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Assessment of Food Safety Knowledge, Attitudes, and Practices of Commercial Salad Vegetable Farmers in the Eastern Region of Ghana

ABSTRACT

Food safety risks, like poor water quality and handling, threaten public health in Ghana's Eastern Region, where farmers' food safety knowledge and practices are unclear. The study aimed to evaluate salad vegetable farmers' food safety knowledge, attitudes, and practices (KAP) through a descriptive, cross-sectional survey. Face-to-face interviews and questionnaires were conducted with 400 farmers, yielding N=390 usable responses. The peer-reviewed, pilot-tested questionnaire covered demographics, food safety knowledge, attitudes, and hygiene practices. The study highlights positive practices among farmers, such as farm access restrictions (70%) and removing dirt from harvested salad vegetables (77%), but also identifies gaps in essential practices like treating irrigation water and manure sterilization. The lack of toilet facilities (12%) on most farms poses a significant risk of contamination. There is good awareness of proper handling and hygiene practices, but chemical contamination (76%) receives the most attention, while physical (37%) and microbial contamination (18%) awareness needs improvement. Barriers included inadequate resources (51%), time constraints (53%), and poor record-keeping (64%). Significant ($p<0.05$) positive correlations between KAP suggest that enhancing knowledge and fostering positive attitudes through regular training can improve food safety practices among salad vegetable farmers.

INTRODUCTION

Food safety is a global concern, with produce contamination and associated foodborne illnesses posing significant health risks worldwide *(22)*. The World Health Organization (WHO) estimates that each year, about 600 million people fall ill after consuming contaminated food, resulting in approximately 420,000 deaths, with low- and middle-income countries bearing a substantial portion of this burden *(7)*. Although fresh vegetables are a vital component of a nutritious diet *(69)*, they are frequently implicated in disease outbreaks *(28)*. From 2013 to 2021, foodborne diseases in Ghana resulted in 36 fatalities and over 1,900 reported cases, raising serious public health concerns. The outbreaks were largely attributed to contaminated food

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and insufficient safety measures *(41)*. The main pathogens identified included norovirus (55%), Shiga toxin-producing *Escherichia coli* (18%), and *Salmonella* (11%) *(28)*. Many outbreaks have been traced to fresh produce, particularly fresh salad vegetables, due to their potential contamination during harvesting and handling *(4)*. Understanding the safety practices linked to these vegetables is crucial for ensuring public health, as contamination often occurs during production or handling stages, exacerbated by inadequate hygiene among farm workers *(42)*.

In Ghana, food safety is a pressing public health issue due to the country's reliance on domestic agriculture for food security and economic sustenance. Salad vegetables, frequently eaten raw or with minimal processing, pose a heightened risk of contamination *(45)*. Without strict adherence to food safety and good agricultural practices (GAP), these vegetables may harbor harmful pathogens, pesticide residues, and other contaminants *(23)*. Foodborne illnesses associated with contaminated vegetables include salmonellosis, campylobacteriosis, listeriosis, *E. coli* infection, cholera, and norovirus infection *(72)*.

Fresh salad vegetables are widely consumed in Ghana *(10)*, and contribute significantly to nutritional intake *(65, 81)*. Ensuring their safety is critical for preventing foodborne illnesses and protecting public health *(57)*. The increasing consumption of fresh vegetables indicates the importance of maintaining stringent food safety standards. Quality control relies on GAP and factors such as cultivation, harvesting, and handling before distribution *(37, 50)*. The adoption of effective management techniques, infrastructure maintenance, and adherence to safety standards are essential for ensuring high-quality, safe food production *(59)*. Farmers' on-farm practices play a crucial role in upholding these standards *(59)*.

Ghana's fertile soils and favorable climate support diverse agricultural activities, including cultivating salad vegetables like lettuce, cabbage, tomatoes, cucumbers, and carrots *(58)*. Small-scale commercial farmers dominate this sector, supplying both local and urban markets *(2)*. In the Eastern Region, about 67% of the population engages in farming *(25)*. With increasing demand for fresh produce, farmers are often under pressure to maximize yields *(62)*, sometimes compromising food safety practices. This pressure may lead to unsafe practices, such as improper irrigation and inadequate sanitation *(31)*. In such contexts, food safety should complement rather than hinder food security. Ghana and other African countries, including Benin, Botswana, Cameroon, the Central African Republic, Chad, and the Democratic Republic of Congo face significant food safety challenges *(22)*. Limited resources, inadequate infrastructure, and varying education levels among farmers contribute to these gaps *(49)*. It has been reported that lettuce farmers' attitudes, perceived behavioral control, and social norms influence on-farm food safety practices *(67)*. These challenges emphasize the need for a comprehensive understanding of commercial salad vegetable farmers' food safety knowledge, attitudes, and practices in the Eastern Region, which is a dominant agricultural region of Ghana.

