Educational Advancement and Development Journal (EADJ)
Volume 1 Number 2 December 2025, pp 175-183
E-ISSN: 3104-8390
https://neadafrica.com/journals/neadj

Adoption of Green Technologies in School Farms by Agricultural Science Students for Enhancing Food Security in Abia State, Nigeria

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Abstract

The study appraised the adoption of green technologies in school farms by Agricultural Science students for enhancing food security in Abia state, Nigeria. Specifically, it determined: the extent of adoption, challenges and strategies for increasing the adoption of green technologies. Three research questions and three hypotheses guided the study. The study adopted a descriptive survey research design. The population of the study was 23,169, consisting 285 teachers and 22, 884 students of Agricultural Science in Abia State. A multistage sampling method was used to obtain a sample size of 237. Questionnaire was the instrument for data collection. It was validated by experts in Crop Science and Agricultural Education from Michael Okpara University of Agriculture, Umudike. Cronbach Alpha reliability method was used to determine the internal consistency of the instrument. The test yielded a coefficient of 0.83. The researcher and three research assistants administered and retrieved copies of the questionnaire. Data collected were analyzed using mean to answer research questions and t-test to test the null hypotheses at 0.05 level of significance. Findings revealed that Agricultural Science students in Senior Secondary Schools adopt green technologies in school farms to a low extent. It also revealed nine challenges and eight strategies for increasing the adoption of green technologies in school farms. Findings on hypotheses revealed that there was no significant difference in the mean ratings of Agricultural Science teachers and students on the adoption of green technologies in school farms by Agricultural Science students in Abia state, Nigeria. It was recommended among others that, Abia state Government should increase the adoption of green-technologies through advocacy and capacity building programmes in the state.

Keywords: Agricultural Science, Food Security, Green-Technologies, School Farm

History:
Received : October 6, 2025
Revised : October 27, 2025
Accepted : November 30, 2025
Published : December 31, 2025
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INTRODUCTION

In Nigeria, the National Policy on Education provides for the teaching of Agricultural Science in Senior Secondary Schools. Agricultural Science is a Senior Secondary School subject which involves the teaching of the principles of agricultural production, with the aim of preparing students for careers and advancement in agricultural fields (Federal Republic of Nigeria (FRN), 2014). The practical aspects of Agricultural Science is carried out in the school farms.

The school farm is an area of land earmarked for students to carryout practical agriculture; both in crop and livestock production. The farm offers students the opportunity to demonstrate what they have learnt in the classroom (Ebere *et. al.,* 2020). It is also established for income generation to the school (Ekele, 2018). However, in Nigeria, many Agricultural Science students adopt the traditional system of crop farming (Olaitan, 2017). This system exposes the soil to erosion and other hazards (Njoku, 2017). This therefore, is not soil -friendly as it has serious negative impacts on the soil and food production (Kenton, 2022). However,

there are technologies to increase productivity in the farm with less minimal negative impact on the soils in farms.

Technology explains the application of scientific knowledge in production to enhance productivity. According to Aithal and Aithal (2016), technology is a set of process for making, modifying, and using knowledge of tools, machines, techniques, crafts, systems and methods of something. In this study, the scientific knowledge includes not only the equipment and machines but also practical skills for improved agricultural production in the school farm. Some of the technological processes are harmful to the school farm, while others are environmentally friendly. The environmentally friendly technologies are referred to as green technologies; and they are sciences for mitigating or reversing the negative effects of human activities on the natural environment; and repairing the damage due to human activities on the environment (shimirwa, 2020). Green technologies reduce greenhouse emission, environmental degradation, and other agro-soil hazards due to human errors on the soil (Das, 2021; Long, 2019). Examples of green technologies include minimal soil tillage, organic farming, farm robots, drones and digital sensors, (Long, 2019). Regrettably, Wreglesworth (2021), observed that many of these technologies are rarely used in farming because of some socio-economic challenges (Wang & Chen, 2020).

