Exploring Irrigable Dams Schemes and Water Quality for Vegetable Cultivation in Wa West District, Upper West Region-Ghana

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Abstract

Water is vital for existence and is universally acknowledged as the paramount natural resource. Water consumption is essential for individuals and various activities in both the formal and informal sectors. This study sought to assess irrigable dam schemes and water quality for vegetable cultivation in the Wa West District, Upper West Region of Ghana. Simple random sampling was employed to select 296 vegetable farmers in the study area. Additionally, a key expert interview was employed to extract information from 50 prominent experts across various government agencies and stakeholders. The research utilized a weighted average index (WAI) to evaluate the viewpoints of the key informants. The study additionally utilized spectrophotometric analysis to examine the water resources of irrigable dams within the research area. The evaluated physico-chemical parameters of water quality revealed that nitrogen, fluoride, potassium, and phosphorus concentrations in the dams surpassed the WHO water quality standards. The study findings revealed that nearly 96% of respondents in the study area obtained their livelihoods directly or indirectly from the dam's water resources. The study concluded that augmenting the capabilities of farmers and households in strategies to mitigate dam pollution would substantially enhance dam protection. It is advisable to effectively disseminate extension programs to furnish pertinent information on irrigable dam systems, thereby improving farmers' adoption of irrigation technology. Authorities must consistently enforce and advocate for the proper utilization of fertilizers on irrigable farms. This pattern will alleviate the potential adverse impacts of nitrogen, phosphate, potassium, and other contaminants on water, resulting in a deterioration of water and agricultural quality. Collaborative partnerships among essential stakeholders, including community members, will enhance the efficiency and conservation of water resources in the Wa West District and adjacent regions.

Keywords: Vegetables, irrigation, water resources, dam, farmers, chemicals

Introduction

Water is vital for all known life forms. It functions as a solvent, a catalyst in chemical reactions, and a thermo-regulator within organisms. Water performs several essential functions, including nutrient transportation, waste elimination, and the facilitation of cellular processes such as photosynthesis and osmosis (UNEP, 2017; WHO, 2017). The establishment of dams, wells, canals, and other infrastructure guarantees water accessibility for domestic and livestock use, in addition to facilitating irrigated agriculture. The swift increase in the global population generates a continuous demand for water to support agricultural output. The present growth rate is roughly 1.13%, equating to 80 million individuals per year (FAO, 2015). UNEP (2017) projects that the global population will attain 9.6 billion by 2050, indicating a 34% increase from present numbers. The increasing demand for water in vegetable crop cultivation from dams, rivers, streams, and wetlands raises concerns regarding the sustainability of finite natural water resources to satisfy future requirements (Ampadu et al., 2015; Gbedemah, 2017; Bradford et al., 2018). These trends may result in water scarcity in the forthcoming years. Furthermore, global climate change substantially affects agricultural production, imposing significant limitations (FAO, 2014; IPCC, 2014; WFP, 2016; Hansen et al., 2018). In 2017, the World Health Organization (WHO) indicated that nitrate from agricultural sources is the predominant chemical contaminant in global groundwater aquifers. Notwithstanding the significant rise in water pollution attributable to agricultural practices, agriculture remains the primary employer in numerous regions and is essential to the Gross Domestic Product (GDP) of countries, especially in Africa (Alfred et al., 2014; Boadi et al., 2015; Oteng-Ababio, 2017).

Research demonstrates that climate change poses a dual threat to agricultural water resources by reducing water availability and concurrently increasing demand (Christoplos et al., 2012; Boadi et al., 2015; Tey and

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Akomeah, 2019; UNFCCC, 2020). Ensuring an adequate water supply for agricultural use is essential, especially in light of the rising demand for water across multiple sectors, including residential and industrial applications. This necessity is critical to meet the changing food requirements arising from population expansion (Sharma et al., 2016; Sankla et al., 2016). Diverse water-conserving irrigation techniques are utilized to address this problem (IFAD, 2011; FAO, 2014; Alfaro et al., 2018; Zhou et al., 2021). The 2020 report by the Ghana Statistical Service (GSS, 2020) indicates that vegetable production constitutes a substantial income source for roughly 30% of households involved in crop production in Ghana. Furthermore, it constitutes approximately 32% of the overall agricultural sales produced by these households. Consequently, it is prudent to refrain from cultivating vegetable crops in proximity to dams. The availability of irrigation promotes economic growth and secures a dependable food supply, especially in water-deficient regions of the country, including the Northern, Upper East, and Upper West areas (Ampadu et al., 2015). Irrigation infrastructure is essential in water-scarce areas, particularly in Upper West, owing to erratic rainfall patterns and a rising demand for agricultural water (Alfred et al., 2014). Disadvantaged communities predominantly participate in subsistence agriculture in these areas.