The Knowledge, Attitudes, and Practices (KAP) framework is a well-established public health model for assessing and understanding behaviors related to health issues *(68)*. Within the food safety sector, the KAP framework can provide important insights into farmers' understanding of food safety risks, their beliefs and attitudes regarding safe practices, and the degree to which they implement these practices *(27, 80)*. Evaluating farmers' knowledge helps to identify farmers' awareness of contamination sources and prevention measures *(29)*, while assessing attitudes clarifies how they perceive the importance of food safety *(44)*. Examining practices reveals actual behaviors during production, handling, and post-harvest processing *(16)*. Using the KAP framework in this study provides a structured approach to identifying areas where improvements may be necessary *(35)*. If farmers possess food safety knowledge but fail to apply it, barriers such as attitudes or resource constraints may exist. On the other hand, if they have positive attitudes but lack knowledge, educational initiatives could be beneficial. The KAP approach also helps identify misconceptions that may hinder safe practices *(43)*.

Studies in Ghana have examined food safety in different settings and among various groups, highlighting the need for improved handling and hygiene practices. Research on institutional food handlers has identified knowledge gaps and inconsistent hygiene compliance *(33, 61)*. while studies on street food vendors have revealed vulnerabilities due to limited resources and diverse educational backgrounds *(3, 79)*. Consumer-focused studies suggest that while awareness of food safety exists, misinformation and limited formal education remain challenges *(12, 54)*. However, little research has specifically focused on on-farm food safety practices among commercial salad vegetable farmers in Ghana, despite the raw consumption of these vegetables *(15)*. Evaluating their food safety KAP can help identify risks early in the supply chain and enable targeted interventions to prevent contamination before salad vegetables reach consumers. This study addresses a critical gap in Ghanaian food safety research by focusing on an agricultural segment that directly impacts consumer health. This study assesses the food safety knowledge, attitudes, and practices of commercial salad vegetable farmers in Ghana's Eastern Region, aiming to identify gaps and propose interventions for improving food safety in salad vegetable production. It also explores the factors influencing food safety behavior and recommends targeted training programs and policy support.

MATERIALS AND METHODS

Study population

A total of 400 salad vegetable farmers participated in this study. A descriptive, cross-sectional survey of 22 districts

in the eastern region of Ghana was employed in this study. The districts include: Kwahu East, Kwahu South, Kwahu West, Fanteakwa, Atiwa, Birim North, Birim Central, Birim South, Denkyembour, Akyemansa, Kwaebibirem, West Akim, Nsawam, Adoagyiri, Ayensuano, East Akim, New Juaben, Yilo Krobo, Lower Manya Krobo, Upper Manya Krobo, Asuogyaman, Akuapim North and Akuapim South except Kwahu Afram Plains North and Kwahu Afram Plains South. Salad vegetable farmers in the Eastern Region of Ghana were recruited for the survey questionnaire research using a combination of purposive and random sampling methods to ensure diverse and representative participation. Agricultural extension officers, and community leaders assisted in identifying suitable respondents based on factors such as farm size, and crop type. Researchers conducted outreach through community meetings, local radio announcements, and word-of-mouth referrals to encourage participation. Additionally, enumerators visited farms directly to distribute and administer the questionnaires, ensuring accessibility for farmers with limited literacy.

Interview

This section was informed by the Knowledge, Attitudes, and Practices (KAP) framework *(6, 30)*. The "not sure" response option was included in relevant questions to accommodate uncertainty and provide clarity in assessing knowledge and practices *(26)*. Face-to-face interviews to gather information on food handlers' KAP regarding food safety. The questionnaire was peer-reviewed and pilot-tested at three districts in Ghana's Eastern Region before being finalized and administered to the participants. Researchers and trained research assistants conducted the interviews using the structured questionnaire, with data collection taking place between January to April 2024. The study employed a structured questionnaire divided into four sections to collect comprehensive data from salad vegetable farmers. The systematic questionnaire was developed based on numerous local and international studies *(5, 24, 77)*. Section 1 comprised 10 questions aimed at gathering demographic information, including age, gender, educational background, farming experience, socio-economic factors, primary source of nutrients, type of irrigation water, and type of vegetable produced. The food safety knowledge section of the questionnaire included 18 closed-ended questions with three response options: "yes," "no," and "not sure." This section assessed the farmers' knowledge of personal hygiene, foodborne illnesses, microorganisms, infection control, and sanitary practices. Questions related to attitudes (section 3) consisted of 8 structured questions designed to evaluate the farmers' attitudes towards safety and hygiene practices. Responses ranged from "Always" to "Never," reflecting their psychological conditions and perceptions. Section 4 contained 13 questions, with answers of "yes," "no," or "not sure," focusing on food hygiene and sanitation practices.

