think they can properly treat (by washing properly) the vegetables without necessarily paying extra to enjoy the reductions that are likely to come with the new technologies

It was found that, about 10.10% opted for the improved use of watering cans. Based on the 5% household expenditure, the average willingness to pay to enjoy the health benefits and the environmental improvement that come with that option (Opt. B) is GH¢ 4.40 ($ 4.50). The majority of consumers' who chose this option belong to low income category (GH¢ 50 to GH¢ 100), they also constitute the majority who had attained Junior high school education.

On cessation of irrigation to allow pathogen die-off, about 60% of the consumers' sampled opted for that option (Opt. C) and was ready to commit an average of 7% extra of the household expenditure on vegetables per month to obtain the benefits this nontreatment option comes with. It was realized that, with the 7% extra household expenditure on vegetables, the consumers average willingness to pay to enjoy the health benefit and environmental improvement associated with this non-treatment option is GH¢ 4.70 ($4.61).

Most consumers, about 74.6% opted for the use of the drip kits which is one of the nontreatment option (Opt. D) with the highest pathogen and soil contamination reduction. This is associated with a corresponding extra increment in the household expenditure on

vegetables of about 9%. With the 9% extra household expenditure on vegetables, the average willingness to pay by the consumers who opted for this option is GH¢ 4.90 ($4.80). This attests to the fact that Ghanaian consumers recognize the importance of reduced contamination on vegetable and are willing to pay for high quality vegetables and environmental quality improvement. The majority of consumers' who opted for this option are a part of the group who had junior high education (JHS), senior high education (SHS) and tertiary education. They also belong to the middle income category (an average monthly income of GH¢250) with an age group of 20 to 40 years.

Market washing of each vegetable with clean water, for example, washing each bulb of cabbage with clean water is another non-treatment option at the market level. For a consumer to enjoy the benefit associated with this option, he/she has to spend about 6% extra of the household expenditure on vegetables. The study revealed that, 26 consumers, representing about 4.0% of the sample opted for that option and they are willing to pay an average of GH¢ 4.40 ($4.5) to move from the status quo.

4.6 Factors affecting consumers' willingness to pay.

The parameter estimates of consumers' willingness to pay on socio-demographic characteristics and the consumers' choice of the non-treatment options of wastewater use were obtained using the econometric software, Lindep 7.0. This was to measure the direct effect of the explanatory variables on consumers' willingness to pay (explained variables) for "safer" vegetables and environmental quality improvement. The results as in *Table 4.9* show that, the overall ability of the explanatory variables to contribute to explain the variation of the consumers' WTP is 91.9%. In addition, the F-statistic of 560.92 which is

significant at 1% shows that, there is a high relationship between the coefficients of the consumers' socio-demographic and choice options with their individual willingness to pay for "safer" vegetables. The F-test also helps to reject the hypothesis that, except the intercept, all the coefficients associated with the explanatory variables are equal between them and zero and hence it indicates the global significance of the model.

The results revealed that, the coefficient of GENDER has a positive impact on the individual willingness to pay for "safer" vegetables. The positive sign was not expected and significant at 5% indicating that male consumers are likely to pay high premiums than female consumers. The results indicate that, male consumers who are responsible for the health of the entire household would be willing to give out more of their income in order to keep the household healthy from any vegetable borne diseases.

The expected negative sign on the coefficients of AGE and household size (HH) indicates that, elderly consumers and larger household size are less willing to pay for "safer" vegetables than younger consumers and smaller households. The results indicate that, the youth who still have more years to live for all things being equal are likely to be wary of the safety of the food they consume as against the aged who have lived their youthful age without concern to the safe measures to what they consume. The results can also be interpreted to mean that aged do not cook and hence the youth who are in the kitchens all the time would be willing to reduce their work in trying to wash the vegetables time and time again to reduce the pathogen contents. On the household size, the results might be that, the larger households have lower incomes compared to the smaller households whose

expenditure would be lower if all things being equal. The negatives sign on the coefficient of EDU was not expected but the result indicates that consumers with higher education are less willing to pay for safer vegetables than consumers with lower education. This can be attributed to the likely alternatives consumers' with higher education might have by virtue of their educational level to treating vegetables before eating or apathy on the part of consumers' with higher education on vegetables because of the treat they believe can be caused by pathogens on vegetables.