Challenges are difficulties that may arise while performing certain activities. In this study challenges are factors that could hinder effective adoption of green technologies in school farms in Senior Secondary School in Abia state. Creech (2021), named inadequate infrastructure, technical expertise, and awareness about green farm technologies as some of the challenges that hinder the adoption of green technologies. Wreglesworth (2021) further observed that many school principals and teachers still prefer the traditional farming system, instead of the adoption of green technologies. These challenges frustrate schools and individuals wishing to adopt green technologies**,** unless appropriate strategies are adopted to upturn the situation (Brown & Ansong, 2018; Jones & Smith, 2019).

Strategies are approaches for overcoming challenges. In the context of this study, strategies are methods for averting the challenges of adoption of green technologies in school farms by Agricultural Science students in Senior Secondary Schools in Abia state. The strategies include the provision of school farms to students to practice green technology, proper funding of Agricultural Science programme, retraining of Agricultural Science teachers and provision of green infrastructure to the school (Wang & Chem, 2020). Alabi and Adeoti (2021) also named other strategies such as, capacity building workshops for students to enhance their understanding and skills of green technologies, collaboration between schools and green technology companies to access expertise, provisions of grants and funding opportunities, among others. These strategies are crucial for promoting environmentally friendly practices that address food security challenges.

Food security is a serious global issue that has attracted the attentions of various world bodies. According to Food and Agricultural Organization (FAO) (2023), food security is defined as a condition in which people, at all times have physical, social and economic access to sufficient, safe, and nutritious food that meet their dietary needs and food preferences for an active and healthy life. Thus to be food secure, individuals must have access to adequate food at all times and resources to obtain appropriate food for nutritious diet, without risk of losing access to food. Therefore, the adoption of green technologies in agriculture could support food security efforts in Nigeria, making it a vital strategy for sustainable development and climate resilience (Smith & Johnson, 2019).

Despite the growing awareness of the importance of green technologies in agriculture, the level of adoption of these technologies by students in Senior Secondary Schools in Abia state, is not clear. Therefore, there is a need to appraise the adoption of green technologies in school farms by Agricultural Science students, determine the specific challenges faced by the students in their operation of the school farms and decide effective strategies to address these challenges in Senior Secondary Schools in Abia state.

Purpose of the Study

The main purpose of this study was to appraise the extent of the adoption of green technologies by Agricultural Science students for enhancing food security in Abia state, Nigeria. Specifically, the study determined:

1. the extent of adoption of green technologies in school farms by Agricultural Science students in senior secondary schools in Abia state,
2. challenges of adopting green technologies in school farms by Agricultural Science students in Senior Secondary Schools in Abia state, and
3. strategies for increasing the adoption of green technologies in school farms by Agricultural Science students in in Abia state.

Research Questions

The following research questions were posed:

1. What is the extent of adoption of green technologies in school farms by Agricultural Science students in Senior Secondary Schools in Abia state?
2. What are the challenges of adopting green technologies in school farms by Agricultural Science students in Senior Secondary Schools in Abia state?
3. What are the strategies for increasing the adoption of green technologies in school farms by Agricultural Science students in Senior Secondary Schools in Abia state?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance. There is no significance difference in the mean responses of Agricultural Science teachers and students on:

HO_1: the extent of adoption of green technologies in school farm by Agricultural Science students in senior secondary schools in Abia state.

HO_2: challenges of adopting green technologies in school farms by Agricultural Science students in Senior Secondary Students in Abia state.

HO_3: strategies for increasing the adoption of green technologies in school farms by Agricultural Science students in Senior Secondary in Abia state.

METHODOLOGY

Descriptive survey research design was adopted in the study. The study was carried out in Abia State, Nigeria. The state is divided into three education zones, namely: Aba, Umuahia and Ohafia Education Zones. The state was chosen because of the continued utilization of traditional methods and facilities in the teaching of Agricultural Science and need for innovations. The population of the study was 23,169, consisting of 285 Agricultural Science teachers and 22, 884 Agricultural Science students in Abia State. A multistage random

sampling method was used to select a sample size of 237. First stage involved a random sampling of Umuahia Education Zone out of the three Education Zones in the state. In the second stage, two Local Government Areas: Ikwuano and Umuahia North were randomly selected from the four Local Government Areas (Ikwuono, Umuahia North, Umuahia South and Umunneochi) in Umuahia Education zone. The third stage involved the selection of all the 31 Agricultural Science teachers and 206 SS2 students of agricultural science from 21 secondary schools in the two selected Local Government Areas.

