Management Techniques Required by Agricultural Education Students for Greenhouse Farming in Tertiary Institutions in Bauchi State, Nigeria

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Abstract
This study investigated the management techniques required by tertiary institutions Agricultural Education students for greenhouse farming in Bauchi State, Nigeria. The study was guided by five specific objectives, five research questions, and five corresponding null hypotheses tested at the 0.05 level of significance. A descriptive survey research design was adopted for the study. The population comprised 52 respondents, consisting of 33 Agricultural Education lecturers and 19 technologists in tertiary institutions offering Agricultural Education programmes in Bauchi State, the entire population was studied. Data were collected using a structured questionnaire titled Management Techniques Required by Agricultural Education Students for Greenhouse Farming Questionnaire (MTRAESGFQ). The instrument was validated by experts, while its reliability coefficients obtained using Cronbach's alpha ranged from 0.700 to 0.856. Data collected were analyzed using the Statistical Package for the Social Sciences (SPSS) Version 25. Mean and standard deviation were used to answer the research questions, while the Independent Samples t-test was used to test the null hypotheses. The findings revealed that irrigation management techniques, housing management techniques, climate control management techniques, and pest control management techniques are highly required, while record management techniques are required by tertiary institutions Agricultural Education students for effective greenhouse farming in Bauchi State, Nigeria. The results further revealed no significant difference between the mean responses of lecturers and technologists regarding all the management techniques required for effective greenhouse farming. The study concluded that effective greenhouse farming depends on students acquiring competencies in irrigation, housing, climate control, pest control, and record management techniques. The study also recommended that tertiary institutions should integrate competency-based greenhouse farming training into the Agricultural Education curriculum, provide modern greenhouse facilities and instructional resources, and organize regular capacity-building programmes to enhance students' practical competencies for sustainable agricultural entrepreneurship, food security, and self-employment.

Introduction

In Nigeria today, agriculture remained a major sector of the economy despite the emphasis on the oil sector, agriculture plays a role of providing food for the teeming population, provision of foreign exchange earnings, income for smallholder and commercial farmers and employment opportunities for about 70 percent of the population (Otekunrin, Oni & Oluwaseun, 2017). This means that, agricultural sector has started regaining its lost glory in recent time through a viable economic plan referred to as Economic Recovery and Growth Plan (ERGP) in which Agriculture is one of the major sectors of the economy considered in the

ERGP to help solve ravaging incidence of food insecurity, reduce unemployment, improve foreign exchange earnings and resuscitate industrialization (Otekunrin *et al.*, 2017).
Despite the importance of crude oil on nation's economic development, the researcher observed that, there is need to bring agriculture back to its lost glory. The reason was that, the growing unemployment in Nigeria and its concomitant consequences constitute a serious challenge to the economic development with negative effect for future generation, especially as the youths are mostly affected. Other researchers such as Faiz (2019), Beegle and Christiaensen (2019) and Fox and Gandhi (2023) have established that, the skyrocketing rate of unemployment in Nigeria is disturbing and it is no longer news that the nation's youth unemployment rate is very high. According to Beegle and Christiaensen (2019), the rate of youth unemployment in Nigeria is between 60% and 70% and that, only 10% of graduates can be absorbed in the Nigerian Labour Market. This means that, among the 165 million estimated population of the country, only 35 million Nigerians own a job. To Beegle *et al.* (2019) this is disastrous because, both unemployment and underemployment constitute a serious constraint to the economic progress of any nation. In order to remedy unemployment and underemployment situation, sound agricultural education which equips students to challenge the status quo and proffer better alternatives is the way out of the present economic quagmire (Ede, Chedi & Jibril, 2023). As stated by Anyanwu and Iwuamadi (2015) agricultural educational environment helps people to figure out management techniques that they direly need to get rid of poverty, unemployment, illiteracy and any other social problems. This calls for the use of modern agricultural systems that emphasize efficiency, environmental control and global sustainability. One of the most prominent of such systems according to Gruda (2019) is greenhouse farming, also referred to as controlled-environment agriculture (CEA). Greenhouse farming is defined as the cultivation of crops within specially constructed structures covered with transparent materials such as glass or polyethylene, which allow sunlight to enter while enabling the regulation of environmental factors such as temperature, humidity, light, ventilation, and irrigation (Osagiede *et al.,* 2024). Osagiede *et al.,* explained further that this controlled environment creates optimal conditions for plant growth and development throughout the year. Unlike traditional open-field farming, greenhouse farming significantly reduces dependence on rainfall and minimizes exposure to adverse weather conditions (Kanu et al., 2025). Kanu et al. continued that greenhouse farming limits pest and disease infestation through physical barriers and controlled entry, thereby reducing excessive reliance on chemical pesticides. These advantages make greenhouse farming particularly relevant for countries like Nigeria, where climate variability and land degradation continue to threaten agricultural productivity (FAO, 2016; World Bank, 2023). In North-east Nigeria, including Bauchi State, prolonged dry seasons and increasing temperature extremes further limit the reliability of open-field crop production (World Bank, 2023). As stated in FAO greenhouse farming represents a shift toward technology-driven agriculture, integrating innovations such as automated climate control systems, efficient irrigation technologies, energy-saving structures, and improved crop management practices.