Table 4.9: Results of parameter estimates of WTP

Variable	*Coefficient*	*z-statistic*
Constant	*3.781*	*0.67*
GENDER	*1.880***	*2.083*
AGE	*-0.024*	*-0.98*
H H	*-0.041*	*-0.388*
EDU	*-0.307*	*-1.195*
MARISTAT	*-0.216*	*-0.527*
MAJOCCUP	*0.729*	*1.105*
INCOME	*0.080****	*77.55*
SDSE	*3.899****	*3.25*
OPTION A	*-8.727***	*1.924*
OPTION B	*1.581*	*0.356*
OPTION C	*5.68*	*1.298*
OPTION D	*10.976****	*2.489*
OPTION E	*3.464*	*0.743*
R^2	*0.92*	
Adjusted R_2	*0.918*	
F-test	*560.92****	

*Where ** and *** represents, 5% and 1% significant levels respectively. Source: Field survey, January, 2008 & authors estimation.*

The expected positive signs on INCOME and SDSE coefficient which are both significant at 1% indicate that households with higher incomes are more willing to pay for safer vegetables than households with lower incomes and consumers who have had experience

with vegetable borne diseases are more likely to be willing to pay for safer vegetables than consumers without experience with vegetable borne disease. The higher income group can afford to pay and possibly they are much concerned with their health and hence would likely be willing to pay in order to enjoy the health benefits and environmental quality improvement.

On the experience of vegetable borne diseases, consumers with the experience are likely to be willing to pay because the opportunity cost of treating themselves in the hospitals will be to pay a bit higher for "safer" vegetables or they might have lost some income due to lost of man hours when they were down with the disease.

The significance of the coefficients of GENDER, INCOME and SDSE indicates a direct impact on consumers' individual willingness to pay. The results are consistent with other empirical studies that indicate that; male consumers are willing to pay for health risk (pathogen) reduction (see Akgungor *et al*., 1999); income and experience of vegetable borne disease is an increasing function of consumers' individual willingness to pay (see Boccaletti *et al*., 2001; Waibel *et al*., 2006; Mukhopadhaya *et al*., 2004). The result also supports the economic theory that willingness to pay is an increasing function of the income level (Eckert and Leftwich, 1988).

The result also revealed, the impact of the choice options on consumers individual willingness to pay. The findings on *Table 4.9* above show that apart from the coefficient of the status quo option (Option A) which is negatively related to WTP the rest (Option B, Option C, Option D and Option E) are positively related to willingness to pay. This

suggests that consumers are likely to be willing to pay for a technology that will result in reduced pathogen and faecal matter on vegetables. However, only the coefficients of Option A and Option D are significant at 5% and 1% respectively. The significance of option A to willingness to pay at 5% means that, as the consumers choice increases for option A their willingness to pay for that option decreases. This can be attributed to the inability of that option to reduce the pathogen content on vegetables. The significance of option D at 1% level to willingness to pay confirms consumers awareness of vegetable safety and it implies that, consumers willingness to pay for that option increases as their choice for that option increases.

CHAPTER FIVE SUMMARY, CONCLUSSION AND RECOMMENDATION

5.0 Summary of results

The summary of the results as discussed in the previous chapter is presented below. The results revealed that, 92.2% of the respondents mostly eat vegetables at home,

7.2% at food vendors, and 0.6% in restaurants. Vegetables were mostly eaten in the cooked form (76.3%) and others in the raw form (23.7%). The study revealed that the market outlets available for consumers to get their fresh vegetable supply include; market vegetable retailer (81.5%), street hawkers (14.2%), farm gate (3.8) and supermarkets (0.5%). It was found that on the average, the consumer spends GH¢ 4.80 per month on vegetables representing 1.8% of the household income.

The study revealed that, about 52.2% of consumers sampled heard or know about diseases caused by contaminated vegetables and they heard about this through the media such as the radio (42.2%), television (5.9%) and news papers (4.1%); social gatherings where family and friends meet (35.4%) and through their various schools attended (12.4%). It was found that 6.4% of sample had suffered from diseases and attributed the cause to contaminated vegetables. Based on the awareness level of Ghanaian consumers, diseases such as stomach pains (33.7%), diarrhea (23.5%), typhoid (16.8%), cholera (13.7%) and food poisoning (5.9%) were found to be caused by eating contaminated vegetables. Others include goiter (3.9%), cancer (0.8%), diabetic conditions (0.8%) and cardiovascular diseases (0.8%). It was found that, vegetable consumers associated the cause of the vegetable borne diseases to the use of wastewater (dirty water) and chemicals (pesticides/insecticides) in the production of the vegetables by the urban and peri-urban vegetable farmers.

On the vegetable food chain; from farm/production level, transportation, market and the consumer kitchen level, the result showed that, consumers think vegetables are

contaminated at the farm/production level (47.7%), the market level (41.4%), during transportation (8.5%) and the consumer kitchen (2.6%) and causes of contamination at the farm level was attributed to the type of water (wastewater) and the chemicals used and poor handling during transportation and at the market.

The results also indicated that, consumers agreed to the fact that, technology introduction in wastewater application methods at the farm level can help improve the quality of vegetables (in terms of pathogen reduction) produced by urban and peri-urban vegetable farmers. They also agreed strongly to the fact that washing vegetables by market women with clean water can also help reduce contamination. They also agreed strongly to the fact that proper washing and boiling of vegetables at the kitchen level can further reduce the contamination completely.