The irrigation projects in the Wa West District were implemented to supply water for agricultural and fishing endeavors, with the objective of augmenting food production and generating employment opportunities for the local populace. The communities in the West District continue to confront substantial challenges associated with food insecurity and unemployment, exacerbating the factors that drive out-migration. The government and various stakeholders have enacted measures to enhance food security through initiatives such as dry season gardening. Dams have beneficially influenced vegetable cultivation in local communities. The application of chemicals, including inorganic fertilizers, pesticides, and herbicides at the dam sites, has led to the contamination of these water bodies.

This study seeks to examine the effects of vegetable cultivation methods on the water resources of irrigable reservoirs. The assessment will evaluate the water quality of dams appropriate for irrigation and recommend strategies to optimize the safe utilization of dam water resources for irrigation and other livelihood activities.

Materials and Methods

Study Area

The Wa West District was carved out of the Wa Municipality and made an autonomous district by L.I 1746. The District is located in the western part of the Upper West Region, approximately between longitudes 9º 40’ N and

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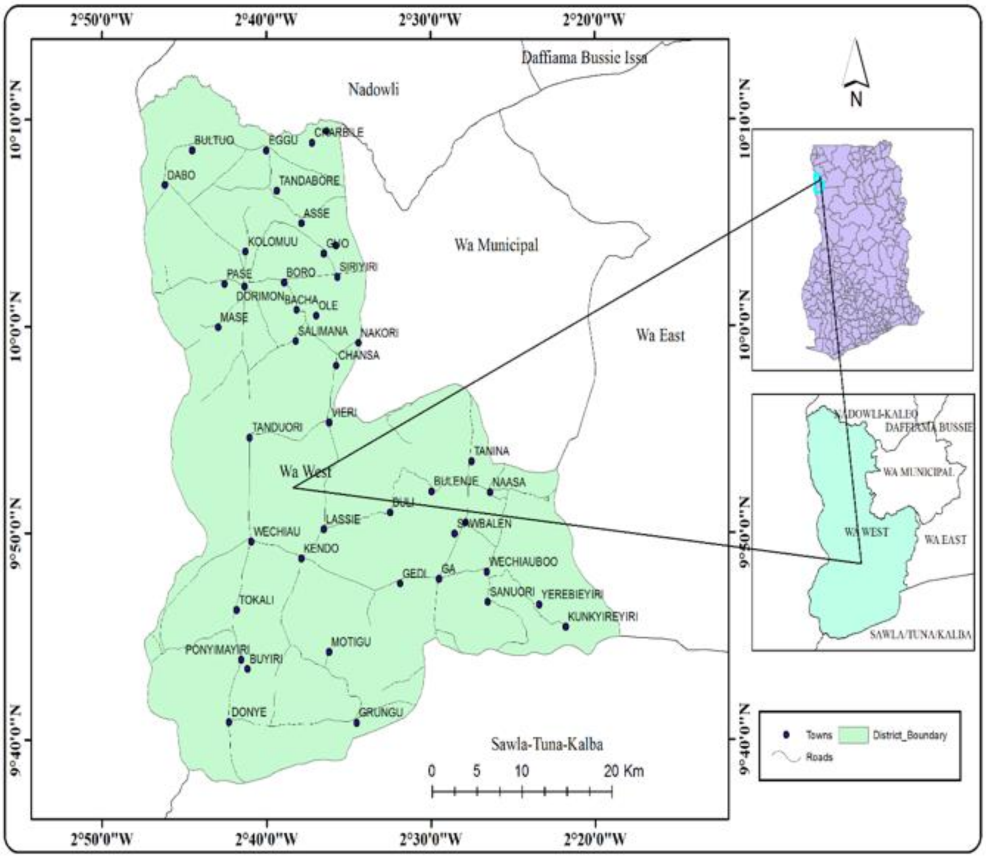
10º 10' N and also between latitudes 2º 20' W and 2º 50' W. The administrative capital is Wechiau. The District Shares Boundaries with Sawla-Tuna-Karlba District to the south, the Wa Municipal to the east Nadowli Kaleo District to the north and to the west with the Ivory Coast. The population of the District, according to 2020 population and housing census, stands at 81,348 with 40,227 males and 41,121 females.

Figure 1: Map of Study Area



Source: Authors construct

Sample Size determination

According to the District Agriculture Development Unit's (DADU) 2022 farmers updated census data, 39,134 people between the ages of 15 and 65 were farmers, with men making up the bulk of these farmers. Only 296 respondents out of the 396 sample size obtained participated in the survey. Ten (Wechau, Lassie, Gedi, GA, Tanina, Motigu, Donye, Naasa, Buyiri and Tokali) communities, which mostly use Dams for irrigation actvities were chosen with the assistance of Agriculture Extension Agents (AEAs).

