



# Assessment of Irrigation Dynamics on Vegetable Production Safety in the Accra Metropolis

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## Abstract

This work assessed modes of irrigation on vegetable production in fifty (50) vegetable gardens from ten (10) sampled areas in the Accra Metropolis. Irrigation water sources include: pipe, segment, gutter, dug-well, dam, river, and drains. Demographic survey, nature of the surrounding of the water bodies, physico-chemical and microbiological analysis of irrigation waters were carried out and contrasted with standard values. The analysis of the parameters of various water samples was within the accepted standard values, except the Chemical Oxygen Demand (COD) value for the irrigation water from Opeibea (3020) and Kasoa (340), which were relatively high compared to standard value of 250. The faecal coliform counts for irrigation water at Abossey-Okai are also high (1150/100 ml) compared to the standard values of 1000/100 ml irrigation water. The vegetable farming was found to be a male dominated activity (86%), mostly practised by 21 - 30 year age group (69%). However the education levels of farmers are low; 70% either do not have formal education or only up to primary education levels. A greater percentage (68%) of the water used for irrigation was waste water, mostly from gutters and segments. Proper management practices of effluent are recommended for vegetable production.

## Keywords

Coliforms, Microbiological, Demographic, Physic-Chemical, Vegetables

**Subject Areas:** Environmental Sciences

## 1. Introduction

Water is vital in vegetable production. In the Accra Metropolis the source of water for vegetable farming includes rivers, dams, drains or gullies, segments/ponds, gutters, dugged wells and pipe water. The Densu river

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and its tributaries or streams are major source of water for irrigation. The irrigation practices are energy demanding—using containers to carry water. Traditionally males are family heads and physically strong, and are expected to be providers of food. They are therefore mostly seen watering vegetables. The common vegetable cultivated in the study area include: leafy types—cabbage, lettuce, kenaf, spinach, alefu (*Amarantus*); root and stems types—carrot, shallot, onion, potatoes, fruit types—cucumber, pepper, tomato.

The common tools for irrigation include watering cans, buckets and water hoses. Sometimes tins and calabashes are used. A survey around the study area indicates that some of the irrigation water source looks clear (transparent), while others are dark with or without suspended visible particles. Some of the water sources are surrounded by weeds; others flow by public toilet facilities, refuse dumps sites, and some gaining their supplies from rainfalls which wash down various sorts of debris, including animal and human waste. While some are surrounded by farm lands, others are around construction sites. The sampling was done within the months of March to April, just at the beginning of the minor raining season. Sonou [1] indicated that about 700 people are engaged in vegetable farming in Accra Metropolis, occupying about 300 hectares of land.

Urban vegetable production is characterized by the proximity of production to consumption sites. Vegetables have great nutritional benefits (vitamins, minerals and fibres), and a large number of families in urban areas owe their living on its farming and marketing. Safe water is preferred for irrigation purpose, however there are limitations in using potable water for irrigation due to constraints by high tariffs, making it uneconomical even if such water was available [1]. This makes most vegetable producers use waste water which are reliable and available throughout the year [2].

Pipe water and dug well water may be with less faecal contamination unless contaminated with surface run-offs. However, sometimes the dug well water may have high mineral content [3]–[5]. The increase in both pollution levels and frequency of food related illnesses has led researchers to assess the linkage between polluted irrigation water and food safety [6]. This thus forms the basis of the study.

Various measures could be adopted for quality vegetable production. Greenhouses or glasshouses, buildings or complex in which plants are grown, have been introduced to farmers by Dizenoff Ghana Limited in Ghana for quality production of tomatoes, pepper, chilli pepper [7]. In this case crop cultivation is done in controlled environment which protects crops from rain, strong winds, insects and diseases. Temperature is controlled using mechanized open-close ventilation system. Reclamation of waste water could be done through particle removal, using flow micro-filters or with membranes [8]. Waste water could be stored to allow suspended materials and eggs from worms settle before use [9].

The main objective of this paper is to assess the contamination levels of the various sources of water used for irrigation in the Accra Metropolis for vegetable production as compared to the EPA and WHO recommended standards; and the public health related implications posed in order to recommend practical solutions to reducing the sources of contamination.

## 2. Method

### Study Area and Geographical Location and Map

Ten (10) sectional areas in and around Accra Metropolis which is located on latitude 5.56°N and 0.2°W with elevation of 91 m [10] were selected for the study. These ten (10) sectional areas include 37/Opeibea, Korle Bu, GBC Frontage, Pig Farm, Abossey Okai, Castle Road, Dworwulu, Kanda, Kasoa and Weija. Figure 1 shows the map of the study areas.