It was found that consumers are willing to pay high premium for a guaranteed technology which can help in the production of "safer" vegetables by using wastewater. Consumers in the sample are willing to pay an average amount of GH¢ 4.70 ($4.61) to move from the status quo for any new technology designed to bring a reduction in the pathogen level of the vegetables produced in Ghana. The average amount represented about 97.9% of the average amount a consumers spends on vegetables per month and represents an extra 1.79% of the average household income per month.

Vegetable consumers in urban and peri-urban Accra and Kumasi have a choice when it came to the introduction of technologies which will result in the reduction of pathogens on vegetables. The results revealed that 10.1% of the consumers based on percentage of their household expenditure on vegetables opted for the improved use of watering cans which is a new technology (non-treatment option of wastewater use) with attributes such as; 16,7% reduction in pathogen and 8% reduction in soil and groundwater contamination levels. Based on the 5% household expenditure on vegetables, the average willingness to pay for this technology with its attributes is GH¢ 4.40 ($4.50).

the technology options involving the cessation of irrigation to allow pathogen dieoff which has attributes such as 25% reduction in the pathogens and 7% reduction in soil and groundwater contamination levels, 9.2% of the consumers sampled opted for that technology and were willing to pay on the average, GH¢4.70 ($4.61) representing 7% of the household expenditure on vegetables. Majority (74.6%) of the consumers opted for the use of drip kits which is another technology (nontreatment option) with attributes such as 33.3% reduction in pathogens and 9% reduction in soil and groundwater contamination levels. Consumers are WTP on the average GH¢ 4.90 ($4.80) representing 9% of the household expenditure for the attributes of that option. On market washing with clean water, 4% of the consumers' opted for that non-treatment option with attributes of 16.7% reduction in pathogen and 5% reduction in soil and groundwater contamination levels and are willing to pay GH¢ 4.40 ($4.50) representing 6% of their household expenditure on vegetables.

The Ordinary Least Squares (OLS) method was used to estimate the direct effects of consumers choice of the non-treatment options, socio-economic and attitudinal characteristics on their individual willingness to pay. The explanatory power of the model is high, about 91.9% with an F-test of 560.9 which is statistically significant at 1% which shows a high relationship between the variables. The results revealed that, GENDER coefficient which was expected to have a negative sign was found to be positive and statically significant at 5% indicating that male consumers were likely to be willing to pay for safer vegetables than the female consumers.

The expected positive signs of INCOME and experience with vegetable borne diseases (SDSE) coefficients which were statistically significant at 1% on consumers' willingness to pay indicates that, high income earners were likely to be willing to pay high for vegetable safety and environmental quality improvement than lower income earners whiles consumers with experience of vegetable borne diseases were likely willing to pay higher for safer vegetables than those without the experience of vegetable borne diseases. This indicates that consumers' willingness to pay is an increasing function of income and experience of suffering from vegetable borne diseases.

On the consumers choice of the technology options, the significant negative sign on the coefficient of the status quo indicates that, as there was no change in technology to reduce pathogen content increases, consumers willingness to pay decreases. This is a clear sense of consumer apathy (lack of interest). The results showed that,

individual willingness to pay increases with an introduction of a new technology which will result in reduction in pathogen and soil and groundwater reduction. The significant positive sign on the use of drip kits (option D) indicates that WTP increases with increasing technology that has a high attributes in pathogen reduction and reduction in soil and groundwater contamination levels. The other nontreatment options show positive signs on consumers' willingness to pay but are not statistically significant.

5.1 Conclusions

The study has presented the results of the findings from the field survey conducted in January, 2008 and conclusions based on the findings are;

1) Hypothesis 1: Vegetable consumers in the study area were aware of the health risks associated with vegetables produced by urban and peri-urban vegetable producers using wastewater and hence are concerned of the health risk of the vegetables sold in the markets.

2) Hypothesis 2: Vegetable consumers in the study area were very much aware of the stage of vegetables food chain where they get contaminated. It was found that vegetables are contaminated at the farm level by the type of water (wastewater) and the chemical used in the production and at the market and during transportation due to poor handling.

3) Hypothesis 3: Vegetable consumers in the study area were willing to pay a small percentage of their household expenditure on vegetables for a

technology change in urban and peri-urban vegetable production which will result in the reduction of pathogens and environmental quality improvement. It was found that on the average, a consumer was willing to pay GH¢ 4.70 ($ 4.61) to move from the current water application methods used to the improved technologies (non-treatment options of wastewater use) with their associated health and environmental benefits. For example; on improved use of watering cans, the average amount consumers were willing to pay was GH¢4.40 ($4.50); on cessation of irrigation, the average willingness to pay was GH¢ 4.70 ($4.61); on the use of drip kits, the average WTP was GH¢ 4.90 ($4.80) and on market washing with clean water, the average WTP was GH¢ 4.40 ($4.50).

4) Hypothesis 4: Gender, income, and experience with vegetable borne diseases have positive impact on consumers willingness to pay. Hence gender, income, and experience of suffering from vegetable borne diseases were the determinants of consumers willingness to pay. In general, the choice of the non-treatment option (option D) with high percentage of pathogen, soil and groundwater reduction had direct positive impact on individual willingness to pay whiles the status quo option (option A) had negative impact on individual willingness to pay.