Literature Review

The study is underpinned by two major theories. These are: Human Capital Theory which was propounded by Gary S. Becker (1964) and Vocational Education and Training (VET) theory propounded by Wolfgang H. Bielefeld (1980). These theories provide a comprehensive understanding of the relationship between education, skills development, and sustainable employment, which is central to the study's aim of identifying the management techniques required by agricultural education students for effective greenhouse farming. The Human Capital Theory which was developed by Gary S (1964). Becker suggests that acquiring education and training improves skills and abilities, increases efficiency and effectiveness in the workforce (Becker, 1964). Becker's seminal work, "Human established a framework for

understanding how such investments lead to greater economic benefits for both individuals and society". The theory emphasizes that education and training are investments that yield returns in the form of higher wages and improved job prospects. This investment increases what is known as human capital the stock of skills, knowledge, and experience that contributes to productivity (Becker, 1964). According to the theory, the market value of management techniques, skills and knowledge acquired through education and training is reflected in higher wages and better employment opportunities, highlighting the link between educational attainment and economic outcomes. Human Capital theory provides a rationale for investing in education and training programs (like agricultural programs) to enhance productivity and drive economic growth. In the context of this study, the theory can be used to evaluate how management techniques training impacts students' abilities to manipulate greenhouse farming for improve productivity, employment and career success, in vocational agriculture.

The Theory of Vocational Education and Training (VET) Systems has been developed and expanded by various scholars and educational theorists. One of the key contributors is Wolfgang H. Bielefeld (1970), who made significant contributions to the theoretical foundation of vocational education, including its relevance to agricultural education. His work emphasized the relationship between vocational education, training systems, and labour market demands, particularly in ensuring that learners acquire practical skills and management techniques required for effective job performance, such as those needed in greenhouse farming.

Over time, the theory has evolved through contributions from scholars in educational psychology, vocational education, and economics. It provides a framework for understanding how vocational education systems can be structured to meet industry needs by equipping learners with relevant, practical competencies. In the context of agricultural education, this includes the acquisition of essential greenhouse farming management techniques such as irrigation management, greenhouse housing, temperature control, pest management, and record management.

Concept of Greenhouse Farming

The integration of greenhouse farming into educational settings has a significant, positive impact on student self-reliance, primarily by fostering entrepreneurship, technical skill acquisition, and financial independence. According to Mwalupaso *et al.* (2019) clean, sustainable production technology is necessary to decouple projected increases in production to feed a growing population from environmental degradation. 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. According to Rahaman et al. (2025) greenhouse programs provide hands-on training that transforms students into active producers rather than just consumers, enhancing their ability to generate income and manage food resources. The greenhouse industry must take advantage of its considerable potential to contribute to meeting the ever-increasing global demand for environmentally and hygienically safe food (Gorjian et al., 2021). There are many reasons why greenhouses can be good options for future food production. According to Balan et al. (2024) greenhouse operators can minimize climate-related risks by creating an ideal microclimate for plants using many customizable features, such as natural ventilation, screens for energy efficiency, artificial lighting, and carbon dioxide dosing, among others. Balan et al greenhouse can decouple production from external conditions, essentially allowing for the possibility of a given crop being produced consistently over the year with a controlled quality of the end product. The excellent physical protection from the environmental stressors and pathogens achievable in greenhouse environments is particularly interesting for integrated pest management and plant disease control (Chen et al., 2022). As stated by Sapounas (2020); Khan

et al. (2021) there should be a change to the traditional agricultural perspectives and develop not merely adaptations of today's best greenhouse technologies, but innovative new ones that make the best possible use of the unique positive facets of a greenhouse cultivation system to meet the needs of the future. Tonle and Niassy (2024) asserted that the effects of climate change that are ever more noticeable may already be impacting agriculture, influencing plant phenology and the spread of pests and diseases. Water is a scarce resource and we must not waste it; the same applies to carbon, and our greenhouse crops must be even better suited to capture and fix carbon into plant mass (Skendzicm, 2021).