With the aid of the sample size determination formula, the sample size of the respondents was determined as follows:

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

$$n=\frac{N}{1+N(e^2)}$$

n=sample size, N= sample population, e= margin of error =0.05
N= 39134

$$n=\frac{39134}{1+39134(0.05^2)}$$

$$n=396$$

In addition to the survey, a total of 50 key experts were interviewed regarding irrigable dam schemes and water quality for vegetable cultivation, comprising 5 representatives from the Environmental Protection Agency (EPA), 5 from the Ghana Irrigation Development Authority (GIDA), 5 from the District Agriculture Development Unit, 30 from Farmer-Based Organizations (FBO), and 5 municipal assembly officers. The objective of the key expert interview was to gather diverse perspectives on issues pertaining to vegetable production and dam water contamination. The data was collected over a four-month period, from February to June 2024. The figure below presents semi-structured questions and the interview guide for key experts.

1. **Demographic characteristics of respondents**
   i. What is your age? a. less than 25 years old, b. 25 to 36 years old, 37 to 45 years old, 46* years old.
   ii. What is your gender? a. Male, b. Female
   iii. What is your marital status? a Single, b. Married, c. Divorced, d. Widowed
   iv. What is your level of education? a. No formal education, b. Basic or primary sch, b. Junior High Sch, c. SHS/VOC/TECH, d. Tertiary education.

2. **What is the form of land ownership in your community?**
   a. lease, b. Purchase, c. family land, d. friend, other

3. **What are the types of vegetables grown at the dam site?**
   a. Okro b. Garden egg. c. Pepper, d. Tomatoes. e. Other.

4. **What are the types of fertilizer used?**

a.Organic fertilizer. b. Inorganic fertilizer.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Key Expert Interview Guide

1. **In your own opinion, rank the following perceived causes of dam water contamination**

Variables	strongly agree	agree	do not agree	Not sure
Use of Farm inputs (fertilizers, weedicides, pesticides)				
Fishing				
Erosion and runoffs				
Livestocks				
Climate change				

2. **Rank the following perceived strategies to address dam water contamination?**

Variables	strongly agree	agree	do not agree	Not sure
Capacity building and education				
Law enforcement				
Stakeholders engagement				
Protection of dam site				
Livestock receptacles and canals				

Analyses of Data

The statistical package for social sciences (SPSS) version 23 was used to evaluate the field survey data and presented in tables and figures to clearly illustrate the responses of the respondents.

Weighted Average Index:

A total of 50 key experts (comprising 5 from the Environmental Protection Agency (EPA), 5 from the Ghana Irrigation Development Authority (GIDA), 5 from the District Agriculture Development Unit, 30 from FBOs, and 5 from Municipal Assembly officers) were interviewed regarding irrigable dam schemes and water quality for vegetable cultivation, and their responses were analyzed using the Weighted Average Index (WAI). The Weighted Average Index (WAI) is employed in research to assess participants' perceptions or opinions concerning a single 'latent' variable (phenomenon of interest). Therefore, employing WAI to analyze irrigable dam schemes and water quality for vegetable cultivation variables such as crop yield, water bodies, soil fertility, and livelihood impact was considered to be effective. The WAI for the respondents' variables was calculated using the following formula:

$$WAI = \frac{F0W0 + F2W2 + F3W3 + F4W4}{F0 + F1 + F3 + F4}$$

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WAI= $\frac{\sum FiWi}{\sum Fi}$ where W = the weight of each assessed variable on the scale, Fv = frequency of variables, i = response on the scale (e.g., i = 0-not sure, 1-do not agree, 2-agree, 3-strongly agree)

The physico-chemical analyses of sampled dam water

The spectrophotometric analysis method was used to evaluate the physicochemical properties of water. Heavy metals, turgidity, and dissolved oxygen levels in the selected irrigation dams were measured using spectrophotometers. This method was chosen for water quality analyses because it can quickly and precisely detect the presence and concentration of different substances and elements in water.

Results and Discussion

Socio-demographic characteristics of respondents

The findings on the socio-demographic characteristics of the research respondents are shown in Table 1. They are analysed according to their age, gender, marital status, educational level, and primary employment.

Table 1: Socio-demographic characteristics of respondents

Socio-demographic characteristics	Response categories	Frequency	Percent
Age	Less than 25 years old	76	25.7
	25 to 36 years old	73	24.7
	37 to 45 years old	74	25.0
	46/+ years old	73	24.7
Gender/Sex	Male	102	34.5
	Female	194	65.5
Marital status	Single	27	9.1
	Married	244	82.4
	Divorced	8	2.7
	Widowed	17	5.7
Level of education	None	165	55.7
	Basic/Primary	59	19.9
	J.H.S	49	16.6
	S.H.S/TECH/VOC	18	6.1
	Tertiary	5	1.7