5.2 Recommendations

The results of the study on consumers willingness to pay for "safer" vegetables in Ghana as discussed above have policy implications;

1) Vegetable consumers were willing to pay for the non-treatment options of wastewater use in urban and peri-urban vegetable production hence the options, based on the cost and benefit analysis should be implemented taking into consideration the amount consumers are willing to pay for each particular nontreatment option.

2) Certification of produce from the non-treatment options should be promoted to both the urban/peri-urban producer and the market vegetable seller such that consumers can differentiate among the produce and help sustain farmers and market sellers in business. This can be done by forming a vegetable niche market in Ghana where consumers can get safe vegetables produced by nontreatment options of wastewater use.

3) Investment in educational campaigns on the risks associated with vegetables produced without using the non-treatment options of wastewater in urban vegetable production should be promoted to vegetable consumers to build consumer confidence in the yet to be introduced technologies and its benefits. This should be targeted at the youth who show positive WTP for safer vegetables.

Future studies in this area should consider the impact of the combinations of the various non-treatment options on pathogen reduction on vegetables. Studies on the financial viability of each of the non-treatment options are recommended to compliment this study on consumers' willingness to pay for "safer" vegetables and environmental quality improvement, for an efficient and cost-effective implementation of the technologies.

Bibliography:

Agodzo, S.K., Huibers, F. P., Chenini, F., Van Lier, J. B. and Duran, A., 2003. *Use of Wastewater in Irrigated Agriculture. Country Studies from Bolivia, Ghana and Tunisia.* Vol. (2): Ghana. Pp 12-30.

Anderson, Glen, D. and Richard, B., 1986. The valuation problem. In natural resource economics: *Policy Problems and Contemporary Analysis*. Boston, MA. Klower Nijkoff Publications. Pp 88-13.

Ara, Shihani, 2003: Consumers' WTP for Multiple Attributes of Organic Rice: A Case Study in the Philippines. *Paper Presented at the 25th Iternational Conference of Agricultural Economists,* August 16-22, 2003, Durban, South Africa. Pp.1-15

Bennett, J. and R. Blamey, 2001. *The Choice Modeling Approach to Environmental Valuation.* Edward Elgar Pub. Ltd. UK. Pp 1-69

Buechler, S., Hertog, W., and Van Veen Huizen, R., 2002. *Wastewater Use for Urban Agriculture. Agriculture Magazine. Number 8*. December 2002. pp 3-4.

Buzby, J.C., Fox, J.A., Ready R.C. and Cruchfield, S.R., 1998. Measuring Consumer Benefits of Food Safety Risk Reduction. *Journal of Agricultural and Applied Economics*. 30(1), July 1998. pp. 69-82.

Combris, P., Pinto, S. A., Fragata, A., Giraud-Heraud, E., 2007. *Does Taste Beat Food Safety? Evidence form the "Pera Rocha" Case in Portugal*. Contributed paper for presentation at 105th AAEA Seminar, International Marketing and International Trade of Quality of Food Products. Bologna, Italy, March 8-10, 2007. pp 1-16.

Drechsel, P., and Keraita, B. N., 2004. Agricultural use of untreated urban wastewater in Ghana. A paper on wastewater use in irrigated Agriculture. *Coordinating Livelihood and Environmental Realities*. CABI Publishing. Also available on the internet at http//www.cabi.org. (cited, 11/06/07).

Eckert D. R and Leftwich H. R. 1988. The Price System and Resource Allocation. 10th Edition. The Dryden Press. New York. USA. Pp 106-223.

Farolfi, S. Mabugu, R. E. and Ntshingila S.N., 2007. Domestic Wastewater Use and Values in Swaziland: A Contingent Valuation Analysis. *Agrekon,* 46(1). Pp 1-4.

Goldberg, I. and Roosen, J., 2005. Measuring Consumer Willingness to Pay For Health Risk Reduction of Salmonellosis and Campylobacteriosis. Paper presented at the 11th Congress of EAAE. *The Future of Rural Europe in the Global Agri-Food System.* Denmark, 24-27/08/05. pp 1-6.

Gonzalez, M. J. and Loomis, B. J., 2006: *Testing Welfare Measurement Gains of combining Stated and Revealed Preferences Method using Count Data Models.* Paper presented at
AAEA Annual meeting, Long Beach, California, July 23-26, 2006. Pp.1-20.

Groote, D. H., Kimenju, C. S. and Morawetz, B. U., 2006: *Comparing Accuracy and Costs of*

Revealed and Stated Preferences: the Case of Consumer Acceptance of Yellow Maize in East

Africa. Paper Presented at the International Association of Agric. Economists *Conference,* Gold Coast, Australia, August 12-18, 2006.

