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Potentials for the Utilization of Greenhouse as School Garden in Public Senior High Schools in Ghana: The Role of Educational Leaders.

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Abstract: The study explored the potentials for the utilization of greenhouse technologies as school gardens in Senior High Schools in Ghana: the role of educational leaders. The study employed the descriptive survey design with mixed-method approach. Multistage and convenience sampling techniques were used to sampled schools offering agriculture science as a programme and agriculture science teachers. A total of 100Agricultural science teachers were used as respondents for study. Open-ended and closed-ended questionnaire were used to collect data from the respondents. Descriptive statistics including mean and standard deviations were also used to analyze and present the data. It has been revealed that greenhouse technology can be a replacement of school garden in SHS in Ghana, the results further revealed that a policy document is needed for effective utilization of greenhouse as a school garden in SHS in Ghana. Based on the findings of the study it was recommended that it has been recommended that a policy document should be put in place for greenhouse to be effectively used as a garden in SHS since schools will not have enough land for garden in the future. It was also recommended that the current educational system should be reviewed to allow technology implement and sustenance in teaching agriculture science in Senior High Schools.

Keywords: *School Garden, Greenhouse, Potentials*, *Utilization*

I. Introduction

Clean, sustainable production technology is necessary to decouple projected increases in production to feed a growing population from environmental degradation (Mwalupaso et al., 2019). Benke and Tomkins (2017) stated that clean technological innovations such as hydroponics, aeroponics, vertical farming, and other controlled environment agricultural production techniques like greenhouse farming can enhance productivity, ensure environmental sustainability, and tackle present production-related challenges.

Greenhouse farming greatly lowers the effects of biotic and abiotic stressors such as climate, weeds, pests, and diseases as compared to open field farming. It also increases the efficiency of resource (water, energy, and nutrient) utilization. Furthermore, compared to open field farming, greenhouse culture yields have been found to be higher while requiring less space (Kanwar, 2011). There is, however, little indication of a continental plan for implementing such cutting-edge technologies. One of the biggest regional agricultural policies and initiatives, the

Comprehensive African Agricultural Development Programme (CAADP) (NEPAD, 2003), does not adequately address the importance of greenhouses or offer adoption strategies.

As more greenhouses are used for farming, the effects of extreme climatic occurrences (such as floods and droughts) on agricultural output will be reduced. Additionally, it will guarantee year-round agriculture, overcoming seasonality issues that make growing in the dry season extremely difficult or impossible. Furthermore, the extensive application of greenhouse technology will contribute to the accomplishment of several Sustainable Development Goals (SDGs). While effective water use in a controlled environment will help achieve SDG 6 (clean water and sanitation) and lessen the impact of extreme weather events on production (SDG 13), greenhouses' relatively high productivity will help achieve SDG 2 (no hunger), and little to no use of pesticides and fertilizers will help achieve SDG 3 (good health and well-being). Greenhouse technology offers a great alternative to job and income generation for a young population as traditional agricultural methods (for instance, open fields) become less and less enticing to young people. The achievement of SDGs 1 (no poverty), 5 (gender equality), 8 (decent work and economic growth), and 11 (sustainable cities) would therefore be significantly aided by increased adoption of new industrial technology. Wang et al. (2021), for instance, investigated how organizational support, norm, and learning positively influence the adoption of environmentally friendly technology, in this case greenhouse farming.

II. Problem Statement

Danso-Abbeam and Baiyegunhi (2020), revealed that agriculture employs more than 50% of Ghana's labor force, contributes around 22% of the country's GDP, and meets more than 70% of the nation's food demands. This makes agriculture a significant source of income for the rural poor. Despite agriculture immense potential, it is still entrusted to the old or illiterate youth (Njeru, 2017).

The agriculture industry is facing a number of challenges on a global scale, including urbanization, drought, temperature increases, and scarcity of water. Due to global movement from rural to urban areas, new industrial zones, and rapid economic One of the main causes of agricultural land being converted into built-up areas is urbanization and expansion. From 2.5 billion in 1950, the world's population has been steadily growing (Al-Thawwad, 2008; Chandio and Shirazi, 2022).

A number of variables, such as climate change and fluctuation, unsustainable management methods, a lack of available land, and complicated land tenure arrangements, place restrictions on Ghana's agricultural sector. The majority of Ghana's agriculture is rainfed and conducted in open fields, making it extremely susceptible to climate change. Adeosun et al. (2020) indicates that if e-learning can be adopted as a method of instructing the course in our various schools and Agricultural training centers, problems with teaching Agricultural education, such as insufficient the financial implications of setting up practical farms for students' education without making money from such facilities, as well as the availability of land for practical agriculture, should be better addressed. In Ghana, rain-fed agriculture predominates, which makes it very exposed to disease-causing organisms, climate change, and fluctuation. Benke and Tomkins (2017) discovered that greenhouse agriculture is less affected by pest, diseases, weeds and climate among other stresses, which can lower food quality and ultimately lead to food poisoning, than open field production.

In order to help accomplish SDG 15 (life on land), the small amount of land needed for greenhouse technology is expected to lessen issues of deforestation, loss of biodiversity, land deficiencies, and degradation. The productivity of agriculture is further hampered by land scarcity (which results from rising population expansion and rivalry for varied land usages) and complicated land tenure arrangements. For instance, urban and peri-urban agriculture is being quickly replaced by rapid urbanization, with most sites being acquired by real estate developers for commercial and residential use, which are thought to be more profitable than farming (Ayambire et al., 2019). The predominance of unsustainable management techniques, such as the management of soil and water and the development of farmland into forested regions, has an impact on production as well. Complex land tenure

arrangements restrict availability of land for modernizing agriculture as well (Kansanga et al., 2018), which may also cause inter communal disputes and emigration to urban areas (Kuusaana and Bukari, 2015).