Source: Study survey, 2022; N = 296

Table 1 indicates that 25.7% of vegetable farmers were aged 18 to 25, whereas 25% were in the 37 to 45 age range. A smaller percentage, 24.7%, was found in the 46–55 age group, which shows how diverse the farming community is. This distribution highlights the need for targeted support programs that cater to the specific age groups engaged in vegetable farming. By addressing the unique challenges and opportunities faced by these age groups, stakeholders can foster a more sustainable and productive agricultural environment. Additionally, understanding these demographics can help in

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creating educational resources and financial assistance tailored to their needs. The survey indicated that a greater percentage of women (65.5%) participated compared to men (34.5%) in terms of gender. The findings indicate that women in the study area exhibited a greater level of engagement in vegetable cultivation than men. Interactions with indigenous communities about women's substantial role in vegetable production indicated that the involvement of NGOs in the district, which offer support and promote gender empowerment, is a critical factor influencing the elevated percentage of women engaged in this sector. The research indicated that the convenience and robust market demand for vegetables throughout the year act as motivators for women to engage in vegetable production. The survey results reveal that a significant majority (82.4%) of participants were married, whereas a lesser percentage were single (9.1%), divorced (2.7%), or widowed (5.7%). A majority of respondents (55.7%) had not attained any formal education. A small proportion of individuals had completed basic/primary education (19.9%), junior high school (16.6%), senior high school/vocational/technical education (6.1%), or higher education (1.7%). This implies that fewer people with higher levels of education work as vegetable growers in the research region than those with lower levels of education. The low level of education in the study area could affect the adoption of complex technology to boost agriculture. This lack of formal education among vegetable growers in the research region could potentially hinder their ability to adopt and implement more advanced agricultural technologies that could greatly improve their crop yield and overall efficiency. Without a solid educational foundation, these individuals may struggle to keep up with the latest innovations and best practices in the field of agriculture, putting them at a disadvantage compared to their more educated counterparts. It is crucial for government and non-governmental organizations to provide support and resources to help these growers improve their education and technical skills to enhance their productivity and success in the industry.

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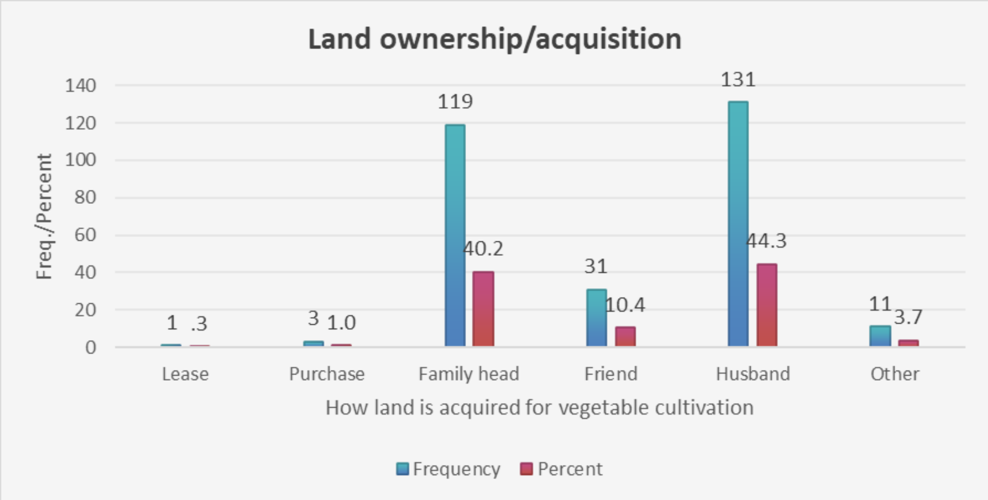
Land Ownership/ Acquisition

Figure 2: Land acquisition for vegetable cultivation



Source: This study survey, 2024

According to Figure 2, a significant proportion of respondents who grew vegetables did so on land owned by the family head (40.2%) or spouse (44.3%). In contrast, fewer respondents acquired land through friends (10.4%), purchases (1%), leases (0.3%), or other means (3.7%). This indicates that a limited number of individuals opt to purchase or lease land for their vegetable gardening activities, demonstrating a tendency to utilize their own properties. This could indicate a sense of independence and personal investment in their gardening activities. Overall, these findings show a trend of self-reliance and a commitment to sustainability among vegetable gardeners. The findings show that, despite the presence of many female vegetable producers in the study area, their primary mode of land acquisition was through allocation from their husbands or other male family members, rather than self-acquisition. Personal observations indicate that cultural precedent reflects a patriarchal system, with males having greater ownership rights than females. Numerous vegetable cultivators, who own land primarily for short-term crop production, use fertilizers and pesticides to increase yield. This contributes to irrigable dam contamination from dissolved nitrates and phosphorus that remain undissolved after application and use. The environmental consequences of these practices endanger not only local ecosystems but also the health of communities that rely on these water sources. As the contamination cycle continues, there is a critical need for sustainable agricultural practices that prioritize both food security and sustainable land and water management in the study area.