Halstead, J. M., Huang, J.C, Stevens, T. H. and Harper, W., 2002. Tinkering with valuation Estimates: Is there a future for willingness to accept measure? *American Agricultural Economics Association*. California, July 28-31, 2002.

Hanemann, M. W., Loomis, J.B. and Kaninnen, B., 1991. Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics*: 73(4). Pp 1255-1263.

Hanemann, M. W. and Kaninnen, B., 1999. The statistical analysis of discrete response to contingent valuation data. In Bateman, I. J. and Willis, K. G. Valuing environmental preferences. *Theory and Practice of the Contingent Valuation Method in US, EU and Developing Countries*. Oxford Univ. press, New York. Pp. 302-441.

Hanley N., Shogren F. And White B., 1997. *Environmental Economics in Theory and Practice*. Palgrave Macmillan Publishers, NY. PP 357-360.

Hanley N. and C. Splash L., 1993. *Cost-Benefit Analysis and the Environment.* Edward Elgar publishers, England. Pp.26,53-56

IWMI, 2006. Recycling Realities: *Managing Health Risks to Make Waste Water an Asset*: water policy briefing. Issue 17. pp 2.

Jatib, I., 2003. Food Safety and Quality Assurance Key Drivers of competitiveness. *International Food and Agribusiness Review.* Volume 6. Issue 1, 2003.

Kimenju, S.C. and De Groote, H., 2005. Consumers' willingness to pay for genetically modified food in Kenya. *Paper Presented at 11th International Congress of EAAE*, Denmark, August 24-27, 2005. pp. 2-6.

Kovacic, D., Radman, M., and Kolega, A., 2002. *Behaviour of Fruit and Vegetable Buyers on the City Markets in Croatia.* Paper Pprepared for presentation at the 13th International Farm Management Congress. Wageningen. The Netherlands. July 7-12, 2002. pp. 1-14.

Louviere, J. J., D. A. Heshner and J. D. Swait, 2000. *Stated choice methods, analysis and applications*. New York: Cambridge University press.

Lusk, J. L. and Hudson, D., 2004. Willingness to pay estimates and their relevance to agribusiness decision making. *Review of Agricultural Economics*. 26(2). Pp. 152-169.

Mergenthaler, M., Qaim, M., Weinberger, K., 2007. *Changing Consumer Buying Habits in Developing Countries: A Disaggregate Demand Analysis for Fruits and Vegetables in Vietnam*. Selected Paper for presentation at the AAEA Annual Meeting, Portland, OR, July29-August 1, 2007.

Misra, Sukant, Chung, L., Huang and Stephen, L Ott. 1991. Consumers willingness to pay for pesticide-free fresh produce. *Western Journal of Agricultural Economics*. 16(2): pp.218-227.

Mukhapadhaya, K., Adhikari, B., Mumma, G. and Tiesl, M., 2004. Consumers Willingness to Pay for Food Safety: A Pathogen Specific Analysis. *A Paper Presented at AAEA Annual Meeting*. Denver, Colorado. 1-4/08/04

Obuobie, E., Keraita, B., Danso, G., Amoah, P., Cofie, O. O., Rachid-Sally, L. and Drechsel, P. 2006. *Irrigated Urban Vegetable Production in Ghana. Characteristics, Benefits and Risks*. CSIR-INST Accra, Ghana. Pp.70-98.

Quagrainie Kwamena, 2006: IQF Catfish Retail: A Study of consumers' WTP. *International Food and Agribusiness Management Review. Volume 9, Issue 2*, 2006.

Rewerts, A., Hauf, J., 2006. *Culture and Values-Their Relevance for Marketing Strategies*. Paper prepared for presentation at the 98th EAAE Seminar 'Marketing Dynamics in Global Trading Systems: New Perspectives', Chania, Crete, Greece, 29th June-2nd July, 2006. Pp1-18.

Ridell, P.J., Westlake, M. and Burke, J. 2006. *Demand of Irrigated Agriculture in SubSaharan Africa*. FAO water reports, 31. Pp.8-9.

Smith I. Francisca and Eyzaguirre Pablo, 2007. African Leafy Vegetables: The Role in the WHO Global Fruit and Vegetables Initiative. *African Journal of Food Agriculture, Nutrition and Development. Vol. 7. No. 3, 2007.*

Strauss, M., 1994. health implications of excreta and wastewater use. *Hubie Environmental Sanitation 2nd Workshop*, Wuham. 3-4/03/94. Pp3-6. Available on the internetat:http/www.eawag.ch/organization/abtelungen/publikationen/publicationswra/downloads wra/Hubie-Health aspects of reuse pdf (cited, 11/06/07)

Tindall , H. D. 1983, *Vegetables in the Tropics*. Macmillan Press Limited, London.