Adoption of Green Technologies in School Farm Questionnaire (AGTSFQ) developed by the researcher was used for data collection. The questionnaire sought demographic information and measured respondents' level of responses in the questionnaire. The response scale for each questionnaire item in research question 1, is Very Low Extent (VLE), Low Extent (LE), High Extent (HE) and Very High Extent (VHE) with corresponding values of 4, 3, 2 and 1. For research questions 2 and 3, the response scale is Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) with corresponding value, 4, 3, 2 and 1. The questionnaire was validated by two experts in Crop Science and one in Agricultural Education from Michael Okpara University of Agriculture, Umudike. Cronbach Alpha reliability method was used to determine the internal consistency of the instrument. The test yielded a coefficient of 0.83. The researcher and three research assistants administered and retrieved the questionnaire with a return rate of 98% (232).

Data collected were analyzed using mean to answer research questions, while t-test was used to test null hypotheses at 0.05 level of significance. In deciding the cut-off point, in research question 1, decisions made were guided by the real limit of the mean range of 1.00-1.49 Very Low Extent, 1.50-2.49 Low Extent, 2.50-3.49 High Extent and 3.50-4.49 Very High Extent. In research question 2 and 3, a mean of 2. 50 was set as benchmark for decision making. Any item whose mean was greater than or equal to 2.50 was interpreted as "Agree" while the mean below that was regarded as "Disagree". On null hypotheses tested, the hypothesis of no significance difference was accepted when the t-calculated (t-cal) value was less than the table (t- tab) value at 0.05 level of significance but rejected when t-cal value was greater than t-tab value.

RESULTS

Table 1: Mean Responses on the Extent of Adoption of Green Technologies in School farm by Agricultural Science students in Senior Secondary Schools in Abia state (n=232).

SN	Items on extent of adoption of green technologies	$\bar{X}$	SD	Remarks
	Extent of adoption of green technologies in school farms include:			
1	use of solar panels to generate electricity to power farm facilities.	1.32	0.66	Low Extent
2	transforming organic wastes into compost for fertilizer.	2.57	0.41	High Extent
3	zero or minimal tillage to reduce soil degradation.	1.31	0.45	Very Low Extent
4	harvesting and storing of rain water for irrigation in the school gardens.	2.63	0.73	High Extent
5	use of farm robots to enhance planting, weeding and harvesting.	1.21	0.52	Very Low Extent
6	use of farm drones to provide data on crop health, pest infestation and irrigation needs.	1.38	0.55	Very Low Extent
7	place digital sensors in the field to monitor soil moisture and nutrient level.	1.14	0.61	Very Low Extent
	Grand Total	**1.65**	**0.56**	**Low Extent**

Key: x = Mean, SD=Standard Deviation, N=Number of Respondents, NS=Not Significant.

Table 1 shows that the mean values of items 1, 3, 6 and 7 ranged between 1.10 and 1.38 which were within the real limit of the number range 1.00-1.49. This means that the respondents indicated a very low extent responses. The Table also shows that the mean values of items 2 and 4 ranged between 2.57 and 2. 63 which were within the real limit of the number range 2.50-3.49. This means that the respondents indicated a high extent mean responses. The grand mean of 1.65 which falls within the real limit of numbers range of 1.50-2.49 that the Agricultural Science students to a low extent adopt green technologies in school farms in Senior Secondary Schools in Abia state. The grand standard deviation of 0.56 means that the respondents were not far from the mean and from the opinions of one another in their responses.

Table 2: Mean Results of Responses of Agricultural Science Teachers and Students on Challenges of adopting Green Technologies in school farms by students in Senior Secondary Schools in Abia state (n=232).