Ethical approval (Reference: HuSSREC/AP/102/Vol.3) was granted by the Humanities and Social Sciences Research and Ethics Committee of Kwame Nkrumah University of Science and Technology.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 27.0 (SPSS Inc., Chicago, USA) was used for coding and analysis. Percentages and frequencies were used to summarize categorical variables as appropriate. Spearman's test of association was employed to analyze the correlation between knowledge, attitude, and practices. Bivariate correlation analysis was conducted to estimate the strength of significant correlations ($p<0.05$). A multiple linear regression analysis was performed to evaluate the relationship between the independent variables: knowledge and attitude, and the dependent variable: practice. The model's significance was assessed using Analysis of Variance (ANOVA), Regression coefficients, standard errors, *t*-values, and *p*-values were reported to determine the strength and significance of the predictors.

RESULTS

Demographic characteristics of respondents

Table 1 presents the summary of the respondents' demographic profiles for this study. The largest groups are those aged 35-44 (27%) and 45-54 (32%). There is also notable participation from those aged 55-64 (18%), suggesting experienced individuals continue to contribute significantly. Younger respondents (18-24 and 25-34) form smaller but still relevant proportions, contributing 2% and 13%, respectively. Older respondents (65 or above) make up 7% of the total. The majority of respondents are male, constituting 72% of the sample. Female respondents account for the remaining 28%. A significant portion of respondents (56%) have basic education and second-cycle education represents 23% of a substantial minority. Fewer respondents have higher qualifications, with only 3% having a diploma and 1% holding a bachelor's degree or higher. A notable proportion (17%) has no formal education. The data shows a varied scale of farming operations among respondents. A significant portion (40%) operates on relatively small plots of 1-3 acres, which may indicate intensive farming practices. Nearly a third (31%) of the respondents farm on more than 5 acres. Approximately 27% farm on 4-5 acres, representing a mid-range scale of operations. A small percentage (2%) operate on less than 1 acre. Most salad vegetable farms (59%) employ between 1-5 workers. A significant but smaller portion (21%) employs 6-10 workers. About 6% of farms employ more than 10 workers, and 15% of farms operate without any hired workers. A significant majority (84%) of respondents have been producing salad vegetables for more than 5 years. Fifteen percent have between 1-5 years of experience, while only 1% are relatively new to vegetable production (less than 1 year). The majority

TABLE 1. Demographic profile of the respondents studied (*N* = 390)

Variable	No. of participants *n* (%)
Age group (years)	
18-24	8 (2.1%)
25-34	49 (12.6%)
35-44	107 (27.4%)
45-54	126 (32.3%)
55-64	71 (18.2%)
65 or over	29 (7.4%)
Sex	
Male	282 (72.3%)
Female	108 (27.7%)
Educational level	
Basic education	220 (56.4%)
Second cycle education	88 (22.6%)
Diploma	12 (3.1%)
Bachelor's Degree and above	4 (1.0%)
No formal education	66 (16.9%)
Farm size	
1-3 acres of land	8 (2.1%)
4-5 acres of land	156 (40.0%)
6-10 acres of land	107 (27.4%)
More than 5 acres of land	119 (30.5%)
Number of workers employed	
None	57 (14.6%)
1-5 workers	228 (58.5%)
6-10 workers	80 (20.5%)
More than 10	25 (6.4%)
Years of farming experience	
Less than 1 year	5 (1.3%)
1-5 years	57 (14.6%)
More than 5 years	328 (84.1%)
Types of vegetables grown	
Salad vegetables	100 (25.6%)
Both (salad vegetables and other vegetables)	290 (74.4%)
Type of fertilizer used	
Organic manure	131 (33.6%)
Synthetic fertilizer	209 (53.6%)
Both	50 (12.8%)

TABLE 2. Types of vegetables cultivated and their irrigation water sources (*N* = 390)

Types of vegetables		
Variable	**Yes *n* (%)**	**No *n* (%)**
Cabbage	273 (70.0%)	117 (30.0%)
Lettuce	74 (19.0%)	316 (81.0%)
Green pepper	121 (31.0%)	269 (69.0%)
Carrots	47 (12.1%)	343 (87.9%)
Cucumber	78 (20.0%)	312 (80.0%)
Tomatoes	269 (69.0%)	121 (31.0%)
Other vegetables	293 (75.1%)	97 (24.9%)
Source of water for irrigating		
Rainwater	293 (75.1%)	97 (24.9%)
Small reservoirs	43 (11.0%)	347 (89.0%)
Dams	62 (15.9%)	328 (84.1%)

(74%) of respondents produce both salad vegetables and other types of vegetables while 26% specialize in producing salad vegetables exclusively as shown on *Table 2*. Synthetic fertilizer is the most commonly used primary nutrient source, with 54% of respondents relying on it. Organic manure is also significant, with 34% of respondents using it as their primary nutrient source. A smaller percentage (13%) use both organic and synthetic fertilizer sources.