Travisi, C. M. and Nijkamp, P., 2004. Are Italians willing to pay for agricultural environmental safety? A Stated Choice Approach. *A Paper Presented At 84th EAAE Economic Seminar on Food Safety in a Dynamic World.* Ziest, Netherlands. 8-11/02/04. pp.1-7

Van der Hoek W., 2003. *A Framework for Global Assessment of the Extent of Wastewater Irrigation.* The Need for a Common Wastewater Typology. Pp. 11. Also available on the internet at http//www.idrc.ca/openebook112-4 (accessed on 11/06/07).

Waibel, H. and Garming, H. 2006. *Willingness to Pay to Avoid Health Risks from Pesticides, a Case Study of Nicaragua*. Paper presented at 46th annual meeting of GAAE. Giessen,4-6 october, 2006. pp 1-12.

WHO, 1989. *Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture*.
Report of WHO scientific group, WHO Technical Report Series 778.

WHO, 2006.Guidelines for Safe use of Wastewater, Excreta and Grey Water: *Wastewater*
Use in Agriculture (Vol. 2). Available at http//www.who.int/water-sanitation-Health/wastewater/en/ (accessed on 12/06/07).

WHO/FAO, 2004. Fruit and Vegetables for Health: *Report of a Joint FAO/WHO Workshop.* 1-3 September, 2004, Kobe, Japan. Available on; http//www.who.int/dietphysicalactivity/fruit/en/index html.(accessed 16/07/2007).

World Bank. 2004: GDP, National Poverty Rates, International Poverty Rates, Income Inequality, and UnemploymentRates:. *World Development Indicators Online.* Washington, DC: The World
Bank. Available at http://www.worldbank.org/data/onlinedbs/onlinedbases.htm.

Yue, C., Alfnes, F., and Jensen, H. H., 2006: *Discounting Spotted Apples: Investigating Consumers' WTP to Accept Cosmetic Damage in Organic Products*. Working Paper 6, November, 2006.

APPENDICES

APPENDIX A: Results logit models

DEPENDENT VARIABLE = P (OPTA = 1)

Variable	Coefficient	z-statistic	p-value
Constant	-3.596	-1.323	0.186
Gender	-1.071	-1.743	0.082
Age	0.042	2.244	0.025
Household size(HH)	0.081	0.985	0.325
Educational level	-0.149	-0.642	0.521
Marital status	0.970	0.308	0.760
Major occupation	-0.606	-0.011	0.991
Income	-0.001	-0.171	0.864
Experience of veg. borne disease (sdse)	0.062	0.057	0.955
Log likelihood function	-70.738		
Chi-square (8)	8.667		0.371

Dependent variable = P (OPTB=1)

Variable	Coefficient	z-statistic	p-value
Constant	-2.586	-1.437	0.151
Gender	-0.237	-0.612	0.540
Age	0.077	0.709	0.478
Household size(HH)	-0.015	-0.304	0.761
Educational level	-0.123	-1.024	0.311
Marital status	0.059	0.333	0.740
Major occupation	-0.388	-1.352	0.176

Income	-0.001	-1.062	0.246
Experience of veg. borne disease (sdse)	0.869	1.159	0.246
Log likelihood function	-210.377		
Chi-square (8)	6.232		0.621

Dependent variable= P (OPT C = 1)

Variable	**Coefficient**	**z-statistic**	**p-value**
constant	-5.093	-2.160	0.031
Gender	0.203	0.448	0.654
Age	-0.028	-2.088	0.037
Household size(HH)	0.012	0.245	0.806
Educational level	0.114	0.981	0.327
Marital status	-0.251	-1.068	0.285
Major occupation	-0.857	-0.287	0.774
Income	0.001	0.915	0.360
Experience of veg. borne disease (sdse)	1.718	1.660	0.097
Log likelihood function	-194.466		
Chi-square	11.266		

Dependent variable = P (OPT D = 1)

Variable	**Coefficient**	**z-statistic**	**p-value**
constant	1.883	1.636	0.102
Gender	0.114	0.411	0.681
Age	0.008	1.143	0.253
Household size(HH)	-0.011	-0.334	0.738
Educational level	-0.013	-0.158	0.874
Marital status	-0.027	-0.211	0.833
Major occupation	0.288	1.429	0.153
Income	0.001	0.793	0.428

Experience of veg. borne disease (sdse)	-0.889	-1.930	0.054
Log likelihood function	-364.185		
Chi-square (8)	8.107		0.423

Dependent variable = P (OPT E = 1)

Variable	**Coefficient**	**z-statistic**	**p-value**
constant	-0.799	-0.366	0.714
Gender	0.019	0.303	0.762
Age	-0.059	-2.590	0.009
Household size(HH)	0.022	0.309	0.757
Educational level	0.226	1.301	0.193
Marital status	0.256	0.816	0.414
Major occupation	-0.596	-1.343	0.179
Income	-0.001	0.917	0.359
Experience of veg. borne disease (sdse)	-0.488	-0.723	0.470
Log likelihood function	-101.611		
Chi-square (8)	15.105		0.057

APPENDIX B CONSUMER SURVEY QUESTIONNAIRE
MEASURING CONSUMERS' WILLINGNESS TO PAY FOR SAFER VEGETABLES IN GHANA.