Research Methodology

This section describes the methodology adopted for conducting the study under the following subheadings; - Research Design, Area of the Study, Population of the Study, Sample and Sampling Technique, Instrument for Data Collection, Validation of the Instrument, Reliability of the Instrument, Method of Data Collection and Method of Data Analysis.

Research Design

This study adopted a descriptive survey research design. A survey research design is appropriate when a study seeks to obtain information on respondents' opinions, perceptions, attitudes, and beliefs regarding a particular phenomenon through the use of a structured questionnaire (Sekaran & Bougie, 2016). Similarly, Nannim (2018) described a descriptive survey design as a systematic and comprehensive approach to collecting data on respondents' opinions, feelings, and beliefs about a given situation. In the same vein, Knussan (2014) asserted that a descriptive survey design is suitable for studies involving the collection of respondents' opinions through questionnaires concerning specific issues or relationships. Furthermore, Emaikwu (2015) maintained that descriptive survey design is most appropriate for studies that assess the current status of variables without manipulating them. The descriptive survey research design was considered appropriate for this study because it involved collecting data through a structured questionnaire from Agricultural Education lecturers and technologists in tertiary institutions in Bauchi State. The study sought to determine the management techniques required by tertiary institutions Agricultural Education students for greenhouse farming. Specifically, the study examined respondents' perceptions regarding irrigation management techniques, housing management techniques, climate control management techniques, pest control management techniques, and record management techniques required for effective greenhouse farming. Therefore, the descriptive survey research design was considered suitable because it enabled the researcher to obtain reliable information from the respondents and adequately address the objectives, research questions, and hypotheses of the study.

Area of the Study

The study was conducted in Bauchi State, Nigeria. Bauchi State comprises of twenty (20) Local Government Areas, namely: Alkaleri, Bauchi, Bogoro, Darazo, Dass, Dambam, Gamawa, Ganjuwa, Giade, Itas/Gadau, Jama'are, Katagum, Kirfi, Misau, Ningi, Shira, Tafawa Balewa, Toro, Warji, and Zaki. The State lies between latitudes 9°3′ and 12°3′ North and longitudes 8°50′ and 11° East, covering a total land area of approximately 49,119 square kilometres, which represents about 5.3% of Nigeria's total land mass. It shares boundaries with Kano and Jigawa States to the north, Taraba and Plateau States to the south, Gombe and Yobe States to the east, and Kaduna State to the west. According to the National Bureau of Statistics (2021), Bauchi State has an estimated population of 6,653,300 people. The State is characterized by diverse ethnic groups, including Gerawa, Sayawa, Jarawa, Kirfawa, Ngas, Bolewa, Karekare, Kanuri, Warjawa, Hausa, and Fulani, among others. Agriculture is the predominant occupation of the

people, with crop production and livestock farming serving as major sources of livelihood. Bauchi State was considered appropriate for this study because it has tertiary institutions that offer Agricultural Education programmes, where lecturers and technologists are actively involved in training students in agricultural production and related practical skills. The State also possesses favourable agro-ecological conditions, including suitable land, climate, and water resources that support greenhouse farming and other modern agricultural practices. Furthermore, the increasing emphasis on sustainable agriculture, food security, and youth empowerment through agribusiness has heightened the need to equip Agricultural Education students with appropriate greenhouse farming management techniques. Therefore, the selection of Bauchi State provided an appropriate setting for investigating the management techniques required by tertiary institutions Agricultural Education students for effective greenhouse farming.