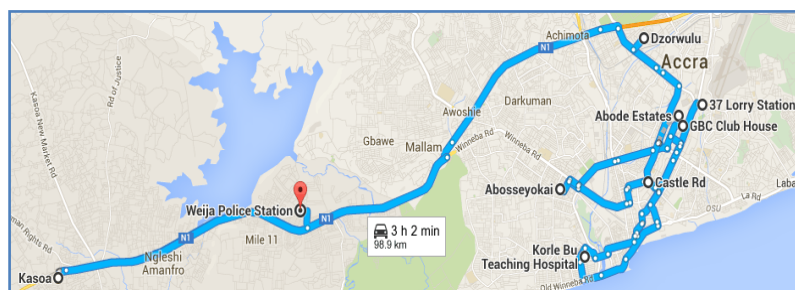


Figure 1. Geographical location map of study areas.

### Climatic and Vegetation Conditions of the Study Areas

There are two rainy seasons. The average annual rainfall is about 730mm, which falls primarily during the two rainy seasons. The daylight hours are practically uniform during the year with relative humidity generally ranges between 65% in the mid-afternoon to 95% at night. Less temperature variations is recorded throughout the year in the region of 24.7 - 26.8 [10]. Shrub land, grasslands and coastal lands are the three broad vegetation zones are identified within Accra but the areas of study falls neatly into the grassland vegetation zone.

### Sampling

These areas were randomly selected using stratified sampling technique from which five (5) irrigation water sources in each of these sites were randomly sampled and analysed. Thus a total of fifty (50) samples were used. The types of irrigation waters for the analysis included: pipe water, segment water, gutter, drain water, dam, dugged-out well water, and river. The samples were taken during the hours of 6 am to 8 am, the time the farmers irrigate their gardens. The sampling was done within the months of March and April, on weekly bases for three weeks; thus three replicates were taken from each site and the average results of the analysis used.

### Materials

Questionnaires were used for the demographic characteristics of the data on vegetable gardening activities in the study areas. Sterilized sampling bottles, hand gloves, and ice chest were used to collect the water sample, before transporting to the laboratory. Reflux apparatus was used to determine the COD, pH-meter to measure the pH of the water, agar media for culturing, and magnifying glass to help count colonies.

### Methods

For the COD analysis, the closed refluxed method as described by [11] was used to determine the blank and sample values. These results were used to evaluate the COD (mg O<sub>2</sub>/l).

Using the formula:

$$COD = (A - B) \times M \times 8000$$

where: *A*—ml FAS used for Blank; *B*—ml FAS used for Sample; *M*—Molarity of FAS; 8000—(milli-equivalent weight of O<sub>2</sub> × 100 ml)/2.

For faecal coliform test, the membrane filtration and culturing methods as described in [12] were to determine the standard plate count (colony form units – (CFU)/100 ml). The pH meter was used to determine the pH values for each of the samples water. Also a physical survey of the study area was carried out especially on the nature of the surroundings of the water bodies and the nature of works during watering.

## 3. Results

In all ten (10) sites within the Accra Metropolis and its environs were studied on the types of irrigation water sources used. In each of these sites five (5) irrigation water samples were taken, usually in the morning when irrigation of the crops was carried out during the months of March to April. The various water sources included pipe, segment, gutter, dugged well, dam, river, gullies and canals.

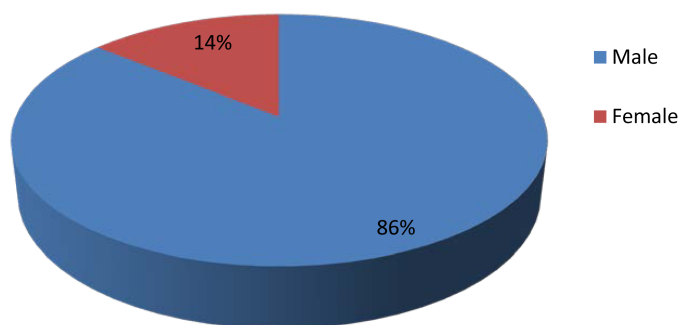
Observation made at the study sites indicate that some of the water sources were transparent or clear, others were dark coloured with or without suspensions. Some water sources were surrounded with weeds, others were by construction sites, while others pass closer to toilet and refuse dump sites. The water source included waters from segment, drains, gutters, rivers, pipes, dugged wells and dam.

This is a male dominated activity (86%) as seen in **Figure 2**. Traditionally males are family heads and are suppose to be providers of food. This finding agrees with [4] report that men are mostly involved in open space urban vegetable farming in West Africa.