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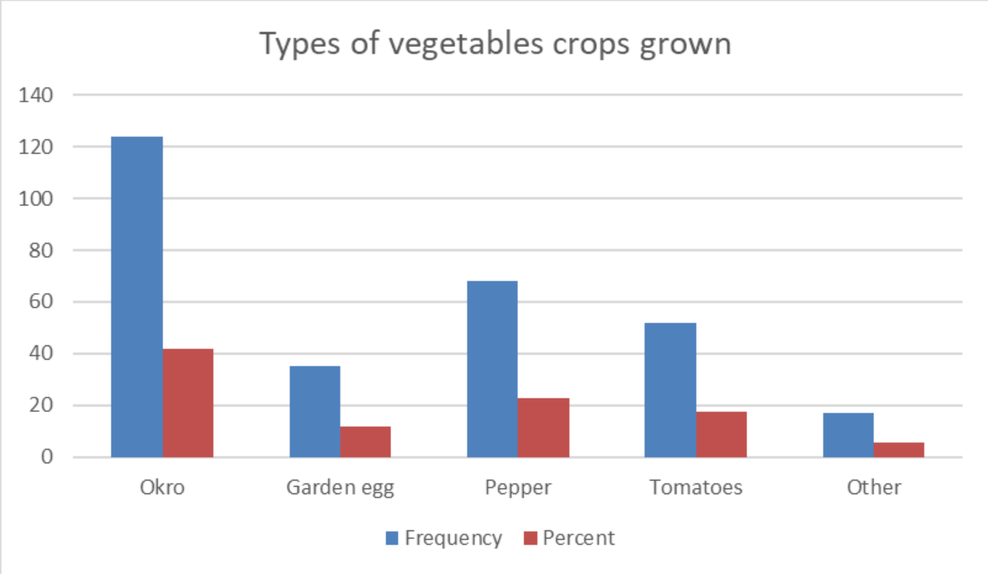
Types of Vegetable Crops Grown

Figure 3: Types of vegetables crops grown

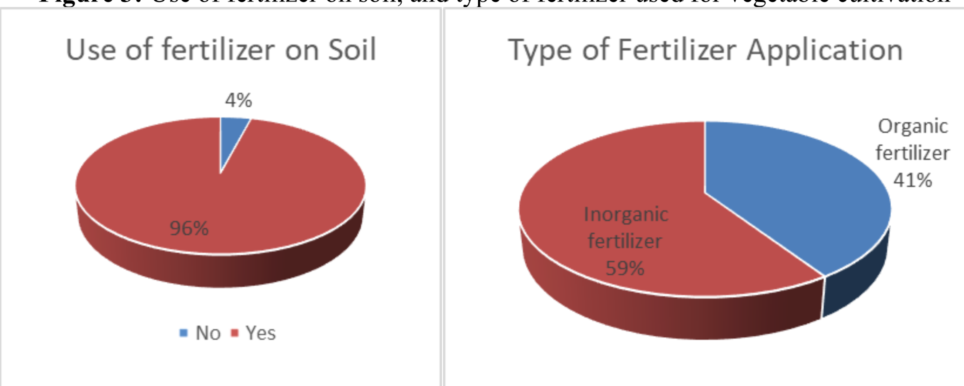


Source: Study survey, 2024

Figure 3 exhibits data on vegetable crops grown by farmers, with okra (98.9%), pepper (77.4%), other crops (67.9%), and tomatoes (63.9%) being the most common. In contrast, only 33.8% of farmers cultivate garden eggs, pumpkin, moringa, Jew's Mallow (ayoyo), cucumber, green pepper, bean leaves, "kontomire" (cocoyam leaves), and onions. The cultivation of these vegetables contaminates bodies of water. The use of pesticides, weedicides, and fertilizers at dam sites for vegetable cultivation increase the concentration of chemicals in dam water resources.

Types of Fertilizer Application

Figure 3: Use of fertilizer on soil, and type of fertilizer used for vegetable cultivation



Source: Study survey, 2022

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Figure 3 illustrates that a large majority (96%) of respondents use fertilizer on their vegetable farms, with inorganic fertilizer (59%) outperforming organic fertilizer (41%), to improve soil nutrient levels. Only 4% of respondents said they don't use fertilizer due to their soil's fertility or a lack of financial resources for inorganic manure. The pollution of water bodies, particularly groundwater, caused by excessive chemical use tends to overshadow the important functions performed by these fertilizers (Amoah et al., 2014; Zhou et al., 2021). Excessive fertilizer use can have a negative impact on soil fertility, plant growth, aquatic ecosystems, and human and animal health. Excess runoff from agricultural activities, especially vegetable cultivation, contributes to the formation of aquatic dead zones. Most aquatic organisms suffocate and die as oxygen levels drop in these environments. Crops grown with irrigation from these contaminated water sources contain chemical residues that may pose a health risk to humans. The use of organic fertilizers causes the release of nitrates, potassium, and phosphates, which contribute to water contamination. Groundwater contamination occurs when nitrates from fertilizers leach into the groundwater. A consistent correlation has been found between fertilizer leaching in arid regions and intensive irrigation (Zhou et al. 2021). Fertilizer applications introduce contaminants into ground and surface waters at levels that pose significant risks to human and animal health; additionally, the emission of ammonia from fertilizers contributes to acidification, lowering the quality of water bodies. This acidification has the potential to harm aquatic organisms and disrupt natural systems. To protect human and environmental health, agricultural practices must take into account the effects of fertilizers on water quality.