In order to redefine the mission, vision, and goals of the educational system in the twenty-first century, Okilwa and Barnett (2017) found that school leadership is essential (Naidoo and Petersen, 2015). The development and prosperity of institutions depend on the leadership philosophies employed. It is imperative to revive educational movements in order to stay current (Ucar and Dalgic, 2021). Despite the numerous contributions agriculture makes to Ghana's economy, enrollment in agricultural studies has been dropping at the secondary and post-secondary educational levels. This regrettable condition resulted from the false belief that farming is not academic and that young people who become farmers after finishing school are failures in life (Twumasi et al., 2019).

It is on the basis of this that the researcher wants to look into this issue because researcher believe that innovative and modern farming systems, like greenhouses, can effectively replace school gardening programs and correct the misconceptions that students have about agriculture education and farming.

Research Objectives

The objectives of the study seek to:

1. Examine the policies governing the utilization and management of greenhouses as school garden in SHS in Ghana.
2. Determine the potentials of greenhouses as sustainable food source in SHS in Ghana
3. Explore the role of educational leaders in utilizing greenhouses as innovation for teaching Agriculture science in SHS in Ghana.

Research questions

1. What policies and management strategies influence the utilization of greenhouses in SHS school gardens in Ghana?
2. What are the potentials contributions of green houses to food production and sustainability in Ghana?
3. How does educational leaders influence the adoption and integration of greenhouses as an innovative teaching tool in Agriculture in SHS in Ghana?

III. Literature Review

The Need for Greenhouse Innovation Technology

Greenhouse technology has been promoted and has redefined the production of vegetables like tomatoes, sweet peppers, cucumbers, and lettuce in particular among young people. In Africa, especially Ghana, controlled environment agriculture (CEA) is widely used to control pests and diseases, combat drought, ensure year-round farming, and improve vegetable output and quality (Antwi-Boasiako, 2021). Additionally, there is a boost in the stability and security of vegetables because the external conditions have little to no impact on the vegetables planted, lowering production risks and increasing revenues. Youth find farming appealing because of controlled environment agriculture (CEA). For example, controlled environment agriculture (CEA) has resulted in the establishment of the Youth in Greenhouse Enterprise Project (YuGEP) between Agri-Impact Consult (AIC) and the Ghana EXIM Bank to encourage investment in greenhouse vegetable production in order to decrease imports from neighbors like Burkina Faso and to create jobs for Ghanaians (Antwi-Boasiako, 2021). Greenhouse technology (GT) is already being used in nations including the Netherlands, Canada, America, China, Japan, and Egypt, and Ghana is open to businesses who want to capitalize on it. A number of variables, such as climate change and fluctuation, unsustainable management methods, a lack of available land, and complicated land tenure arrangements, place restrictions on Ghana's agricultural sector. The majority of Ghana's agriculture is rainfed and conducted in open fields, making it extremely vulnerable to climate change.

Benke and Tomkins (2017) discovered that controlled environment agriculture (CEA) has the ability to solve current problems and hasten Ghana's sustainable growth. The Paris Agreement, Agenda 2030, and 2063 are just a few examples of the regional and international agreements Ghana has signed that provide a vehicle for funding the adoption and promotion of clean and sustainable production technology. Agriculture and food security, one of six sectors covered by the adaptation goals in its Nationally Determined Contributions (NDCs), is a sector where clean and low-carbon production methods, like greenhouse technology, can be promoted to have positive effects on the economy, society, and the environment. Since growing takes place in a controlled environment, increased adoption of greenhouses will reduce the influence of extreme climatic events (for instance, floods and droughts) on agricultural production. Additionally, it will guarantee year-round agriculture, overcoming seasonality issues that make growing in the dry season extremely difficult or impossible.

Adoption of Greenhouse Innovation Technology in Ghana

Food and Agriculture Sector Development Policy FASDEP I (2002) sought to modernize Ghana's agriculture, the Food and Agriculture Sector Development Policy (FASDEP II, 2007) was developed and builds on the knowledge gained from putting FASDEP I into practice, placing particular focus on environmental sustainability and the use of science and technology. It highlights the crucial role played by the private sector and initiatives made to increase productivity in the value chains for commodities. FASDEP II, (2007) "is a modernized agriculture culminating in a structurally transformed economy and evident in food security, employment opportunities, and reduced poverty" (MoFA, 2007; p. 20) is the national objective for the food and agriculture sector.

Theoretical Frameworks of Garden-based Learning

Theories of experiential in education and intelligence, and theories explaining the advantages of integrated curricula could all contribute to a scientific investigation into why gardens are a helpful setting for learning. Experiential Learning Theory in the view of (Baker, Jensen, & Kolb, 2002) provides a holistic model of the learning procedure and a multi-linear model of adult development. In other words, this is an all-inclusive model of adult among learning that intends to clarify the complexities of and differences between adult students within a single framework. Experience is the focus of this theory, which serves as the core driving force in knowledge, as knowledge is constructed through the transformative reflection n on one's experience (Baker, Jensen, & Kolb, 2002). A process called experiential education uses first-hand encounters to build knowledge, skill, and value. Kolb's experiential learning model (Kolb, 1975 in Weatherford & Weatherford, 1987) states that direct experience results in observations and reflections. In turn, these lead to the development of abstract concepts, their generalizations, and the ability to evaluate their applications in novel contexts. The significance of experience and its function in the learning process is emphasized by the Experiential Learning Theory (ELT) (Kolb, 1984). Additionally, it employs experience to highlight how it differs significantly from behavioral learning theory and cognitive learning theory, which place a strong emphasis on cognition. These theories “ignores the possible role of subjective experience in the learning process” (Cherry, 2019), while, as Kolb (1984) attests, “learning is the process whereby knowledge is created through the transformation of experience”

Model of Theory of Experiential Learning (ELT)

The model of ELT (see Figure 2) shows the process and sequence of experiential learning with its concepts, constructs, and proposition. These components are briefly explained below