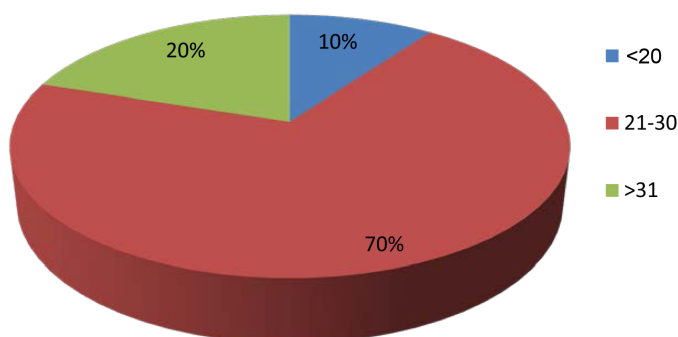
A greater percentage (70%) of the farmers were within the 21 - 30 age bracket as indicated in **Figure 3**. Fetching and watering of the crops is mostly done manually; this requires a lot of energy and calls for young persons. It thus renders means of livelihood for the youth, who could help employ others, if they are able to expand the business.

**Figure 4** shows that seventy percent (70%) of the farmers are either without formal education or educated up to the primary level. This phenomenon is typical in most African countries and is unfortunate since most illiterate farmers may not appreciate and adopt good agronomical practices easily, especially compromising profits for better health issues.

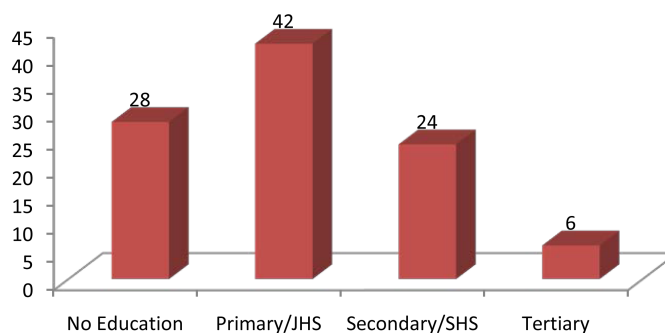
Gutter and Segment water are the most predominantly water sources used in the study area. Though a greater percentage (68%) of irrigation water is waste water, other sources of water is also used, including pipe, dam,



**Figure 2.** Distribution of vegetable farmers by gender.



**Figure 3.** Distribution of vegetable farmers by age groups.

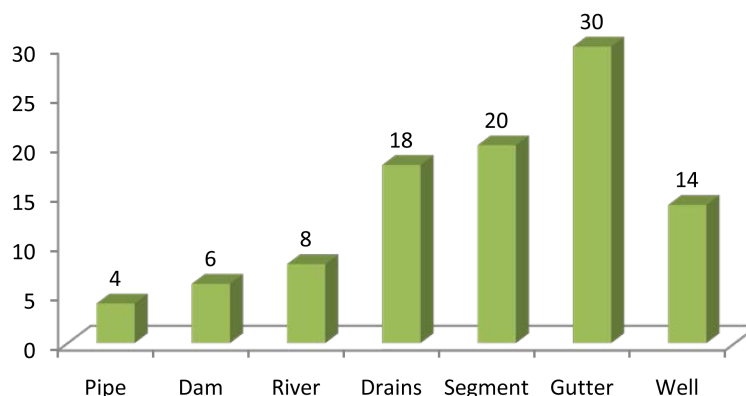


**Figure 4.** Distribution of vegetable farmers by level of formal education.

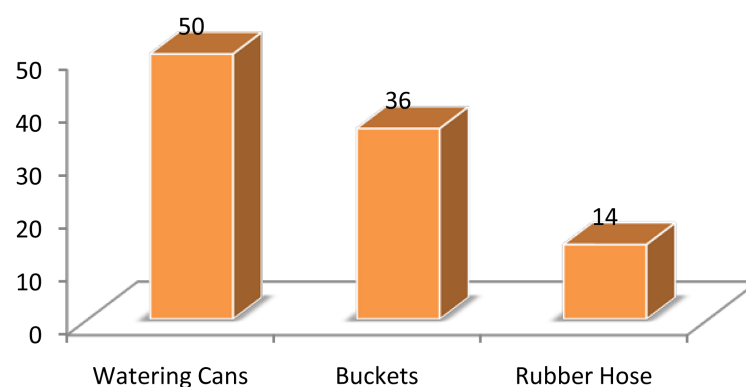
river, and water dugged wells as shown in **Figure 5**. The use of pipe water is constrained by high tariffs as well as its unreliability.