SN	Items on Challenges of adopting green technologies	$\bar{X}$	SD	Remarks
	The challenges of adoption include:			
8	lack of school farms to practice green technologies.	2.86	0.79	Agreed
9	less emphasis on farm practical in some of the schools.	3.93	0.69	Agreed
10	high cost of green technology facilities in the state.	3.20	0.68	Agreed
11	low level of awareness on green technology in Abia State.	3.68	0.86	Agreed
12	insufficient knowledge and skills to effectively operate green technologies in school farm plots.	2.86	0.69	Agreed
13	teachers and students in the state still prefer the traditional farming methods.	2.67	0.93	Agreed
14	use of school farm basically for income generation instead of for teaching and learning.	3.86	0.83	Agreed
15	some soil types in the school farm may not support green farming technology.	3.44	0.77	Agreed
16	*Inadequate training workshops on green technologies in school farms in Abia state*	2.99	0.88	Agreed
	Grand Mean/SD	**3.31**	**0. 78**	**Agreed**

Key: X = Mean+ of Respondents, SD = standard Deviation, N = Number of Respondents.

Table 2 shows that all the nine items obtained mean scores above the cut-off point of 2.50. This means that the respondents agreed that the items are challenges of adopting green technologies in school farms in Abia state. The standard deviation of the responses of the teachers and students on the nine items ranged from 0.68 to 0.93, indicating that the respondents were not far from the mean and from the opinions of one another in their responses. The grand mean score of 3.31, which was above the cut-off point of 2.50, showed that the items are challenges of adopting green technologies in school farms by Agricultural Science students in Abia state. The grand standard deviation of 0.78 means that the respondents were not far from the mean and from the opinions of one another in their responses.

Table 3: Mean Results of Responses of Agricultural Science Teachers and Students on strategies for increasing the adoption of green technologies by Agricultural Science students in Senior Secondary in Abia state (232)

SN	Items on strategies for increasing adoption	$\bar{X}$	SD	Remarks
	The strategies include:			
17	provision of land for school farm.	3.15	0.69	Agreed
18	capacity building workshops for teachers and students to enhance their skills of green technology.	2.91	0.71	Agreed
19	collaboration between schools and green technology companies for technical support.	3.15	0.67	Agreed
20	provision of grants and loan facilities to schools.	3.38	0.61	Agreed
21	provision of demonstration farms that are in line with green farm technologies.	3.28	0.67	Agreed
21	setting up of committees for planning and implantation of green technology initiatives in schools.	3.02	0.65	Agreed
22	integrating green technologies into school curriculum.	3.21	0.69	Agreed
23	increasing awareness of green technology in Abia state.	3.44	0.56	Agreed
	Grand	3.10	0. 66	Agreed

Key: X = Mean of Respondents, SD = Standard Deviation, N = Number of Respondents.

Table 3 indicates that all the eight items obtained mean scores above the cut-off point of 2.50. This means that the respondents agreed that the items are strategies for increasing the adoption of green technologies in school farms in in Abia state. The standard deviation of the responses of the teachers and students on the eight items ranged from 0.8 to 0.93, indicating that the respondents were not far from the mean and from the opinions of one another in their responses. The grand mean scores of 3.10 were above the cut-off point of 2.50, confirms that they are strategies for increasing the adoption of green technologies in school farms by Agricultural Science students in Senior Secondary Schools in Abia state. The grand standard deviation of 0.66 means that the respondents were not far from the mean and from the opinions of one another in their responses.

Table 4: t-test Results of Responses of Agricultural Science Teachers and Students on the Extent of Adoption of Green Technologies in school farms by Agricultural Science students in Senior Secondary Schools in Abia state (n=232).

Respondents	N	Mean	SD	Df	t-cal	t-tab	Decision
Teachers	31	3.16	1.14	230	0.49	1.68	Not Significant
Students	201	2.96	0.85				Rejected

Table 4 reveals that t-calculated value (t-cal) value of 0.49 was less the than the t-table (t-tab) value of 1.68 at 0.05 level of significance and 230 degree of freedom. Since the calculated t-value is less than the table value, the null hypothesis of no significant difference in the mean responses of teachers and students of Agricultural Science on extent of adoption of green technologies in school farms in Senior Secondary Schools in Abia state was accepted.

Table 5: t-test Results of Responses of Agricultural Science Teachers and Students on challenges of adopting green technologies in School Farms by Agricultural Science student in Senior Secondary Schools in Abia state (n=232).