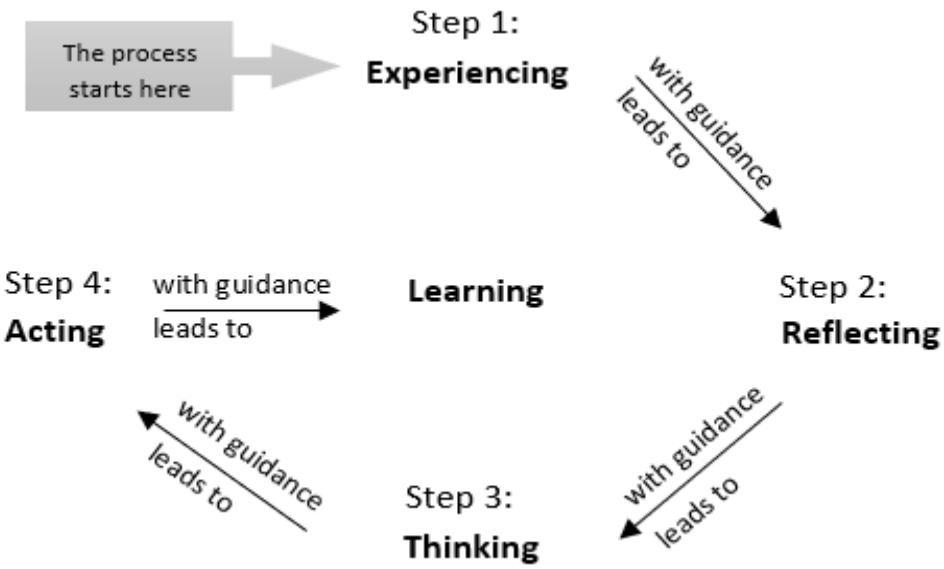

Figure 1: Model of Experiential Learning Theory (Kolb, 1984).

Diffusion of Innovations Theory (DOI)

When examining the use of technology in higher education and educational settings, Rogers' diffusion of innovations theory makes the most sense (Medlin, 2001; Parisot, 1995). Since technological advances are actually a major component of diffusion research, Rogers (2003) frequently used the terms "technology" and "innovation" interchangeably. According to Rogers (2003), "a technology is a design for instrumental action that lessens the uncertainty in the cause-and-effect relationships involved in achieving a desired outcome" (p. 13). There are two components to it: software and hardware. Software is “the information base for the tool,” but hardware is “the tool that embodies the technology in the form of a material or physical object” (Rogers, 2003, p. 259). The adoption rate of software is quite gradual due to its low level of observability as a technological innovation.

The adoption rate of software is quite gradual due to its low level of observability as a technological innovation. These phases normally occur one after the other in a time-ordered way. This procedure is demonstrated in

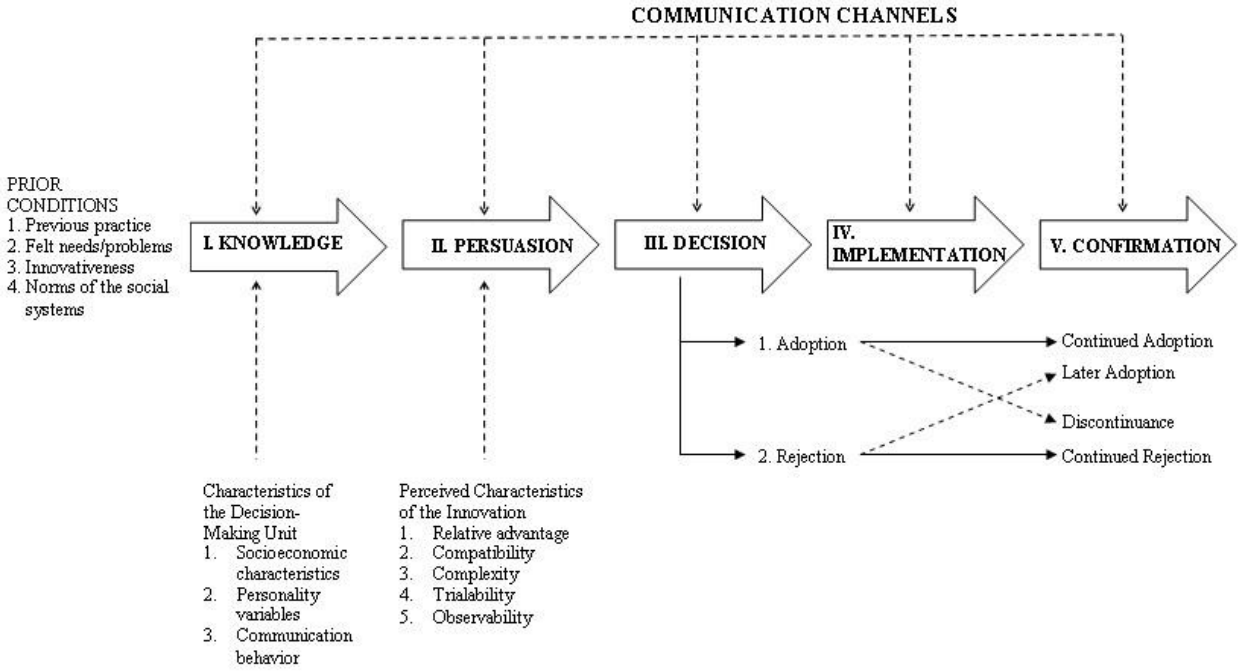

Figure 2*:* A Model of Five Stages in the Innovation-Decision Process
(Source: *Diffusion of Innovations, Fifth Edition* by Everett M. Rogers. Copyright (c) 2003 by The Free Press. Reprinted with permission of the Free Press: A Division of Simon & Schuster.)

IV. Methodology

Research design

The study employed a descriptive research design. Best and Kahn (1998) explained that descriptive research focuses on the relationships or conditions that already exist, such as identifying the types of trends, practices, and attitudes that are prevalent, as well as opinions held and ongoing processes.

Apuke (2017) indicated that quantitative approach uses particular statistical approaches to analyze and answer problems using numerical data.