Cabbage (70%) and tomatoes (69%) are the most commonly produced vegetables on the list, with other vegetables (75%), being the most common answer as shown in *Table 2*. Rainwater (75%) is the primary source of water for irrigating salad vegetable farms. Wells (23%), rivers (28%), and boreholes (19%) are also utilized to a lesser extent. Markets (72%) and farm gates (64%) are the primary locations where respondents sell their vegetables. Restaurants (9%) and other venues (9%) represent smaller sales channels.

Knowledge of hygiene and safe handling of salad vegetables

A significant majority (86%) of farmers have received training on Good Agriculture Practices (GAP) from Agriculture Extension Officers, as shown in *Table 3*. GAP ensures sustainable farming by promoting soil health, water conservation, pest control, safe harvesting, environmental protection, worker safety, and compliance with food safety standards. This indicates a high level of exposure to GAP training among the respondents. Most farmers (73%) have implemented the lessons on their farms. However, about 19% have not implemented the lessons, and 7% are uncertain. Less than half of the farmers (46%) clean and sanitize their vegetables after harvesting, while a slightly higher percentage (52%) do not. Only a small fraction of farmers (7%) treats their irrigation water, indicating that the vast majority (91%) do not practice water treatment. The majority of farmers (70%) believe that obtaining manure from certified companies helps ensure food safety. Only 15% of farmers thermally treat and check their manure for microbial contamination before use, indicating that most (79%) of the salad vegetable farmers do not follow this practice. Also, a majority (70%) of salad vegetable farmers restrict human and vehicle access to their farms. Over half (59%) of the farmers clean and sanitize storage bags before use. Very few farmers (12%) have toilet facilities on their farms. A majority (62%) of salad vegetable respondents agree that asking workers not to come to work when they have infectious diseases can help control vegetable contamination. Similarly, a significant percentage (66%) believe that annual health checkups for workers contribute to controlling salad vegetable contamination. A large majority (74%) understand that improper cleaning of salad vegetables can lead to contamination with harmful microorganisms. A significant percentage (72%) acknowledges that inadequate cleaning may lead to a loss of freshness and quality in salad vegetables. Most salad vegetable respondents (73%) recognize that poor handling practices can result in reduced shelf life for salad vegetables. A majority (63%) understand that unhygienic

TABLE 3. Knowledge of hygiene and safe handling of salad vegetables (*N* = 390)

Variable	Yes *n* (%)	No *n* (%)	Not Sure *n* (%)
Good Agricultural Practices training	335 (85.9%)	51 (13.1%)	4 (1.0%)
Implementation of lessons	285 (73.1%)	74 (19.0%)	31 (7.9%)
Cleaning and sanitizing of vegetables	179 (45.9%)	203 (52.1%)	8 (2.0%)
Treatment of irrigation water	27 (6.9%)	355 (91.0%)	8 (2.0%)
Certified manure	273 (70.0%)	74 (19.0%)	47 (12.0%)
Sterilization of manure	59 (15.1%)	308 (79.0%)	27 (6.9%)
Restriction of human and vehicle	273 (70.0%)	117 (30.0%)	4 (1.0%)
Cleaning and sanitizing the storage sacks	230 (59.0%)	62 (15.9%)	20 (5.1%)
Toilet facility	47 (12.1%)	339 (86.9%)	4 (1.0%)
Sick leave	242 (62.1%)	133 (34.1%)	12 (3.1%)
Annual health checkups	257 (65.9%)	101 (25.9%)	27 (6.9%)
Improper cleaning causes contamination	288 (73.8%)	78 (20.0%)	24 (6.2%)
Poor cleaning reduces freshness	281 (72.1%)	86 (22.1%)	20 (5.1%)
Poor cleaning shortens the shelf life	285 (73.1%)	66 (16.9%)	43 (11.0%)
Unhygienic handling causes foodborne illnesses	245 (62.8%)	74 (19.0%)	71 (18.2%)
Education on chemical contamination	296 (75.9%)	94 (24.1%)	-
Education on physical contamination	144 (36.9%)	246 (63.1%)	-
Education on microbial contamination	70 (17.9%)	320 (82.1%)	-