Figure 1: Map of Bauchi State, Nigeria
Sources: http.mapofthenorth.com

Population of the Study
The population of this study comprised of 52 agricultural education Lecturers and technologist in tertiary institutions of Bauchi State. This made up of 33 and 19 agricultural Lecturers and technologist in tertiary institutions respectively. The breakdown for the population of this study comprises of all the 52 agricultural Lecturers and technologist in all the five tertiary institutions offering agricultural education as a course in Bauchi state. The five tertiary institutions that offering agricultural education are as follows: Abubakar Tafawa Balewa University (ATBU Bauchi) with 6 agricultural Lecturers and 3 technologists, Abubakar Tatari Ali Polytechnic (ATAP Bauchi) with 6 agricultural Lecturers and 4 technologists, College of Agriculture,

Bauchi with 10 agricultural Lecturers and 5 technologists, Aminu Sale College of Education Azare with 6 agricultural Lecturers and 4 technologists, Adamu Tafawa Balewa College of Education Kangere with 5 agricultural Lecturers and 3 technologists. The table illustrate five tertiary institutions with their respective number of agricultural education lecturers and technologists.

Table 1: Population Distribution of Tertiary Institutions Agricultural Education Lecturers and Technologists in Bauchi State, Nigeria

S/N	Institutions	Number of agricultural education Lecturers	Number of technologists	Total
1.	Abubakar Tafawa Balewa University (ATBU), Bauchi	06	03	9
2.	Abubakar Tatari Ali Polytechnic (ATAP), Bauchi	06	04	10
3.	College of Agriculture, Bauchi	10	05	15
4	Aminu Sale College of Education Azare	06	04	10
5	Adamu Tafawa Balewa College of Education Kangere	05	03	08
	Grand Total	**33**	**19**	**52**

Source: Academic office of the institutions, 2026.

Sample and Sampling Technique

This study adopted the Total Population Sampling (TPS) technique. Accordingly, the entire population of 52 respondents, comprising of 33 Agricultural Education lecturers and 19 technologists from tertiary institutions offering Agricultural Education programmes in Bauchi State, Nigeria, was used for the study. The decision to adopt the total population sampling technique was based on the relatively small and manageable size of the population, making it feasible for the researcher to include every member of the population in the study. The adoption of the total population sampling technique is consistent with the recommendation of Casteel and Bridier (2021), who argued that when a population is small and accessible, there is no need to select a sample because studying the entire population provides more accurate and comprehensive information. Similarly, Shukla (2020) defined Total Population Sampling as a purposive sampling technique in which all members of a population possessing one or more common characteristics are included in the study. In the present study, all the respondents shared common characteristics, as they were Agricultural Education lecturers and technologists directly involved in the teaching and practical training of students in tertiary institutions. Therefore, the use of the entire population eliminated sampling error, enhanced the representativeness of the data, and increased the validity and reliability of the study findings.

Instruments for Data Collection

The instrument used for data collection in this study was a structured questionnaire titled Management Techniques Required by Agricultural Education Students for Greenhouse Farming Questionnaire (MTRAESGFQ) (see Appendix II). The questionnaire consisted of 45 items organized into five sections based on the major constructs of the study. Specifically, the instrument comprised 8 items on irrigation management techniques, 10 items on housing management techniques, 9 items on climate control management techniques, 8 items on pest control management techniques, and 10 items on record management techniques. The

questionnaire items were adapted from relevant empirical studies, including Chah et al. (2013), Alalade et al. (2017), Abdullahi et al. (2021), Ramirez et al. (2022), and Absanto et al. (2025), with necessary modifications to suit the objectives and context of the present study.
The respondents were requested to indicate the extent to which each management technique is required for effective greenhouse farming using a five-point rating scale of Very Highly Required (VHR) = 5, Highly Required (HR) = 4, Required (R) = 3, Moderately Required (MR) = 2, and Not Required (NR) = 1 (see Appendix I). The five-point scale was adopted because it provides respondents with adequate response options while enhancing the reliability and validity of the measurement. According to Joshi, Kale, Chandel, and Pal (2015), rating scales ranging from four to seven response categories produce more reliable and consistent results than scales with fewer or more response options. Similarly, Esu and Inyang-Abia (2016) asserted that four- or five-point Likert scales are appropriate for measuring respondents' perceptions and attitudes because they reduce response ambiguity and improve the quality of data collected. Therefore, the five-point Likert scale was considered suitable for eliciting reliable responses from the respondents regarding the management techniques required by Agricultural Education students for effective greenhouse farming in Bauchi State, Nigeria.