Rationale for the Design

It is important to note that the goal of descriptive surveys is to collect data at a certain moment in time in order to characterize the nature of current conditions or to provide benchmarks by which current conditions can be measured (Creswell, 2012). Additionally, surveys can yield descriptive, inferential, and explanatory data that can be utilized to determine relationships between survey topics and item content (Cohen, Manion, & Morrison, 2007).

Study Location

The research was conducted in Ghana taken into consideration all the sixteen (**16**) regions.
Ghana is a west African nation that lies on the Gulf of Guinea, a few degrees north of the Equator. A portion of the Greenwich Meridian also goes via Ghana. The majority of the coast is made up of low, sandy beaches that are dotted with numerous rivers and streams and bordered by plains and bush. There formerly was a belt of tropical rainforest that stretched northward from the coast, broken up by hills covered in dense forest and numerous streams and rivers. However, the most of the rainforest was destroyed in the 20th century, leaving only sporadic remnants, mostly in the southwest, some of which are protected. The region north of this belt is made up of grassy plains and savanna. It has a tropical climate. The north is hot and dry, the southwest is hot and humid, and the eastern coastal belt is warm and rather dry. Lake Volta, a vast artificial lake, spans through considerable areas of eastern Ghana.

Population

Population is defined by Pilot and Hungler (1996) as the entire aggregation of cases that meet designated set of criteria. In this particular study, all agricultural Science teachers in Senior High Schools in the sixteen regions of Ghana were targeted. However, these categories of teachers were considered for the reason that most often they are supposed to use the school gardens for academic activities.

Sampling Technique and size for the study

The process of choosing a number of groups of units by means of purposeful sampling aims to create results that, for the features that are already known statistically, are as near to the totality's average or proportion as possible (Thomas, 2022).

purposive sampling techniques was used to sample schools perusing agriculture science programme as well as agriculture science teachers.

Censuses sampling technique was used to sampled all agricultural science teachers in SHS in Ghana. However, the total population for the study comprises of **Hundred (100)** participants

Research Instruments

Research instruments are the tools for data collection, which include questionnaire, interview, observation and reading (Godfred, 2017). Open-ended and closed-ended questionnaire were used to collect data from the participants. Primary and secondary data were both utilized in this study. The primary data was obtained through the questionnaire. The aspect of the research instrument that utilized a four-point Likert scale, ranging from 1 (Strongly Disagree) to 4 (Strongly Agree) measured the level of agreement with the various statements, with higher values indicating greater agreement. A mean value of 2.5 and above indicated that majority of participants agreed with a particular statement. In the process of coding the data, negatively worded items were reversed to ensure consistency in the analysis. This approach enabled the researcher to effectively assess attitudes, opinions, and beliefs related to the topic under study.

Data collection procedures

Data collection is the systematic process of obtaining and evaluating information on variables of interest in order to test hypotheses, evaluate results, and respond to research questions (Muhammad & Kabir, 2016). Data was collected through survey. Questionnaire was used to collect data on research question 1, 2 and 3.

Data validity and reliability

To validate the instrument, piloting was conducted on the instruments.

Ethical Considerations

The researcher took introductory latter from the dean of the faculty of education UDS, ethically, the mandate and consent were henceforth sort from all participant considered for the study.

Data Analysis and reporting of Research results

Data analysis is the systematic process of utilizing logical and/or statistical methods to evaluate, summarize, and explain data (Shamoo & Resnik 2009). Data gathered in the field was be double-checked to assure accuracy. Version 20 of the Statistical Package for Social Science (SPSS) software was used to code and analyze the raw data from the completed questionnaires. It should be noted that tables, percentages, and frequencies were utilized to examine the respondents' background data. Research question sought to emphasized on the policy and utilization mechanisms of greenhouses as school garden in Senior High Schools in Ghana, descriptive statistics such as mean and standard deviations were also used to analyses the data. The second research question also sought to determine the potentials of green houses as a food source for Senior high Schools in Ghana, descriptive statistics such as mean and standard deviations were used to analyze the data. The last research question sought to explore the role of educational leaders in the use green houses as innovation in teaching Agriculture in Senior High Schools in Ghana, descriptive statistics such as mean and standard deviations were used to analyze the data.

V. Results and Discussion

1. **Researcher Question 1: What policies and management strategies influence the utilization of greenhouses in SHS school gardens in Ghana?**

Table 1: Respondents' knowledge on policies, management and strategies for utilization of green house

S/N	Items	Yes F (%)	No F (%)
1	Respondent heard of greenhouse policy in his/her career	71 (71)	29 (29)
2	Knowledge of any policy in the utilization of greenhouses in Ghana	17 (17)	83 (83)
3	Knowledge of any policy on the utilization of school garden in Ghana	17 (17)	83 (83)
4	Greenhouse can be an effective mechanism of implementing school garden in Senior high schools in Ghana	92 (92)	8 (8)
5	Knowledge any Senior High School in Ghana that uses greenhouse technology as school garden	7 (7)	93 (93)
6	Policy is needed for the implementation of greenhouses in teaching in SHS as school garden in Ghana	98 (98)	2 (2)

N = 100, *Source: field survey, 2024*

Table 1 shows 71 %of the respondents indicated that they have heard of greenhouse policy in their career. However, 92 % testified that greenhouse can be an effective mechanism of implementing school garden in Senior high schools. On the other hand, 98% of the respondents stated that a policy is needed for the implementation of greenhouses as agarden in SHS.