Perceived Causes of Dam water contamination

Table 2: Perceived Causes of Dam Water Contamination

Variables	strongly agree	agree	do not agree	Not sure	WAI	Rank
Use of Farm inputs (fertilizers, weedicides, pesticides)	30	10	6	4	2.32	1
Fishing	25	15	5	5	2.2	2
Erosion and runoffs	22	17	4	7	2.08	3
Livestocks	20	15	5	10	1.9	4
Climate change	22	8	8	12	1.78	5

Source: Key expert interview discussions (2024)

This study examines the perceived factors contributing to dam contamination, as outlined in Table 2. The study concludes that the primary source of pollution in the dam water is the use of fertilizers and other agricultural chemicals, such as herbicides and pesticides, in vegetable

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

cultivation at the dam locations. Observation of the vegetable gardens adjacent to the dams indicated the presence of discarded chemical containers surrounding the perimeter of the dam. Interactions with farmers revealed a lack of knowledge regarding proper disposal procedures for chemical containers, leading to the deliberate disposal of empty containers after use. Fishing (2.2) has been recognized as a major contributor to water pollution. The study reveals that the majority of fishermen in the communities employ chemicals, such as DDT (Dichlorodiphenyltrichloroethane), for fishing purposes, leading to increased levels of heavy metals in the dams. The fish species inhabiting the dams are at risk of extinction, and the water quality has deteriorated to a level that renders it unsuitable for human consumption. The study identified erosion and runoff (2.08) as major factors contributing to water pollution in the dams. Dams are built in low-lying regions within communities to enable water accumulation. The high-pressure influx of water into the dams results in the accumulation of foreign substances, thereby increasing the concentration of particulate matter (PPM) within the dam. The brown coloration of the water indicated a significant presence of impurities. The study revealed that livestock (1.9) contribute to water pollution. Livestock reliant on dams for their water supply contribute to the contamination of these water bodies. The presence of a significant cattle population competing with humans for water resources results in the pollution of aquatic environments (Fagariba et al. 2023; UNFCCC, 2020). The water contamination was only marginally ascribed to climate change. The reduction of water levels in water bodies caused by drought is exerting considerable pressure on dams used for livelihood activities, which in turn results in contamination problems.

The physico chemical parameters of water from irrigable dams

The study collected water samples from three dam sites, Siru Dam, Gbache Dam, and Ponyengtanya Dam to evaluate the water quality of irrigable dams utilized for vegetable cultivation. The primary objective was to evaluate the presence of physico-chemical parameters, including pH, residual free chlorine, taste and odor, turbidity, dissolved oxygen, nitrogen, fluoride, potassium, aluminum, sulfate, and phosphorus, which are considered to affect water quality and may potentially influence vegetable cultivation at this stage. Consequently, Table 4 displays the outcomes of a laboratory analysis of a physico-chemical parameter affected by agricultural practices, which impacts water quality and public health in the study region.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Table 3: Water Quality Laboratory test results at three Dam sites in the study area

Physico-Chemical Analysis						
PARAMETER	**Test Method**	**Method Detection Limit/Units**	**Standard Specification**	**RESULTS**		
				Siru Dam	**Gbache Dam**	**Ponyengtanga Dam**
Ph	Electrometric	-	6.5-8.5	6.70	6.60	6.10
Residual free chlorine	Colorimetric	-	0.0	0.30	0.25	0.10
Taste & Odour	TTN/TON	**Unobjectionable**	**<1**	**Objectionable**	**Objectionable**	**Objectionable**
Turbidity	Nephelometric	NTU	5.0	38.00	43.00	32.00
DO	Diaphragm electrode	Ppm	-	10.12	9.61	11.27
Nitrogen	Cadmium reduction	0.0-30ppm	50	0.015	0.027	0.005
Fluoride	Spans	0.0-2.00ppm	1.5	1.44	1.10	1.48
Potassium	Palintest (PHOT.30)	0.0-12.0ppm	30.0	4.20	3.40	3.60
Aluminium	Palintest (PHOT.3)	0.0-0.5ppm	0.2	0.05	0.08	0.02
Sulphate	Sulfaver 4	0.0-70ppm	250	4.00	18.00	0.00
Phosphorus	PhosVer 3	0.0-100ppm	N/A	3.56	12.80	2.05