QUESTIONNAIRE NUMBER [……..]
INTERVIEWER NUMBER [……..]
DATE OF INTERVIEW (DD/MM/YY)……/……/200…..
CITY WHERE INTERVIEW TOOK PLACE: ACCRA […..], KUMASI […..].
NAME OF AREA: […….]
HOUSE NUMBER: […….]

INTRODUCTION

Please I am,(**interviewers name**), a student of ……, who would like to spend 20 min. of your time by asking you a few questions concerning food safety. This is a survey on wastewater use in urban vegetable production and the health and environmental risks associated with the use of this water.

The questionnaire is three parts:

Part A consists of questions on the socio-demographic characteristics of the interviewee.

Part B consists of questions on food safety issues.

Part C consists of questions on consumers WTP to gain improvements in health and environmental risk reduction of the non-treatment options of wastewater use

PART A: SOCIO-DEMOGRAPHIC CHARACTERISTICS OF INTERVIEWEE

1. PERSONAL INFORMATION

1.1 Name of household (*NMHH*)……

1.2. Gender of respondent (*GENDER*)

☐ Male

☐ Female

1.3. Age (**specify in years**)……..years (*AGE*)

1.4. House hold size (**specify number**)…….members (*HH*)

1.5. Educational level of respondent (*EDU*)

☐ Primary education

☐ Junior secondary/middle education

☐ Senior secondary education

☐ Tertiary education

☐ others (specify)……..

1.6 Marital status *(MARISTAT)*

☐ Married

☐ Single

☐ Divorced

☐ other (specify)……..

2. OCCUPATION *(HHOCCUP)*

HOUSEHOLD MEMBER	**MAJOR OCCUPATION (*MAJOCCUP*)**	**MINOR OCCUPATION (*MINOCCUP*)**

HH MEMBER 1		
HH MEMBER 2		
HH MEMBER 3		

3.0 HOUSEHOLD INCOME (*INCOME*)

HOUSEHOLD MEMBER	**AVERAGE INCOME/MNTH (GH ¢)**	
	Major occupation	Minor occupation
MEMBER 1		
MEMBER 2		
MEMBER 3		
TOTAL		

PART B: VEGETABLE SAFETY ISSUES

4. Vegetable consumption behavior *(CONSBEH)*

4.1 Within the past 6 months have you eaten vegetables? (*EATVEG*)

☐ Yes **(if yes, continue with 4.2)** ☐ No (**If no terminate interview**)

4.2 If yes to 4.1, where do you mainly eat the vegetables? *(YSWHE*)

☐ Home

☐ Restaurant

☐ Food vendors

☐ Others (specify)……

4.3 List the type of vegetable eaten and the frequency (*TYPEFREQ)*

Type of vegetable	Frequency/month	Average amount spent/month **(GH¢)**

4.4 In which form do you usually eat your vegetables? (*FRMEAT*)

☐ Raw form

☐ Cooked form

4.5 What characteristics do you look for in a quality (healthy looking) vegetable?

☐Greenish leaves

☐ Cleanliness

☐Spots on the leaves

☐Freshness

☐ Others (specify)…….

5. Vegetable safety issues (*VEGSAF)*

5.1 Have you heard or read about diseases or illnesses caused by vegetables? (*DSECSV EG*)

☐ Yes (**if yes, continue 5.2)** ☐ No (**If no go to 5.4)**

5.2 If yes, where/how did you hear about it? (*HWVGSAFE*)

☐ Radio

☐ Newspapers

☐ Television

☐ Through friends/family members ☐Others (specify)……

5.3 From your knowledge can you list some of the diseases or illnesses caused by eating contaminated vegetables (*CSEDVEG)*

- .....
- .....
- …….
- ……

5.4 Have you or any member of your household fallen ill for eaten contaminated vegetables? *(SDSE*)

☐ Yes **(if yes, continue with 5.5**) ☐ No **(if no go to 5.7)**

5.5 If yes to 5.4 above, do you think the illness was? (*SVRITY)*

Very Severe severe not very severe not severe at all don't know

☐ ☐ ☐ ☐ ☐

5.6 How many days did the illness keep you at home?

- .....days

5.7 Did you or your household member visit the doctor because of the illness? *(VSTDCTOR*)

☐ Yes

☐ No

5.8 Vegetables sold in the cities are produced within the cities mostly using wastewater from the streams and drains. Do you think this wastewater can be the cause of the diseases/illnesses related to vegetables? (*WWCSEDSE)* ☐ Yes

☐ No

►If yes, why do you think the wastewater can cause diseases when used in vegetable production? (*YSWHYWW*)

- …….
- ……

6.0 Sources of Vegetables for the Household and Opinion (*HHSOCE/OPN*)

6.1 Where do you get your regular supply of vegetables? (*VGSPLY*)

☐ Farm gate

☐ Market vegetable retailer

☐ Street hawkers

☐ Supermarkets

☐ Others (specify)……

6.2 What does a safe vegetable mean from the stand point of wastewater use*? (MNSFEVEG*).....……
…….

7.0 Vegetable food chain *(VEGFDCHN)*

7.1 Along the vegetable food chain (ie. From production, transportation, marketing and the consumer-kitchen level), where do you think vegetables get contaminated? (*VGCNTD*)

☐ farm/production level

☐ During transportation

☐ At the market level

☐ Consumer-kitchen kevel

☐ Other (specify)……..