Respondents indicated that they have heard of greenhouse policy in their career. It was further established that greenhouse can be an effective mechanism for school garden in Senior High schools. A policy is needed for the implementation of greenhouses as a garden. The responses of respondents that they have heard of greenhouse policy and somewhat agreed that a policy is needed in other for greenhouse to be used effectively as a garden in SHS is a clear indication that greenhouse technology will be widely supported in schools, greenhouse is extensively used as a school garden globally because of the changing trends with respect technology, it is captured in Roger innovation diffusion theory (2003) that awareness-knowledge represents the knowledge of the innovation's existence. This type of knowledge can motivate the individual to learn more about the innovation and, eventually, to adopt it. Literature established that Daiz et al. (2018) indicated that organizations should be supported to effectively engage the school system to have meaningful policy discussions and attain administrative support, its inherent complexities may stymie that process. Technology globally is widely accepted as a resourceful means for delivering academic lessons. This finding is in line with the report of Rajender et al. (2017) and Samapika et al. (2020) stated that greenhouses are crucial to agriculture, horticulture, and botanical science. The typical modern greenhouse is an enclosed frame made of glass or plastic that is used to grow fruits, vegetables, flowers, and any other plants that need a controlled atmosphere to survive. Although there are many various types of greenhouses, polyethylene or polyvinyl, fiberglass, plastic films, transparent, and translucent materials are frequently used as the cover materials.

Table 2: Management strategies to influence utilization of greenhouse technology as school garden in SHS in Ghana

S/N	Items	Mean	Std. Deviation

1	Senior high school agriculture curricula be changed to reflect more experiential and technology driven learning	3.6600	0.60670
2	Senior high school agriculture curricula must be updated to reflect the agriculture sector's dynamic shift away from family-on-farm to market needs with the use of greenhouse technology	3.6000	0.55048
3	Greenhouse technology as a replacement of school garden will positively impact learners' agriculture practical skills in Senior High Schools in Ghana	3.4300	0.76877
	Mean of means/SD	**3.5633**	**0.64198**

Source: field survey, 2024

Table 2 shows respondents' views on utilization of greenhouse technology as a school garden in SHS. Respondents agreed to the statements "Senior High School agriculture curricula be changed to reflect more experiential and technology driven learning" (Mean = 3.66, Std. Dev = 0.60), additionally, respondents agreed with the statement "Senior High School agriculture curricula must be updated to reflect the agriculture sector's dynamic shift away from family-on-farm to market needs with the use of greenhouse technology'' (Mean = 3.60, Std. Dev = 0.55), the respondents furthermore, agreed with the statement "Greenhouse technology as a replacement of school garden will positively impact learners' agriculture practical skills in Senior High Schools in Ghana" (Mean = 3.40, Std. Dev = 0.76),

Senior High School current agriculture science curriculum should be changed to reflect more experiential and technology driven learning**.** The responses that the current SHS agriculture science curriculum be changed to reflect experiential and technology driven learning is essential in this modern era because technology drives the world including delivering academic lessons in schools. The fourth industrial revolution demands experiential and technology driven learning in all fields including agriculture so the agriculture science curriculum need to review to reflect 21 century learning requirements of learners**,** this will make schools more relevant to society, this finding is in connection with the theoretical foundation which looked at the effectiveness of Experiential Learning Theory (ELT) in the learning process. When used in educational settings, ELT is most effective when teachers "take the students through the whole process in sequence." (McLeod, 2017). Similarly, Alkan (2016) added that because experiential learning encourages students to go through a process of experiencing, reflecting, thinking, and acting upon their own experiences, it can have a good impact on students' academic attainment and learning outcomes. Greenhouse technology as a replacement of garden will positively impact learners' agriculture practical skills in Senior High Schools. Respondents assessed that greenhouse technology can be a substitute of garden in SHS and subsequently aid to impact learners' skills in the field of practical's is remarkable. Stakeholders in education should therefore support greenhouse as a substitute of school garden in SHS to enhance effective and efficient agricultural science practical to meet the learning needs of students. It is found in literature that Lai et al. (2007) used ELT as a paradigm to explore the role of technology in experiential learning. Lai and colleagues (2007) thought about how technology might be used to deliver and facilitate experiential learning. Their findings show that incorporating technology into the four-stage process of Kolb (1984) Model of Experiential Learning Theory helped students learn more; highlighting the value of experience as it gives students the opportunity to act and evaluate their actions. Benke and Tomkins (2017) also reported that controlled environment agriculture (CEA) has the ability to solve current problems and hasten Ghana's sustainable growth. The Paris Agreement, Agenda 2030, and 2063 are just a few examples of the regional and international agreements Ghana has signed that provide a vehicle for funding the adoption and promotion of clean and sustainable production technology. Agriculture and food security, one of six sectors covered by the adaptation goals in its Nationally Determined Contributions (NDCs), is a sector where clean and low-carbon production methods, like greenhouse technology, can be promoted to have positive effects on the economy, society, and the environment.

Table 3: Existing policy and management strategies on the establishment of greenhouse as school garden in SHS in Ghana

Response	Frequency	Percent
Yes	2	2 %
No	96	96 %
I don't know	2	2 %
Total		**100**

Source: field survey, 2024

The idea of a policy been put in place for greenhouse to be used as school garden in SHS is a novelty as the respondents mentioned that there is no such policy in the country, out of the total number of respondents 96 % stated that they do not know of any existing policy on the utilization of greenhouse as a school garden in SHS, surprisingly 2 % of the respondents indicated that they are aware of a policy on greenhouse utilization as a garden in Table 3.

There is no existing policy on the use of greenhouse as school gardens in SHS in Ghana. Greenhouse technology is a novelty particularly with the proposal for it to be used as a garden in SHS in Ghana, this has necessitated a policy document to ensure that it is properly integrated into the SHS agricultural science curriculum and subsequently used as a tool for teaching practicals. This finding is in connection with the account of Antwi-Boasiako (2021) who said that a greenhouse's adoption is influenced by a number of factors, including policy categories, economic, social, institutional, ecological, resource and production. Forkuor et al. (2021) is also found to have reported that in order to advance the adoption of the greenhouse technology an amount of cooperation is need in policy areas.