TABLE 4. Respondents' attitudes toward hygienic and safe practices (*N* = 390)

Variables	Always *n* (%)	Very Often *n* (%)	Sometimes *n* (%)	Rarely *n* (%)	Never *n* (%)
Farmers ensure vegetable safety	261 (66.9%)	74 (19.0%)	51 (13.1%)	8 (2.1%)	4 (1.0%)
On-farm practices affect safety	203 (52.1%)	101 (25.9%)	82 (21.0%)	4 (1.0%)	0 (0.0%)
Soiled vegetables may cause poisoning	215 (55.1%)	98 (25.1%)	74 (19.0%)	4 (1.0%)	4 (1.0%)
Lack of education hinders food safety	183 (46.9%)	94 (24.1%)	101 (25.9%)	8 (2.1%)	4 (1.0%)
Lack of training hinders food safety	203 (52.1%)	82 (21.0%)	90 (23.1%)	8 (2.1%)	8 (2.1%)
Inadequate resources hinder food safety	199 (51.0%)	105 (26.9%)	66 (16.9%)	4 (1.0%)	4 (1.0%)
Time constraints obstruct hygiene practices	207 (53.1%)	66 (16.9%)	90 (23.1%)	12 (3.1%)	20 (5.1%)
Lack of motivation hinders hygiene practices	183 (46.9%)	98 (25.1%)	86 (22.1%)	8 (2.1%)	16 (4.1%)

handling methods of salad vegetables can lead to consumers contracting foodborne illnesses. A significant majority (76%) of respondents received lessons or practices related to chemical contamination from the extension officers from the Ministry of Food and Agriculture, Ghana. A smaller percentage (37%) received training or information on physical contamination. Physical contaminants can include foreign objects like dirt, stones, or packaging materials that are contaminated with dirt. The smallest percentage (18%) received lessons on microbial contamination. Microbial contaminants include bacteria, viruses, and fungi that can lead to foodborne illnesses if not properly controlled.

Attitude towards hygienic and safety practices

Table 4 summarizes the farmers' reported attitudes toward salad vegetable safety and hygiene practices. Most respondents (67%) affirmed that farmers have an important responsibility for the safety of salad vegetables. A significant portion (19%) think farmers are very often responsible. Few respondents (13%) believe farmers are sometimes responsible, and very few (2% and 1%) think farmers are rarely or never responsible, respectively. Over half (52%) of the salad vegetable respondents believe that on-farm practices always impact vegetable safety. A total of 26% believe that on-farm practices frequently impact safety, while 21% say they have an occasional impact. Only a small percentage (1% and 0%) think these practices rarely or never affect safety. More than half (55%) of respondents believe unclean or soiled vegetables always cause food poisoning. 25% say very often, 19% say sometimes and a small minority (1% and 1%) think rarely or never. 47% believe inadequate education always hinders food safety measures. 24% think it very often hinders, and 26% say sometimes. Very few respondents (2% and 2%) think rarely or never. Fifty-two percent of respondents believe that lack of training always hinders food safety practices. Also, 21% think it very often hinders, and 23% say sometimes and a small percentage (2%) think rarely or never. A majority (54%) of the respondents believe that inadequate resources always hinder food safety practices. Twenty-seven percent think it very often hinders, while 17% say sometimes and very few respondents (1% and 1%) think rarely or never. Over half (53%) believe that time constraints always obstruct adherence to hygienic practices, 17% think it very often obstructs. While 23% say sometimes and a small percentage of the respondents (3% and 5%) think rarely or never. Nearly half of the respondents (47%) believe that a lack of motivation always acts as a barrier to practicing proper food hygiene. Twenty-five percent think it very often acts as a barrier, while 22% say it sometimes. A small minority of the respondents (2% and 4%) think rarely or never.