DO- Dissolved Oxygen, NTU- Nephelometric Turbidity Unit. Ppm-particle per matter
Source: Ghana Water Company- Wa branch Larboratory, 2024

Table 3 presents an evaluation of water quality by comparing field laboratory results with the guideline limits set by the World Health Organization (WHO) for each parameter. The pH test results indicated that the pH levels of Siru Dam, Gbache Dam, and Ponyengtanya Dam were 6.70, 6.60, and 6.10, respectively. The values ranged from 6.5 to 8.5, consistent with the water quality standards recommended by the World Health Organization. The results demonstrate that the pH levels in dam water remained within the recommended guidelines set forth by the World Health Organization (WHO) in the analyzed areas, despite the use of pesticides by farmers involved in vegetable cultivation. However, the investigation revealed that the residual free chlorine concentrations in Siru Dam (90.30 mg/l), Gbache Dam (0.25 mg/l), and Ponyengtanya Dam (0.10 mg/l) exceeded the WHO standard of 0.0 mg/l. According to Cobbina et al., 2013, the application of agro inputs for vegetable irrigation leads to elevated levels of chemicals in dam water, which may exceed acceptable thresholds and thereby cause increased bacterial growth and deterioration of water quality. The results from the three sampling sites indicated that the taste and odor were considered unpleasant rather than objectionable, and were rated below 1 in accordance with the guidelines established by FAO and WHO (FAO, 2015; WHO, 2017). Furthermore, the utilization of such dams may pose a potential threat to consumers of crops. The turbidity levels measured at Siru Dam, Gbache Dam, and Ponyengtanya Dam were 38.00 NTU, 43.00 NTU, and 32.00 NTU, respectively, all

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exceeding the World Health Organization's recommended limit of 5.0 NTU. This suggests that dams utilized for agricultural purposes elevate the expenses associated with water treatment for human consumption and diminish the availability of food for other aquatic species. A turbidity level below 1 NTU indicates adherence to drinking water quality standards (Sigua et al., 2010; Sharma et al., 2016). The WHO has not issued explicit guidelines regarding water quality standards for Dissolved Oxygen (DO); however, the measured DO concentrations at Siru Dam (10.12 mg/l), Gbache Dam (9.61 mg/l), and Ponyengtanya Dam (11.27 mg/l) were significantly high. A suitable level of dissolved oxygen in water should be maintained above 6.5 to 8 mg/l to ensure health. Concentrations surpassing this range may lead to the corrosion of metal pipes employed for irrigation (Kavcar et al. 2009). The nitrogen concentrations in Siru Dam, Gbache, and Poyentanga were recorded at 0.015 mg/l, 0.027 mg/l, and 0.005 mg/l, respectively, in accordance with WHO standards. The results indicate that nitrogen levels at all three locations are below the World Health Organization's advised limit of 50 mg/l. Consequently, the water is considered safe for human consumption and aquatic use. The research results demonstrate the levels of potassium concentration in the examined dams as follows: Siru (4.20 mg/l), Gbache (3.40 mg/l), and Poyentanga (3.60 mg/l). Although vegetables are cultivated in these regions, potassium levels in the irrigable dams have markedly declined, dropping below the WHO guideline standard of 30 mg/l. Consequently, the water obtained from these dams is considered safe for human consumption. Excessive consumption of potassium presents potential health hazards. The study further examined aluminum, in compliance with the WHO standard specification of 0.2 mg/l. The findings from the irrigable dam sites revealed that the Siru concentration measured 0.05 mg/l, Gbache was 0.08 mg/l, and Poyentanga was 0.02 mg/l. Minimal aluminum concentrations in the study region do not pose a risk to human health, even in the context of chemical-intensive vegetable farming practices (FAO, 2015; Srinivasan and Bedi, 2019). Elevated aluminum concentrations exceeding 0.2 mg/l pose adverse effects on human health and various aquatic organisms (Sankhla et al., 2016; WHO, 2017). The study conducted analysis of sulfate concentrations at various dam sites through sample collection. The study results demonstrated that sulphate concentrations consistently remained below the World Health Organization guideline of 250 mg/l. The measurements of Siru (4.00 mg/l), Gbache (18.00 mg/l), and Poyengtanga (0.00 mg/l) indicate that agricultural practices and the use of chemicals and fertilizers in vegetable cultivation do not pose a substantial health risk when employing water from these dams. The investigation revealed that phosphorus concentration levels were markedly higher in Siru Dam (3.56 mg/l), Gbache Dam (12.80 mg/l), and Ponyengtanya Dam (2.05 mg/l), despite the lack of specific guidelines from the World Health

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Organization (WHO) for water quality monitoring. Consequently, these levels are deemed unsuitable for human ingestion. Fluoride concentrations at all sites remained below the WHO guideline of 1.5 mg/l. Siru Dam recorded a level of 1.44 mg/l, while Ponyengtanya Dam measured 1.48 mg/l, both comparable to Gbache Dam's level of 1.10 mg/l. Fluoride concentrations surpassing 1.5 mg/l in drinking water may pose health hazards. The results indicate that only a limited subset of the physico-chemical parameters evaluated in this study conform to the concentration standards set by the World Health Organization (WHO, 2017). Nevertheless, certain parameters posed health risks to consumers and negatively impacted vegetable production and the agricultural community as a whole.