Research Question 2: ***What are the potential contributions of greenhouse to food production and sustainability in Senior High Schools in Ghana?***

Table 4: Potentials of greenhouse as food production source in SHS in Ghana

S/N	Items	Mean	Std. Deviation
1	Greenhouse technology has the potential to serve as a healthy food source in Senior High Schools in Ghana	3.4600	0.50091
2	Greenhouse technology has the potential to serve as a food supplement source in Senior High Schools in Ghana	3.4600	0.65782
3	Greenhouse technology can be used as a tool for teaching students about nutrition and how to make healthier food choices	3.4400	0.60836
4	Greenhouse technology has the potential to serve as nutritious food sources of student diet in Senior High Schools in Ghana	3.3600	0.64385
5	Greenhouse technology has the potential to control chemical contamination of food fed to students in Senior High Schools in Ghana	3.2500	0.82112
6	Greenhouse technology has the potential to reduce food poison in senior high schools in Ghana	3.2100	0.70058

7	Greenhouse technology has the potential to serve as less expensive food source all year round for Senior High Schools in Ghana	3.1100	0.76403
	Mean of means/SD	3.3271	0.67095

Source: field survey, 2024

It is obvious from table 4 that based on the means and their corresponding standard deviations that all the respondents agreed to the statements (1-7) under the heading ‘’potentials of green houses as a food source for Senior high Schools in Ghana’’. This is revealing as all the respondents agreed to the fact that greenhouse technology can serves as food source for SHS in Ghana. Lack of land in schools coupled with food shortage in various senior schools in Ghana which often result to delay in schools reopening across the country could be curbed if government takes an initiative to adopt greenhouse in SHS in Ghana to serve as food source.

Greenhouse technology has the potential to serve as a food supplement source in Senior High Schools. In recent times, some Ghanaian SHS witness food shortages and subsequently were even closed down, the impression that greenhouse has the potentials to supplement food in SHS is a welcoming idea since this could help curb food shortage menace in the schools. For instant on 17th January, 2023, Citifm was on record to have reported that the Conference of Heads of Assisted Secondary Schools (CHASS) has lamented the inability of the National Food Buffer Stock Company to supply food items to Senior High Schools across the country. CHASS further stated that food shortages were constraining academic work across the country and therefore making it nearly impossible to keep second-cycle schools open. Furthermore, CHASS indicated that feeding students have become a challenge that needs urgent attention. Taking into consideration the report that compared yield per output of open field to greenhouse, this is the time to adopt and replace open field school garden with the greenhouse as food source, as it is established by Vox et al. (2020) that with a yield per cultivated unit area up to ten times greater than that of a field crop, greenhouse cultivation is the most intense mode of crop production.

The decision by respondents to adopt green house in SHS is in connection with Roger Diffusion of Innovations Theory (2003) indicated that the individual decides whether to accept or reject the innovation during the decision stage of the innovation-decision process. However, rejection means "not to adopt an innovation," but adoption indicates "full use of an innovation as the best course of action available" (Rogers, 2003, p. 177). Greenhouse technology has the potential to reduce food poison in Senior High Schools in Ghana. Numerous food poison cases have been lately recorded in SHS in Ghana and this is as a result of uncontrollable use of chemicals on food fed to students in various schools from the point of production to consumption, for instant, Accra High School experienced a suspected food poisoning incident on December 5, 2019, again, a report from Ghana News Agency (GNA) on 23 September 2023, indicated that 27 students were hospitalized after consuming food from the school's dining hall. Similarly, on July 24, 2023, Ghana News Agency (GNA) further reported another episode of food poisoning at Abutia Senior High School. Additionally, on Friday, 23, September 2023 students at Abutia SHS were sent to the hospital after eating rice for supper that was possibly infected. All these recorded food poison cases could be ended through greenhouse technology as it found in literature that greenhouse is on record to be clean food source across globally. This result is supported by the report of Benke and Tomkins (2017) who stated that greenhouse agriculture is less affected by biotic and abiotic stressors such climate, weeds, pests, and illnesses, which can lower food quality and ultimately lead to food poisoning, than open field production.

Greenhouse technology has the potential to control chemical contamination of food fed to students in Senior High Schools, the rate at which agro chemicals are used in the agricultural industry across the globe is alarming and has a dire consequence on the health of consumers. Good health is the bedrock to successful academic work, for instant World Health Organization (WHO) and United Nations Environment Programme (UNEP) report indicated that three million people are poisoned and 200,000 people die globally as a result of pesticide exposure, primarily in underdeveloped nations (Boedeker, et al., 2020). Green house is identified to have reduced the level of chemical use and afterward its consumption, this assertion of the respondents is backed by the study outcome revealed by Fernández et al. (2018) who stated that some advantages of greenhouse farming include efficient use of agrochemicals, efficient improved insect and disease control, reduced use of pesticides,

protection of plants from environmental hazards. Considering the Sustainable Development Goals (SDGs), greenhouse technology will help achieve SDG 3 which indicated little to no use of pesticides and fertilizers (good health and well-being).

Greenhouse technology has the potential to serve as nutritious food sources for student diet in Senior High Schools in Ghana. Food quality and nutrition has become a global concern; it is obvious that greenhouse technology is seen as one of the ways to addressing nutritious deficiency in schools. Greenhouse is one of the technologies earmarked for food quality production; greenhouse technology could help achieve SDG 2 which aim at the nutritional aspects of food consumed, promote healthy and sustainable diets and ensure food security globally. Additionally, the finding is in connection with the work of Antwi-Boasiako (2021) who stated that in Africa, especially Ghana, controlled environment agriculture (CEA) is widely noticed to improved output, quality and nutritious food source.

Greenhouse technology has the potential to serve as less expensive food source all year round for Senior High Schools. Government in recent times had challenges in providing food stuffs for SHS in Ghana, respondents agreeing that greenhouse has the potentials to serve as less expensive food source when adopted by government in schools. It is not surprising since greenhouse environmental conditions are under direct control and therefore regardless of the season production, it is possible all year round, production of food all year round in SHS in Ghana could help alleviate the food challenges in schools and the SDG 2 and 13 which stated that relatively high productivity of greenhouses will help achieve (no hunger) and SDG 13 which indicated lessen the impact of extreme weather events on production respectively. The support for green house through international donor organizations like the World Bank (WAAPP, 2020), local banks (Ghana EXIMBANK, 2018), and the private sector have since made investments. As part of its flagship "planting for food and jobs" initiative, MoFA recently developed three greenhouse villages in collaboration with a commercial enterprise to teach numerous young people in greenhouse farming (MoFA, 2017). This could be used as an avenue for less expensive food source. It has been established by (Antwi-Boasiako, 2021) that in Africa, especially Ghana, controlled environment agriculture (CEA) is extensively used combat drought, ensure year-round farming, and improve food yield output and quality. Additionally, this finding is in line with the report of Forkuor et al. (2021) who stated that the government's plan to create the largest greenhouse village in West Africa (1000 units) be implemented decentralized by creating villages in particular districts across all sixteen regions to act as the unit of support for accelerating the adoption of greenhouse technology in Ghana.