Assessment of hygienic and safety practices of salad vegetable farmers

Table 5 summarizes the response regarding hygiene and safety practices in salad vegetable production and handling. Washing your hands before handling salad vegetables is a very important practice in food safety practice. A little over 40% of respondents wash their hands before handling vegetables for shipping, while the majority (58%) do not, and a small percentage (2%) are unsure. Around 41% of respondents use clean and sanitized tools and equipment. The majority of the respondents (56%) do not use clean and sanitized tools and a small percentage (3%) are not sure. About 35% of respondents clean vegetables with water before shipping. However, the majority (59%) do not clean vegetables with water and a notable portion (6%) are not sure. Close to 42% of respondents clean, dry, and cover harvesting containers before use. The majority of the respondents (55%) do not follow this practice and a small percentage (3%) are not sure. A large majority of the respondents (77%) remove dirt, mud, or other debris from the product before packing. Only 20% do not follow this practice, and 2% are not sure. Less than half (43%) of respondents have a storage facility for containers and packaging materials, while the majority (55%) do not and a small percentage (2%) are not sure. More than half (55%) of respondents ensure that containers and packaging materials are cleaned and stored in protected areas. A significant portion (39%) do not follow this practice, and 6% are not sure. A small percentage (20%) of respondents have a toilet facility and hand washing station available on their farm, while a large majority (79%) do not, and very few (1%) are not sure. Only 28% of respondents maintain clean and regularly serviced toilets and hand washing stations, while the majority (72%) do not and a small percentage (1%) are not sure. The results regarding the use of written records in various aspects of salad vegetable production activities. A little less than half of the respondents (43%) keep written records of their vegetable production activities. The majority of the respondents (55%) do not keep such records and a very small percentage (2%) are not sure about whether they keep these records. Only about 30% of respondents keep written records of the entry and exit of humans, vehicles, and animals. A significant majority of the respondents (64%) do not keep these records and a notable portion (6%) is not sure about maintaining such records. Similar to the previous question, around 30% of respondents use written records for product tracking and tracing. A large majority (66%) do not use these records and (5%) are not sure about using written records for this purpose.

Logistic regression analyses

The results demonstrate significant correlations between knowledge, attitudes, and practices among salad vegetable farmers as shown in *Table 6*. A moderate, statistically significant positive correlation was observed between knowledge and practice (Spearman's $\rho = 0.50$, $p < 0.05$), suggesting that higher knowledge levels correspond to improved practices. However, the correlation between knowledge and attitudes was weak and not statistically

TABLE 5. Hygienic and safety practices in salad vegetable production and handling (*N* = 390)

Variable	Yes *n* (%)	No *n* (%)	Not Sure *n* (%)
Wash hands before handling salad vegetables	156 (40.0%)	226 (57.9%)	8 (2.1%)
Use sanitized tools for cleaning vegetables	160 (41.0%)	218 (55.9%)	12 (3.1%)
Wash vegetables before shipping	137 (35.1%)	137 (35.1%)	116 (29.7%)
Use protective clothing for packing	133 (34.1%)	238 (61.0%)	19 (4.9%)
Clean and sanitize containers	164 (42.1%)	215 (55.1%)	11 (2.8%)
Remove debris before packing	300 (76.9%)	78 (20.0%)	8 (2.1%)
Have storage for containers	168 (43.1%)	215 (55.1%)	7 (1.8%)
Store containers protected from contaminants	215 (55.1%)	152 (39.0%)	23 (5.9%)
Provide toilet and handwashing facilities	78 (20.0%)	308 (79.0%)	4 (1.0%)
Keep toilets and handwashing clean	109 (27.9%)	281 (72.1%)	0 (0.0%)
Record keeping is essential	168 (43.1%)	215 (55.1%)	7 (1.8%)
Record on entry and exit of humans, vehicles, and animals	117 (30.0%)	250 (64.1%)	23 (5.9%)
Use records for tracking	117 (30.0%)	258 (66.2%)	15 (3.8%)

TABLE 6. Association among food safety knowledge, attitude, and practices

Level	Spearman's rho(ρ)	Sig.
Knowledge vs practices	0.50**	0.03
Knowledge vs attitudes	0.31	0.14
Attitudes vs practices	0.50**	0.03
Attitudes vs knowledge	0.31	0.14
Practices vs attitudes	0.50**	0.03
Practices vs knowledge	0.51**	0.03

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

significant (Spearman's $\rho = 0.31$, $p > 0.05$), indicating that increased knowledge does not necessarily translate into more positive attitudes. A moderate, statistically significant correlation between attitudes and practices (Spearman's $\rho = 0.50$, $p < 0.05$) suggests that positive attitudes contribute to better practices.

The regression analysis indicated a moderate relationship between knowledge, attitude, and practice ($R^2 = 0.16$), suggesting that these factors explain 16% of the variation in farming practices *(Table 7)*. ANOVA results confirmed the model's statistical significance ($F = 37.51$, $p < 0.001$), demonstrating that knowledge and attitude significantly influence food safety practices. The coefficient analysis showed that both knowledge ($b = 0.09$, $p = 0.002$) and attitude ($b = 0.37$, $p < 0.001$) were significant predictors of practice, with attitude having a stronger impact. These findings emphasize that while knowledge is important, attitude plays a more substantial role in shaping food safety behaviors among salad vegetable farmers.