Respondents	N	Mean	SD	Df	t-cal	t-tab	Decision
Teachers	31	3.07	0.71	230	0.63	1.68	Not Significant
Students	201	3.12	0.69				

Table 5 reveals that t-calculated value (t-cal) value of 0.63 was less the than the t-table (t-tab) value of 1.68 at 0.05 level of significance and 230 degree of freedom. Since the calculated t-value is less than the table value, therefore the null hypothesis of no significant difference in the mean responses of Agricultural Science and students on the challenges of adopting of green technologies in school farms by Agricultural Science teachers in Senior Secondary Schools in Abia state was accepted**.**

Table 6: t-test Results of Responses of Agricultural Science Teachers and Students on Strategies for increasing the Adoption of Green Technologies in School Farms by Agricultural Science students in Senior Secondary in Abia state (n=232).

Respondents	N	Mean	SD	Df	t-cal	t-tab	Decision
Teachers	31	3.16	1.24	230	0.39	1.68	Not Significant
Students	201	2.96	0.85				Rejected

Table 6 reveals that t-calculated value (t-cal) value of 0.39 was less the than the t-table (t-tab) value of 1.68 at 0.05 level of significance and 230 degree of freedom. Since the calculated t-value is less than the table value, the null hypothesis of no significant difference

in the mean responses of teachers and students of Agricultural Science on strategies for increasing the adoption of green technologies in school farms by Agricultural Science students in Senior Secondary in Abia state was accepted.

Discussion of Findings

Table 1 showed that Agricultural Science students to a low extent adopt green technologies in Senior Secondary Schools in Abia state. The result specifically revealed that the students to a low extent: use solar panels to generate electricity to power farm facilities, transform organic waste into compost, carry out minimum tillage, harvest and stores rain water, use farm robots to enhance planting among others. These findings are in line with the opinions of Smith and Johnson (2019) who observed that zero tillage, organic farming, farm robots, drones and digital sensors are rarely used in secondary schools for farming. The study also confirms the submissions of Wang and Chen (2020) that certain socio-economic factors frustrate the adoption of green technologies in secondary schools.

Table 2 revealed challenges of adopting green technologies by Agricultural Science students in school farms in Senior Secondary Schools: lack of school farms to practice green technologies, less emphasis on farm practical in some of the schools, high cost of green technology facilities in the state, low level of awareness on green technology in Abia State, insufficient knowledge and skills to effectively operate green technologies, resistance to change, among others. These findings agree with Creech (2021) who said that inadequate infrastructure, technical expertise, and awareness about green farm technologies are some of the challenges. The finding also agree with Wreglesworth (2021) who said that many school principals and teachers are resistant to change and still prefer the traditional farming system.

Table 3 revealed strategies for increasing the adoption of green technologies in school farms by Agricultural Science students in Senior Secondary in Abia state. The strategies include among others: provision of land for school farm and green technology practices, capacity building workshops for students to enhance their knowledge and skills of green technology, collaboration between schools and green technology companies for technical support, provision of school farms for students to practice farming and provision of grants and funding opportunities. These findings were in line with Wang and Chen (2020) who agreed that provision of school farms to students to practice green technology, proper funding of agricultural science programmes and provision of green infrastructure to the school are strategies to increase green technology adoption. The findings also confirmed the opinions of Alabi and Adeoti (2021) that capacity building workshops for teachers and students enhance their understanding and skills in green technologies.

It was also found out that there was no significance difference in the mean ratings of the opinions of Agricultural Science teachers and students on the extent of adoption, challenges for adoption and strategies for adoption of green technologies by Agricultural Science students for enhancing food security in Abia state, Nigeria. Therefore, the null hypotheses were accepted. The opinions of the authors cited have helped to add credence to the validity of the study.

CONCLUSION

The study established that Agricultural Science students in Senior Secondary Schools experience some challenges in the adoption of green technologies in school farms in Abia State. This development provided a research opportunity to ascertain the extent of adoption, the challenges and strategies to promote the adoption of the green technologies. The study had

therefore, provided information on challenges and strategies for promoting the adoption of green technologies in school farms by students in Senior Secondary Schools in Abia state. This is the gap the study has filled.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:

1. The Secondary Education Management Board should sanction schools that do not own farms.
2. The Abia state Ministries of Education and Agriculture should create greater awareness for the adoption of green technologies in school farms and in the society generally.
3. There should be collaboration between the secondary schools, agricultural extension agents and green technology industries to strengthen the skill base of teachers and students on green technologies.

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