Method of Data Collection

In the first stage of data collection, the researcher obtained a letter of introduction from the Office of the Head of the Department of Vocational Education, Faculty of Technology Education, Abubakar Tafawa Balewa University (ATBU), Bauchi (see Appendix I). The letter served as an official introduction and facilitated access to the selected tertiary institutions by seeking the cooperation of the institutional authorities and respondents during the data collection exercise. In the second stage, the researcher recruited and trained five (5) co-opted research assistants, with each assistant assigned to one of the five tertiary institutions included in the study. The training focused on the objectives of the study, ethical issues, proper administration of the questionnaire, confidentiality of respondents' information, and the procedures for distributing and retrieving the completed questionnaires. This ensured uniformity and consistency in the administration of the research instrument.
The data were collected by the researcher and the five (5) trained research assistants using the structured questionnaire titled Management Techniques Required by Agricultural Education Students for Greenhouse Farming Questionnaire (MTRAESGFQ). The questionnaires were administered to Agricultural Education lecturers and technologists in the selected tertiary institutions in Bauchi State using the direct (face-to-face) method. This approach enabled the researcher and the research assistants to explain the purpose of the study, clarify issues raised by respondents, and assure them that the information provided would be treated with strict confidentiality and used solely for academic purposes. According to Kabir and Adamu (2019), the face-to-face method enhances respondents' participation and improves the retrieval rate of questionnaires compared to other methods of data collection.
A total of 52 copies of the questionnaire were administered to the respondents. Out of these, 49 copies were successfully completed and returned, representing a 94% response rate, while 3 copies (6%) were not returned. The response rate of 94% was considered adequate for statistical analysis and generalization of the findings, based on the recommendation of Sekaran and Bougie (2016), who stated that a questionnaire response rate of 70% or above is considered very good for survey research. The entire data collection exercise lasted for two (2) weeks, after which the completed questionnaires were coded and prepared for data analysis.

Method of Data Analysis

The data collected from the respondents were coded, entered, and analyzed using the Statistical Package for the Social Sciences (SPSS) Version 25. Descriptive statistics comprising mean and

standard deviation were used to answer all the research questions, while the Independent Samples t-test was employed to test the five null hypotheses formulated for the study at 0.05 level of significance.

This chapter presented and discussed the results of data analysis for this study. The chapter started by answering the research questions followed by the results of tested hypotheses.

Results of Research Questions

Research question one

To what extent do irrigation management techniques require by tertiary institutions agricultural education students for greenhouse farming in Bauchi State, Nigeria? The output of the descriptive statistics presented in Table 3 below indicates that the mean scores of the items measuring irrigation management techniques range from 3.12 to 3.86. Based on the decision rule, seven of the eight irrigation management techniques, namely techniques of drip irrigation systems (M = 3.86), techniques for water scheduling (M = 3.84), techniques in fertigation (combined fertilizer and water application) (M = 3.63), techniques for monitoring soil moisture content levels (saturation level) (M = 3.71), hydroponic water systems techniques (M = 3.71), techniques for water channeling (M = 3.63), and water gravimetric techniques (M = 3.70), are highly required because their mean scores fall within the range of 3.50–4.49. However, techniques of water conservation practices recorded a mean score of 3.12, indicating that it is required, as it falls within the range of 2.50–3.49. The grand mean of 3.65 with a standard deviation of .644 falls within the benchmark range of 3.50–4.49, indicating that irrigation management techniques are highly required by tertiary institutions agricultural education students for greenhouse farming in Bauchi State, Nigeria. The result further implies that agricultural education students require adequate competencies in irrigation management techniques to effectively manage greenhouse farming operations. Acquiring these techniques will enable students to optimize water use, improve crop productivity, promote sustainable greenhouse farming practices, and enhance their capacity for self-employment and entrepreneurial success in modern agriculture.

Table 2: Descriptive Statistics of the Extent to Which Irrigation Management Techniques Required by Tertiary Institutions Agricultural Education Students for Greenhouse Farming in Bauchi State, Nigeria.