TABLE 7. Summary statistics of the regression of practice on knowledge and attitude

Regression statistics			Value		
Multiple R			0.40		
R Square			0.16		
Adjusted R Square			0.16		
Standard Error			0.52		
Observations			390		
ANOVA	**df**	**SS**	**MS**	**F**	**Significance F**
Regression	2	19.97	9.98	37.51	0.00
Residual	387	103.00	0.27		
Total	389	122.97			
Regression Coefficients	Coefficients	Standard Error	t Stat	*p*-value	
Intercept	0.96	0.09	11.08	<0.001	
Knowledge (X_1)	0.09	0.03	3.14	0.002	
Attitude (X_2)	0.37	0.05	7.40	<0.001	

DISCUSSION

The demographic information of respondents involved in salad vegetable farming revealed a broad range of age groups with predominantly male participation. Empowering women through the creation and enforcement of policies that grant them equal access to productive resources was essential for economic growth and poverty alleviation *(34)*. Educational backgrounds varied, though most of the salad vegetable farmers had basic education. This result was supported by Mabe et al. *(38)*, whose report showed that most of the farmers had basic education. It was recommended that farmers in the district acquire the necessary skills and knowledge in modern farming techniques and the use of contemporary farm inputs to enhance their knowledge and productivity *(73)*. Farming operations ranged from small plots to larger farms, with workforce sizes generally small to medium. These insights reflected a diverse agricultural community with varying scales of operations *(82)*, which have indicated family-run or very small-scale operations where labor needs were managed internally. Previews research had indicated that vegetable farming was done on small to large plots *(83)*. However, factors like maximum temperature, average temperature, slope, population density, and soil series had a negative correlation with agricultural land use for vegetable production. In contrast, distance to lakes, major rivers, minor roads, road density, number of rainy days, and percentage of urban residents showed a positive correlation with agricultural land use for vegetable production *(75)*.

Respondents largely had extensive experience in salad vegetable production, focusing on both salad and other vegetables. Synthetic fertilizer was the primary nutrient source used, with organic manure also being significant. This indicated a variety of soil fertility management approaches in salad vegetable production *(56, 71)*. The results showed that synthetic fertilizer was the primary nutrient source in salad vegetable production, while organic manure also played a significant role. This suggested that farmers used a mix of soil fertility management strategies to optimize their crop yields *(53)*. Synthetic fertilizer provides readily available nutrients to plants, leading to quicker growth and higher yields *(64)*. However, the use of organic manure helped to improve soil structure, increase microbial activity, and add organic matter to the soil. This combination suggested a balanced approach to maintaining soil fertility, addressing immediate nutrient needs for salad vegetable production *(70, 78)*.

The most cultivated salad vegetables included cabbage, tomatoes, lettuce, green peppers, carrots, and cucumbers. Rainwater was the primary irrigation source, supplemented by wells, rivers, and boreholes. Sales outlets were main markets and farm gates, emphasizing direct local consumer engagement. Salad vegetables were mostly sold at the local markets in Ghana *(1, 11)*.

Farmers had received substantial training and adopted positive practices, such as restricting farm access and anticipating the use of certified manure, but critical gaps in essential safety practices still needed to be addressed. However, gaps in essential practices such as treating irrigation water, improving post-harvest sanitation, and thermally treating manure had to be addressed to enhance both the safety and productivity of salad vegetable production *(36, 55)*, as they were key factors in preventing contamination and ensuring high-quality produce *(42, 46)*. Contaminated vegetables in urban Ghana, particularly due to unsafe irrigation practices, posed serious public health risks. Addressing these challenges requires stakeholder collaboration, political commitment, and improved water treatment. Studies confirmed significant contamination, reinforcing the need for stricter safety measures to protect food quality and public health *(9, 19)*.

The absence of toilet facilities on most farms was a major concern, posing a serious risk of contamination and compromising worker hygiene, necessitating urgent action *(63)*. Factors such as economic limitations, traditional beliefs, and restricted access to sanitation facilities influenced toilet practices in Ghana's farming communities. As a result, open defecation and the use of communal latrines were common. Recognizing these factors was essential for tackling sanitation issues in these areas *(32, 52)*. However, programs like Community-Led Total Sanitation (CLTS) strove to enhance hygiene, but their effectiveness depended on factors such as education, concerns about privacy, and active community involvement *(74, 84)*.