Research Question 3: ***How do educational leaders influence the adoption and integration of greenhouse as innovative teaching tool in Agriculture in Senior High Schools in Ghana?***

Table 5: Educational leaders' role in continuously advancing training in technology innovation in teaching agriculture in SHS in Ghana

Reponses	Frequency	Percent
Yes	92	92.0 %
No	8	8.0 %
Total	**100**	**100.0**

Source: field survey, 2024

From table 5 it has been agreed by 92.0 % of the respondents that it is the role of educational leaders to continuously advance training in technology innovation in teaching agriculture in senior high schools however, 8.0 % think other wise

Educational leaders have role to continuously advance training in technology innovation in teaching agriculture science in Senior High Schools. Teachers teach efficiently what they best known therefore in other to effectively use technology innovation to delivery agriculture science lessons in schools, teachers need to have adequate knowledge in the subject matter, lack of training on available technology in agriculture could hinder the use of such technology in schools. It is reported that the most important factor influencing a teacher's decision to use

educational technology in the classroom is their own ability to use it (Burke, et al., 2018). Educational technology and technology in general are always changing, and teachers frequently lack knowledge of the current educational technology and, as a result, develop low self-efficacy regarding its use in the classroom (Raven & Welton, 1989; Wang et al., 2004; Mishra & Koehler, 2006; Niederhauser & Perkman, 2008; Hastings, 2009; Theoretical Framework for Educational Technology; Stewart, Antonenko, Robinson, & Mwavita, 2013; Irby, 2017).Educational leaders' innovation in agriculture can be strategically used by government through school curricula to modernize the teaching of agriculture science in SHS. The curriculum serves as the roadmap to every country's educational system across the globe and therefore should be up to date for graduates to be useful to the society, it is the role of educational leaders to discharge such duty, the results discovered in the study is similar to the work of Annor-Frempong and Jones (2019) who argued that the curricula must be updated to reflect the agriculture sector's dynamic shift away from family-on-farm production for subsistence needs and toward consumer and market needs

Table 6: Educational leaders' role in the use of greenhouses as innovation in teaching agriculture in SHS in Ghana

S/N	Items	Mean	Std. Deviation
1	Educational leaders' innovation in agriculture can be strategically used by government through school curricula to modernize the agriculture teaching in SHS	3.4000	0.53182
2	It is the role of educational leaders to essentially ensure that students receive innovative agriculture education to give them the scientific, practical, and technological skills	3.3700	0.59722
3	The traditional training systems schools used to train public servants agriculture personnel for government policies are out of date and do not meet the needs of the end users	1.8300	0.76614
4	Cost involve in technological innovation in teaching agriculture in senior high schools makes it impossible for educational leaders to fully implement technology in schools	1.7500	0.89188
5	Lack of involvement of teachers in technology innovation in agriculture science makes teachers incapable of handling practical component of the subject	1.7100	0.78232
6	Lack of professional development and training available on the part of educational leaders is a reason technology is underutilized in senior high schools	1.6700	0.84154
	Mean of means/SD	2.2883	0.73515

Source: field survey, 2024

The results from Table 6have shown that majority of the respondents agreed to the statements "Educational leaders' innovation in agriculture can be strategically used by government through school curricula to modernize the agriculture teaching in SHS" (Mean = 3.40, Std. Dev = 0.53), "It is the role of educational leaders to essentially ensure that students receive innovative agriculture education to give them the scientific, practical, and technological skills" (Mean = 3.37, Std. Dev = 0.59),

Educational leaders have a role in the use of technology in technology innovation in teaching agriculture science in Senior High Schools. It is eminent that the world is driven by technology and therefore educational

leader's role in integrating technology into academic activities in schools is widely acknowledged. The findings of this study are backed by the report of Saleem et al. (2020) who revealed that leadership in educational contexts refers to the capacity to plan, direct, organize, and manage both human and material resources in order to achieve school objectives. It has been established by Okilwa and Barnett (2017) that school leadership is crucial in the twenty-first century for redefining the mission, vision, and objectives of the educational system (Naidoo and Petersen, 2015). Ucar and Dalgic (2021) also indicated that leadership styles are essential to the advancement and success of institutions.

It is the role of educational leaders to put measures in place to ensure that students receive innovative agriculture education to give them the scientific, practical, and technological skills. Educational leaders play a critical role in modern education and should always ensure students receives the best of knowledge, leadership role in technology in education cannot be undermined. In line with literature, Okilwa and Barnett (2017) discovered that school leadership is crucial in the twenty-first century for redefining the mission, vision, and objectives of the educational system (Naidoo and Petersen, 2015). Leadership styles are essential to the advancement and success of educational institutions.

Table 7: Greenhouse technology can serve as an innovation in teaching Agriculture science in SHS in Ghana

Responses	Frequency	Percent
Yes	98	98 %
No	2	2 %
Total		**100**

Source: field survey, 2024

Table 7 shows the views of respondents on greenhouse being used as an innovation in teaching agriculture science in schools, a greater percentage 98 %of the respondents agreed that greenhouse can be an innovation for teaching agriculture science in SHS in Ghana, on other the hand 2 % of the respondents think otherwise. The responses of the respondents that greenhouse can serve as an innovation in teaching agriculture science in senior high schools in Ghana is long overdue since Europe and Asia adopted greenhouse as a teaching and learning tool for over decades now.