Items	N	Mean	Std. D	Remarks
Techniques of drip irrigation systems	49	3.86	.913	HR
Techniques for water scheduling	49	3.84	.007	HR
Techniques in fertigation (combined fertilizer and water application)	49	3.63	.782	HR
Techniques for monitoring soil moisture content levels (saturation level)	49	3.71	.979	HR
Techniques of water conservation practices	49	3.12	.033	R
Techniques hydroponic water systems techniques	49	3.71	.791	HR
Techniques for water channeling	49	3.63	.768	HR
Water gravimetric techniques	49	3.70	.878	HR
Grand Mean		**3.65**	**.644**	**HR**

Note: N= Number of respondents; Std. D= standard deviation; HR = Highly required; R= Required

Research question two

To what extent do housing management techniques required by tertiary institutions agricultural education students for greenhouse farming in Bauchi State, Nigeria?

The result of the descriptive statistics presented in Table 4 indicates that the mean scores of the items of housing management techniques range from 3.39 to 4.00. Based on the decision rule, nine of the ten housing management techniques, namely provision of adequate space to prevent overcrowding in housing units (M = 3.76), ensuring proper ventilation to reduce heat and harmful gas accumulation (M = 3.52), regular sanitation of housing facilities to promote hygiene and disease control (M = 3.65), routine inspection and maintenance of housing structures (e.g., greenhouse fences) (M = 3.51), construction of appropriate beds or ridges to prevent waterlogging (M = 3.57), adoption of regulated farming practices within housing systems to enhance productivity (M = 3.69), securing housing environments against predators and external threats (M = 3.80), proper disposal and management of waste generated within the housing system (M = 4.00), and regular monitoring and adjustment of housing conditions to ensure optimal performance (M = 3.82), are highly required because their mean scores fall within the range of 3.50–4.49. Conversely, regulation of temperature to maintain a conducive housing environment recorded a mean score of 3.39, indicating that it is required, as it falls within the range of 2.50–3.49. The grand mean of 3.67 with a standard deviation of .578 falls within the benchmark range of 3.50–4.49, indicating that housing management techniques are highly required by tertiary institutions agricultural education students for greenhouse farming in Bauchi State, Nigeria. The result further implies that agricultural education students require adequate competencies in housing management techniques to effectively establish and manage greenhouse farming enterprises. Mastery of these techniques will enable students to maintain suitable housing conditions, improve environmental control, enhance crop health and productivity, ensure sustainable greenhouse operations, and strengthen their entrepreneurial capacity for successful greenhouse farming.

Table 3: Descriptive Statistics of the Extent to Which Housing Management Techniques Required by Tertiary Institutions Agricultural Education Students for Greenhouse Farming in Bauchi State, Nigeria.

Items	N	Mean	Std. D	Remarks
Provision of adequate space to prevent overcrowding in housing units.	49	3.76	.787	HR
Ensuring proper ventilation to reduce heat and harmful gas accumulation.	49	3.52	.597	HR
Regulation of temperature to maintain a conducive housing environment.	49	3.39	.169	R
Regular sanitation of housing facilities to promote hygiene and disease control.	49	3.65	.182	HR
Routine inspection and maintenance of housing structures (e.g., greenhouse fences).	49	3.51	.210	HR
Construction of appropriate beds or ridges to prevent waterlogging.	49	3.57	.950	HR
Adoption of regulated farming practices within housing systems to enhance productivity.	49	3.69	.140	HR
Securing housing environments against predators and external threats.	49	3.80	.979	HR
Proper disposal and management of waste generated within the housing system.	49	4.00	.957	HR

Regular monitoring and adjustment of housing conditions to ensure optimal performance	49	3.82	.808	HR
Grand Mean		**3.67**	**.578**	**HR**

Note: N= Number of respondents; Std. D= standard deviation; HR = Highly required; R= Required

Research question three

To what extent do climate control management techniques required by tertiary institutions agricultural education students for greenhouse farming in Bauchi State, Nigeria? The output of the descriptive statistics presented in Table 5 shows that the mean scores of the items of climate control management techniques range from 3.13 to 4.02. Based on the decision rule, four of the nine climate control management techniques, namely regulate greenhouse temperature techniques (M = 3.51), ventilation systems techniques (M = 3.76), shading techniques to reduce heat stress (M = 4.02), and crop rotation techniques (M = 3.78), are highly required because their mean scores fall within the range of 3.50–4.49. However, controlling relative humidity techniques (M = 3.18), techniques in using cooling systems (M = 3.47), heating techniques for cold periods (M = 3.13), drought control techniques (M = 3.24), and techniques for growth deficiencies detection (M = 3.31) are required, as their mean scores fall within the range of 2.50–3.49. The grand mean of 3.50 with a standard deviation of .303 falls within the benchmark range of 3.5 to 4.49, indicating that climate control management techniques are highly required by tertiary institutions agricultural education students for greenhouse farming in Bauchi State, Nigeria. The result further implies that agricultural education students require sufficient competencies in climate control management to effectively regulate environmental conditions within greenhouse farming systems. Acquiring these techniques will enable students to maintain favourable growing conditions, minimize the adverse effects of climatic variations, improve crop growth and yield, enhance resource-use efficiency, and strengthen their preparedness for successful greenhouse farming and agribusiness ventures.