The data indicated a good level of awareness among respondents regarding the importance of proper handling and hygiene practices to prevent contamination of salad vegetables. Measures like managing worker health through sick leave policies and regular health check-ups, combined with proper cleaning practices for salad vegetables, were crucial to ensuring that food safety began at the farm. Research demonstrated that managing worker health through policies such as sick leave and regular health checkups was essential in reducing contamination risks *(17, 63)*. Moreover, literature emphasized that food safety started at the farm level, where proper cleaning and sanitation practices were critical to ensuring the safety of fresh produce *(26, 40)*. Implementing these measures was crucial for upholding high food safety standards of salad vegetable safety, reducing contamination risks, and improving overall product quality.

Chemical contamination received the most attention, with a majority of respondents exposed to related lessons. Physical contamination awareness was notably lower, indicating an area for increased focus in training programs. Microbial contamination, the least addressed, highlighted a critical need for comprehensive education to mitigate risks associated with foodborne pathogens. The emphasis on chemical contamination was consistent with literature that often highlighted chemical hazards in food safety training, given their immediate and noticeable impacts *(14, 76)*. However, the lower level of awareness regarding physical contamination indicated a gap in existing training programs, which could have been improved by broadening their focus to cover this risk more comprehensively *(39, 48)*. The lack of attention to microbial contamination was particularly concerning, as research pointed out that microbial hazards presented the most significant threat to public health through foodborne illnesses *(8)*. This highlighted the urgent need for comprehensive education on microbial safety to mitigate these risks effectively.

There was a strong consensus that farmers were responsible for salad vegetable safety, with many respondents indicating a high frequency of on-farm practices impacting vegetable safety. Research indicated that the initial stages of the food supply chain, where production occurred, were critical for maintaining food safety. Therefore, farmers were expected to follow Good Agricultural Practices (GAPs) acquired through technical training programs that utilized participatory methods to minimize contamination risks *(20)*. Improper handling at the farm level could introduce pathogens like *E. coli* and *Salmonella* spp., which posed serious health risks *(21)*.

Inadequate resources such as water and equipment were significant barriers to implementing salad vegetable safety practices. Similarly, research indicated that resource limitations hindered the adoption of safety practices *(60, 47)*. These constraints could lead to an increased risk of contamination, as farmers might not have had the means to follow all recommended guidelines. Time constraints were also recognized as obstructing adherence to hygienic practices, though slightly less critically but they were considered to impact on food safety.

Additionally, the majority of the respondents did not keep written records, particularly for entry and exit logs in the salad vegetable farms. However, maintaining records was important for an effective Hazard Analysis and Critical Control Points (HACCP) system *(51)*. The results indicated significant positive correlations between knowledge and practices and between attitudes and practices, suggesting that higher knowledge and more positive attitudes were associated with better practices. It had been reported that enhanced knowledge and positive attitudes fostered through regular and targeted training programs were essential for achieving better practices and ensuring the safety and quality of salad vegetable production *(13)*.

The analysis demonstrated that knowledge and attitude significantly predicted farming practices, with attitude having a stronger influence. This highlighted the need for targeted interventions that enhance farmers' knowledge and foster positive attitudes toward food safety practices. Given the substantial impact of attitude, educational initiatives should have incorporated behavioral change strategies alongside

knowledge dissemination to ensure more effective adoption of safe practices. These findings conformed with previous research *(18, 66)*, which suggested that good knowledge and attitudes together promoted proper practice. However, further investigation was needed to understand the specific mechanisms through which attitude influenced behavior and how best to leverage it for improved food safety compliance.

CONCLUSIONS

The findings of this study provide comprehensive information on the demographic characteristics, farming practices, and challenges faced by salad vegetable farmers. The demographic information highlights a diverse yet predominantly male workforce with varying educational backgrounds and scales of operation. Respondents have extensive experience in salad vegetable farming, with a notable reliance on synthetic fertilizer and rainwater for irrigation. The primary salad vegetables cultivated include cabbage and tomatoes, reflecting common production trends in Ghana's Eastern Region.

Despite a high level of training in Good Agricultural Practices (GAP) by Ghana Extension Officers, critical gaps remain in essential areas such as treatment of irrigation water, post-harvest sanitation, and organic manure sterilization. Also, the study reveals a good awareness of the importance of hygiene and safety practices, although some uncertainties persist, particularly regarding the risks associated with foodborne illnesses. Training on chemical contamination is relatively well-covered, but there is a clear need for more comprehensive education on microbial contamination to mitigate the associated risks effectively.

In conclusion, while some positive practices are in place, there is substantial room for improvement in various aspects of salad vegetable farming. Addressing the identified gaps through comprehensive training, better infrastructure, and effective resource management can significantly enhance salad vegetable safety and productivity in the salad vegetable farming sector.

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