Perceived strategies to address water contamination

Table 4: Perceived strategies to adress dam water contamination

Variables	Strongly agree	agree	do not agree	Not sure	WAI	Rank
Capacity building and education	35	10	8	2	2.6	1
Law enforcement	30	9	6	5	2.06	2
Stakeholders engagement	27	10	9	4	1.96	3
Protection of dam site	25	10	10	5	1.88	4
Livestock receptacles and canals	24	5	5	6	1.74	5

Source : Key experts interview (2024)

The analysis of strategies as indicated in Table 4 aimed at improving dam water quality revealed that capacity building and education (2.6) were identified as the most effective approaches for addressing dam contamination in the district. Enhancing expertise and understanding of agricultural practices will substantially decrease the pollution of water bodies caused by the use of inorganic fertilizers, pesticides, and weedicides. The law enforcement approach was identified as the second most effective strategy (2.06) for mitigating pollution in the dams supplying water to the indigenous communities of Wa West and its surrounding areas. Law enforcement authorities will ensure the enforcement of by-laws established by the District Assembly and the EPA to mitigate water body pollution. Engaging stakeholders (1.96) will enhance the collaborative management of resources within communities, thereby decreasing the risk of water pollution caused by the actions of individuals or groups. The analysis further indicated that safeguarding the dam site (1.88) is the fourth most effective strategy for mitigating water pollution within the district. Implementing measures such as afforestation and the installation of fences along the dam banks will effectively restrict local residents' easy access to the dam water. Trees along the

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riverbanks are essential in mitigating erosion and preventing sediment-laden runoff from reaching dams (FAO, 2015; Fagariba et al., 2024). Furthermore, discussions with the FDGs indicated that constructing fences around the dams could serve as a preventative measure to avert contamination of the water bodies by livestock and humans. Based on the focus group discussions, the construction of canals and water receptacles will facilitate farmers' access to water without the need for direct engagement with the dams. Furthermore, the discussions indicated that constructing water receptacles at the dam site will improve access to water for livestock while concurrently restricting their access to the water bodies.

Conclusion

The research indicated that approximately 95% of farmers in the Wa West District depend on existing dams for irrigation to improve their rain-fed agricultural activities. Consequently, the existing water resources are experiencing considerable strain. The investigation demonstrated that farmers' dependence on dams for agricultural activities during the dry season exposes water bodies to chemical contaminants and heightened evaporation. The results demonstrate that water quality assessments show increased concentrations of chemicals, such as nitrogen, potassium, aluminum, and phosphorus fluoride, which significantly impact the overall quality of the water. Furthermore, the utilization of the dam for irrigation and diverse livelihood activities has led to the introduction of dissolved chemicals and particulate matter, adversely impacting the turbidity, color, odor, taste, and dissolved oxygen content of the water. Empirical evidence demonstrates that significant pollution has compromised the capacity of water bodies to sustain aquatic life. Consequently, it was determined that all three dams demonstrated conditions of stagnant water.

The findings indicate that only a small proportion of the physico-chemical parameters evaluated in the study complied with the concentration standards set by the World Health Organization (WHO). This presented a potential threat to consumer health, vegetable cultivation, and the wider agricultural industry. Engagements with the indigenous communities confirmed that elevated potassium levels were the primary factor responsible for symptoms such as abdominal discomfort, diarrhea, chest pain or heart palpitations, muscle weakness, vomiting, and nausea. The community under investigation demonstrated a notable prevalence of dental caries among children, which was associated with elevated nitrogen levels in the surrounding aquatic environments.

The analysis determined that enhancing and fostering collaboration among governmental entities, such as the Ministry of Agriculture, the Environmental Protection Agency (EPA), the District Assembly, and the

Ghana Irrigation Development Authority (GIDA), will facilitate the effective utilization of water resources. Strengthening community capabilities through training in sustainable agricultural practices will be instrumental in minimizing chemical contamination of water bodies and reducing their vulnerability to extreme weather phenomena. To mitigate the impacts of climate change on water availability and quality, it is crucial to protect dam banks through the implementation of tree planting programs. This approach seeks to reduce evaporation and decrease pollution levels related to particulate matter. Training farmers on the proper use of chemicals at the dam site will aid in minimizing water pollution.

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78
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