Table 4: Descriptive Statistics of the Extent to Which Climate Control Management Techniques Required by Tertiary Institutions Agricultural Education Students For Greenhouse Farming In Bauchi State, Nigeria.

Items	N	Mean	Std. D	Remarks
Regulate greenhouse temperature techniques	49	3.51	.023	HR
Controlling relative humidity techniques	49	3.18	.112	R
Ventilation systems techniques	49	3.76	.217	HR
Shading techniques to reduce heat stress	49	4.02	.878	HR
Techniques in using cooling systems	49	3.47	.174	R
Heating techniques for cold periods	49	3.13	.235	R
Drought control techniques	49	3.24	.164	R
Techniques for growth deficiencies detector	49	3.31	.004	R
Crops rotation techniques	49	3.78	.919	HR
Grand Mean		**3.50**	**.303**	**HR**

Note: N= Number of respondents; Std. D= standard deviation; HR = Highly required; R= Required

Hypothesis one

There is no significant difference between the mean responses of lecturers and technologists on the extent to which irrigation management techniques are required for effective practice. The statistical evidence from the independent-samples t-test presented in Table 8 indicated that

there was no significant difference between the mean responses of lecturers and technologists on the extent to which irrigation management techniques are required for effective practice. The result showed that lecturers had a mean response of 3.64 (Std. Dev = .571), while technologists had a mean response of 3.66 (Std. Dev = .519). The independent-samples t-test revealed t(47) = -0.118, p = .907, which is greater than the 0.05 level of significance. Since the p-value (.907) is greater than the 0.05 level of significance, the null hypothesis one was accepted. This finding suggests that lecturers and technologists did not differ significantly in their perceptions regarding the extent to which irrigation management techniques are required for effective greenhouse farming practice. Hence, both lecturers and technologists have similar opinions on the importance of irrigation management techniques, indicating a consensus among the respondents regarding the competencies required for effective greenhouse farming in tertiary institutions in Bauchi State, Nigeria.

Table 5: Independent Samples t-test of Difference Between the Mean Responses of Lecturers and Technologists on the Extent to Which Irrigation Management Techniques are Required for Effective Practice

Variable	Groups	N	F	Sig.	t-value	Mean	Std. Dev	p-value	Decision
HMT	Lecturers	32	.301	.586	-.118	3.64	.571	.920	Accepted
	Technologists	17				3.66	.519		

Note: N=Number of students; Std. Dev= Standard deviation; IMT= Irrigation Management Techniques

Hypothesis two

There is no significant difference between the mean responses of lecturers and technologists on the extent to which housing management techniques are required for effective practice. The statistical evidence from the independent-samples t-test presented in Table 9 indicated that there was no significant difference between the mean responses of lecturers and technologists on the extent to which housing management techniques are required for effective practice. The result showed that lecturers had a mean response of 3.68 (Std. Dev = .412), while technologists had a mean response of 3.66 (Std. Dev = .520). The independent-samples t-test revealed t(47) = 0.102, p = .920, which is greater than the 0.05 level of significance. Since the p-value (.920) is greater than the 0.05 level of significance, the null hypothesis two was accepted. This finding indicates that lecturers and technologists did not differ significantly in their perceptions regarding the extent to which housing management techniques are required for effective greenhouse farming practice. Hence, both lecturers and technologists have similar opinions on the importance of housing management techniques, indicating a consensus among the respondents regarding the competencies required for effective greenhouse farming in tertiary institutions in Bauchi State, Nigeria.