The research discovered that greenhouse technology can be an innovation for teaching agriculture science in SHS. The world, industry players and developed countries have made advancement in the use of technology in delivery of academic lessons in all areas, most schools still use open fields as school garden in schools for teaching agricultural science particularly in Ghana. The idea of the respondents that greenhouse technology can serve as an innovation in teaching agriculture science in Senior High Schools is long overdue since Europe and Asia adopted greenhouse technology as a teaching and learning tool for over decades. In fact, this is undeniably similar to the work of Antwi-Boasiako (2021) who stated that one of the axes on which modern agriculture rotates is greenhouse technology (GT). Also, Pavel, et al. (2015) indicated that the utilization of technological tools offers several benefits to students, including the ability to solve problems independently, the development of technological skills through practice with tools and computers, cost effectiveness, the enhancement of students' self-discipline, increased likelihood of students staying on task, and a decrease in behavioral issues in the classroom.

In fact, when greenhouse technology is adopted as a tool for teaching agriculture science in school as it is practice in the advance world it could demystified the notion that agriculture is non-academic. This is supported by the work of Twumasi et al. (2019) who reported that regrettable condition resulted from the false belief that farming is not academic and that young people who become farmers after finishing school are failures in life.

Table 8: Support mechanism educational leaders can provide for effective greenhouse technology in SHS in Ghana

Type of support mechanism	Responses

	N	Percent
Improved Infrastructure and Access to Resources	15	8.1%
Improved Organizational Support and Operational Efficiency	68	36.6%
Improved Educational Integration and Curriculum	22	11.8%
Improved Program Implementation and Impact	81	43.5%
Total	**186**	**100.0%**

Source: field survey, 2024

Data from table 8 show support mechanism educational leaders can provide for effective greenhouse technology in senior high schools in Ghana. 43.5 % pronounces that improved program implementation and impact is the support mechanism educational leaders can provide for effective greenhouse technology in Senior High Schools in Ghana, however, 36.6 % of the respondents reasoned that improved organizational support and operational efficiency is the support mechanism educational leaders can provide for effective greenhouse in SHS in Ghana, alternatively, 8.1 % respondents indicates that improved infrastructure and access to resources is the support mechanism educational leaders can offer for effective greenhouse technology in Senior High Schools in Ghana.

Improved program implementation and impact (In-service training for agriculture teachers, mandatory Gardening in schools and link gardens with school feeding program) is the support mechanism educational leaders can provide for effective greenhouse technology as gardens in Senior High Schools, the responses that improved program implementation and impact should be the major concern of educational leaders should be looked at in the implementation of technology in school since poor implementation of previous programmes such as garden in schools have resulted to ineffectiveness and poor delivery of educational goals. It is therefore obvious for greenhouse to be effectively implemented educational leaders need to key their roles. This idea is in connection with the discovery that a significant barrier to the general implementation of the technology was a lack of technical know-how and capacity to control the production process (Forkuor et al., 2021). This has also been supported by Pavel et al. (2015) who indicated that ignorance, incomplete information, resistance to change, lack of a cogent and comprehensive management and quality management approaches, lack of high-quality materials, and experiencing difficulties are mostly factors that lead to poor implementation of technology in schools.

Table 9: Potential Challenges faced by educational leaders in implementing and sustaining technology in SHS in Ghana

Challenges	Responses	
	N	Percent
Policy and Governance Issues	52	31.9%
Educational System Challenges	88	54.0%
Practical Implementation Challenges	23	14.1%
	163	100.0%

Source: field survey, 2024

Challenges faced by educational leaders in implementing and sustaining technology in schools in most developing countries have become a global concern, table 9 revealed that 54 % of respondents had a widely held view that educational system challenges make it difficult for educational leaders to implement and sustain technology in SHS in Ghana nevertheless, 14.1 % indicates practical implementation challenges rather makes it problematic for implementation and sustenance of green house.

Educational system challenges make it difficult for educational leaders to implement and sustain technology in SHS. The respondents identify educational system challenges such unfavorable conditions in schools, rigid regulations, lack of in-service training for agriculture science teachers on technology, lack of link gardens with school feeding program and lack of standard design for all school gardens. The idea that systematic challenges hinder the implementation and sustenance of technology in schools is not strange since this impression is similar to the report by Forkuor et al. (2021) who argued that unfavorable regulations and regulatory frameworks can prevent the technology from being used, even with the best designs. Options for overcoming these obstacles have largely gone unexplored, particularly through multi-stakeholder engagements. It has been further established by Diaz et al. (2018) that complexity of school systems and issues of implementing an innovative program into an already existing system built upon are challenges faced by educational leaders. Additionally, Senthil et al. (2020) observed that obstacles to technology adoption in agriculture education are administrative issues scarcity of technology instruments

VI. Conclusions

The absence of a clear policy document backed by legislation to guide the establishment, management, and use of school gardens creates inconsistencies and limits their integration into the school curriculum and development agenda.

A significant number of respondents were unaware of any existing policy regarding the use of greenhouse technology in schools. This indicates a gap in policy implementation and awareness, which must be addressed to promote the adoption of greenhouse farming in SHS.

The study highlights the potential of greenhouse farming to serve as a sustainable food source within schools. Implementing this technology could enhance food security and provide students with real-life experience in modern agricultural techniques.

All respondents agreed that educational leaders play a vital role in integrating technological innovations into Agricultural Science education. However, systemic challenges within the educational sector make it difficult for school authorities to implement and sustain such initiatives effectively.

Despite the recognized benefits of greenhouse technology, obstacles such as limited funding, lack of training, and inadequate infrastructure could potentially hinder its adoption in SHS. Addressing these challenges will be key to ensuring the successful implementation of agricultural innovations in schools.

Recommendations

- It recommended that a policy document should be put in place for greenhouse to be used as a garden in SHS since schools will not have enough land for garden in the future.
- It is recommended that the current educational system should be review to allow technology implement and sustenance in teaching agriculture science in Senior High Schools

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