The watering cans are the common devices used for watering (50%) as seen in **Figure 6**. The shower head of this device is suitable for watering fragile vegetables. These are used where the water sources are near to the farm. Buckets are used to transport water from relatively far sources and also used to water maturing or established, non-tender crops, such as pepper, cabbage and okra. Rubber hose are the least used (14%). They are connected to pumps mounted near the water source. These are efficient and easy to use, but relatively expensive to the reach of most farmers. Irrigation is mostly done overhead and this has greater infection rates on the produce.

The commonest irrigation water source in each of the ten irrigation sites as indicated in **Table 1** were used to determine the parameters such as pH, faecal coliforms and COD. Most of the evaluated values fell within the standard threshold. The river water source used at Abossey-Okai recorded high CFU values 1200 against standard value of 1000/100 ml. This could be due to the indiscriminate defecation around the water body, which goes into the water through rain run offs as well as toilet and dumping site near the water source. The COD for water sources at 37/Opeibeagully drains were very high 3020 as against the standard value of 250 mg/l, and so is the water source from Kasoa well—340 mg/l. The 37/Opeibea drain is fed by hotel/restaurants, canteens,



**Figure 5.** Statistics of sources of water in the study area used for irrigation.



**Figure 6.** Statistics of various watering devices used for irrigation.

**Table 1.** Sample sites and sources of sampled water for physico-chemical and microbial analysis.

Sample Site	Pipe	Dam	River	Drains	Segment	Gutter	Dugged Wells	Sample Size
1	-	-	1	-	2*	2	-	5
2	-	-	-	3*	1	-	1	5
3	-	-	-	1	-	4*	-	5
4	-	-	3*	1	1	-	-	5
5	1	-	-	-	-	4*	-	5
6	-	-	-	1	3*	-	1	5
7	-	-	-	2*	1	2	-	5
8	1*	-	-	-	2	2	-	5
9	-	-	-	1	-	1	3*	5
10	-	3*	-	-	-	-	2	5
Tts.	2	3	4	9	10	15	7	50
Tts. (%)	4	6	8	18	20	30	14	100

\*Type of water source where samples were taken at the site for physico-chemical and microbiological analysis. Standards: pH: 6.0 - 9.0; BOD: 250 mg/l; Faecal Coliform: 1000 per 100 ml [13].

offices, lavatories and resident wastewater, aside rain wash-off surface water. The area had a lot of constructions going on within the study period. This could have contributed to these high values. The Kasoadugged well water could be attributed to the nature of the soil chemical composition. Construction works and farming activities are also prominent there (Table 2).

**Table 2.** Physico-chemical and microbial load in sampled irrigation waters.

No.	Sample Site	Water Source	Faecal Coliform (CFU)/100 ml	COD Value (mg/l)	PH Value
1	Korle Bu	Segment	650	210	7.6
2	37/Opeibea	Drains	265	3020	7.5
3	GBC Frontage	Gutter	100	215	7.2
4	Abossey-Okai	River	1200	230	7.4
5	Castle Road	Gutter	35	50	7.9
6	Pig Farm	Segment	610	19	7.5
7	Kanda	Drains	440	60	7.6
8	Dworwulu	Pipe	10	40	7.1
9	Kasoa	Dugged Well	25	340	7.4
10	Weija	Dam	110	15	7.4
Standard Values		-	<b>1000</b>	<b>250</b>	<b>6.0 - 9.0</b>

Source: Standard Values [13] [14].

## 4. Conclusion

Vegetable gardening is common along/around various water bodies in the Accra Metropolis and is a male dominated occupation especially among the age group of 21 - 30 years. Generally the educational background of the farmers is relatively very low. About 68% of water used is wastewater. Although most of the water sources have parameters within standard levels it is not safe using this water without care. Even if the identified bacteria is as low as 1.0% it still indicates that some of the organisms still exist and are potential health risk [15].

## 5. Recommendation

Vegetable gardening in Accra Metropolis is a laudable business addressing unemployment and food security issues. More education and campaign should be given to the public to embrace the business and carry out safety measures to improve the hygienic nature of the products. This should include cleanliness around the water bodies, addressing indiscriminate defecation, proper management of effluent and wastewater before discharging it for irrigation.

- Encourage educated youth to take up the business, as a full or part-time activity, as they have a higher tendency to understand the health and safety rules on the business better.
- Though expensive the greenhouse farming approach is recommendable; while adapting harvesting and treatments of rain water for irrigation, use of pipes to water the crops around their root zones instead of overhead irrigation must be practised.

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