Table 6: Independent Samples t-test of Difference Between the Mean Responses of Lecturers and Technologists on the Extent to which Housing Management Techniques are Required for Effective Practice

Variable	Groups	N	F	Sig.	t-value	Mean	Std. Dev	p-value	Decision
HMT	Lecturers	32	1.123	.295	0.102	3.68	.412	.920	Accepted
	Technologists	17				3.66	.520		

Note: N = Number of respondents; Std. Dev = Standard Deviation; HMT = Housing Management Techniques.

Hypothesis three

There is no significant difference between the mean responses of lecturers and technologists on the extent to which climate control management techniques are required for effective practice. The statistical evidence from the independent-samples t-test presented in Table 10 indicated that there was no significant difference between the mean responses of lecturers and technologists on the extent to which climate control management techniques are required for effective practice. The result showed that lecturers had a mean response of 3.50 (Std. Dev = .593), while technologists had a mean response of 3.47 (Std. Dev = .600). The independent-samples t-test revealed t(47) = 0.145, p = .885, which is greater than the 0.05 level of significance. Since the p-value (.885) is greater than the 0.05 level of significance, the null hypothesis three was accepted. This finding suggests that lecturers and technologists did not differ significantly in their perceptions regarding the extent to which climate control management techniques are required for effective greenhouse farming practice. Hence, both lecturers and technologists have similar opinions on the importance of climate control management techniques, indicating a consensus among the respondents regarding the competencies required for effective greenhouse farming in tertiary institutions in Bauchi State, Nigeria.

Table 7: Independent Samples t-test of Difference Between the Mean Responses of Lecturers and Technologists on the Extent to which Climate Control Management Techniques are Required for Effective Practice

Variable	Groups	N	F	Sig.	t-value	Mean	Std. Dev	p-value	Decision
CCMT	Lecturers	32	.071	.791	0.145	3.50	.593	.885	Accepted
	Technologists	17				3.47	.600		

Note: ***N = Number of respondents; Std. Dev = Standard Deviation; CCMT = Climate Control Management Techniques.***

The findings of the study revealed that irrigation management techniques, housing management techniques, climate control management techniques, and pest control management techniques are highly required, while record management techniques are required by tertiary institutions agricultural education students for effective greenhouse farming in Bauchi State, Nigeria. Furthermore, the results of all five hypotheses showed no significant difference between the mean responses of lecturers and technologists regarding the management techniques required for effective greenhouse farming. This indicates that both categories of respondents shared similar perceptions on the competencies that agricultural education students need to successfully establish and manage greenhouse farming enterprises. The study contributes to the existing body of knowledge by providing empirical evidence on the management techniques required for greenhouse farming among agricultural education students in tertiary institutions. To the best of the researcher's knowledge, there is limited empirical literature addressing greenhouse farming management competencies within the context of agricultural education in Nigeria. More specifically, no published study was found that comprehensively examined irrigation management, housing management, climate control management, pest control management, and record management techniques as the core management competencies required by tertiary institutions agricultural education students for greenhouse farming in Bauchi State. Therefore, the findings of this study provide a important reference for curriculum developers, agricultural educators, policymakers, researchers, and extension practitioners seeking to strengthen greenhouse farming education and promote sustainable agricultural entrepreneurship among graduates.

Conclusion

This study examined the management techniques required by tertiary institutions agricultural education students for greenhouse farming in Bauchi State, Nigeria. The study empirically established that irrigation management techniques, housing management techniques, climate control management techniques, and pest control management techniques are highly required, while record management techniques are required by agricultural education students for effective greenhouse farming. The findings further revealed that there was no significant difference between the mean responses of lecturers and technologists regarding the management techniques required for effective greenhouse farming, indicating a consensus among both categories of respondents. Hence, effective greenhouse farming requires agricultural education students to acquire competencies in irrigation management, housing management, climate control management, pest control management, and record management. Equipping students with these management techniques will enhance their practical knowledge, technical competence, and entrepreneurial capacity for establishing and managing profitable greenhouse farming enterprises. So that graduates of Agricultural Education will be better prepared for self-employment, agribusiness development, and sustainable agricultural production, thereby contributing to food security, employment generation, poverty reduction, and the economic development of Bauchi State and Nigeria at large. These competencies should therefore be adequately integrated into the Agricultural Education curriculum and effectively taught through practical, competency-based instructional approaches to prepare graduates for the demands of modern greenhouse farming.

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