7.2 If the answer to 7.1 is farm/production level, what in your opinion do you think is/are the cause (s) of the contamination? (*FMCSECNTD*)

☐ Water used

☐ Pesticides

☐ Poor handling

☐ Others (specify)……..

7.3 It is tried and tested that vegetables produced from the non-treatment options of wastewater use, from production through to the consumer kitchen level, are "safer" in terms of pathogen content. I would like to get your opinion from the levels as below (*NNTTSFETY*);

	Strongly agree	agree	somewhat disagree	disagree	strongly disagree
a). Vegetables produced by safe water application methods reduces the pathogen content significantly (*FWAPP*)	☐	☐	☐	☐	☐
b). when market women wash vegetables with clean water all the time, the pathogen further reduces .(*MWAPP*)	☐	☐	☐	☐	☐
c). further washing boiling of vegetables at consumer kitchen level further reduces the pathogen level.(*WBKHNL*)	☐	☐	☐	☐	☐

PART C: WILLINGNESS TO PAY QUESTIONS *(WTP)*

8.0 Consider carefully the following options. Suppose these were the only options available, which one would, you choose? *(CMQNS)*

ATTRIBUTE	OPTION A Status quo	OPTION B Improved use of watering cans	OPTION C Cessation of traditional irrigation allowing pathogen die-off	OPTION D Use of drip kids	OPTION E Traditional irrigation in addition to washing vegetable produce with clean water[1]
% of HH Expenditure on Food (*HHEXP*)	NONE (0%)	5%	7%	9%	6%
% Health Risk (Pathogen) Reduction *(HRR)*	NONE (0%)	16.7%	25%	33.3%	16.7%
% Reduction in Soil and Ground Water Contamination (*SGW)*	NONE (0%)	8%	8%	9%	5%
Would you choose……..(please select only one option)	☐ **I would choose option A**	☐ **I would choose option B**	☐ **I would choose option C**	☐ **I would choose option D**	☐ **I would choose option E**

[1] NB:
Traditional irrigation: The normal irrigation practices used by the urban vegetable producers. E.g. Use of open buckets for watering etc.
Ceasation of irrigation: Stopping irrigation for between 2-5 days before harvest.

APPENDIX C: Correlation matrix of variables used in OLS estimates

		gender of respondent	age of respondent	household size	educational level of respondent	marital status of respondent	major occupation of head of household	household income	suffered from vegetable borne disease
gender of respondent	Pearson Correlation	1	.000	.049	-.103**	.001	.085*	-.068	.070
	Sig. (2-tailed)		.994	.208	.008	.974	.030	.082	.074
	N	650	650	650	650	650	650	650	650
age of respondent	Pearson Correlation	.000	1	.150**	.087*	-.108**	.024	.060	.004
	Sig. (2-tailed)	.994		.000	.026	.006	.537	.125	.910
	N	650	650	650	650	650	650	650	650
household size	Pearson Correlation	.049	.150**	1	.006	-.071	-.044	.089*	-.055
	Sig. (2-tailed)	.208	.000		.882	.070	.263	.024	.160
	N	650	650	650	650	650	650	650	650
educational level of respondent	Pearson Correlation	-.103**	.087*	.006	1	.051	-.159**	.144**	-.105**
	Sig. (2-tailed)	.008	.026	.882		.192	.000	.000	.007
	N	650	650	650	650	650	650	650	650
marital status of respondent	Pearson Correlation	.001	-.108**	-.071	.051	1	.112**	-.158**	.012
	Sig. (2-tailed)	.974	.006	.070	.192		.004	.000	.769
	N	650	650	650	650	650	650	650	650
major occupation of head of household	Pearson Correlation	.085*	.024	-.044	-.159**	.112**	1	-.266**	.203**
	Sig. (2-tailed)	.030	.537	.263	.000	.004		.000	.000
	N	650	650	650	650	650	650	650	650
household income	Pearson Correlation	-.068	.060	.089*	.144**	-.158**	-.266**	1	-.190**
	Sig. (2-tailed)	.082	.125	.024	.000	.000	.000		.000

	N	650	650	650	650	650	650	650	650
suffered from vegetable borne disease	Pearson Correlation	.070	.004	-.055	-.105**	.012	.203**	-.190**	1
	Sig. (2-tailed)	.074	.910	.160	.007	.769	.000	.000	
	N	650	650	650	650	650	650	650	650

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

*. Correlation is significant at the 0.05 level (2-tailed).