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COST AND YIELD ANALYSIS OF DRIP IRRIGATED GREEN PEPPER UNDER POLY-HOUSE AND OPEN-FIELD CONDITIONS

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ABSTRACT

Cost and yield analysis are crucial for optimizing crop production in Nigeria, especially for ensuring the sustainable and profitable cultivation of vegetables. This study evaluates the economic viability and productivity of drip-irrigated pepper cultivation in poly-house and open-field environments. Drip irrigation is an effective solution to water scarcity by delivering water directly to plant roots. Green pepper (California wonder), samples used for demonstration in this study were obtained from Dizenghoff W.A. Nigeria Limited, Ibadan, Nigeria. The experiment was conducted at the Teaching and Research Farm of the Federal Polytechnic, Ado-Ekiti, Nigeria during the 2020/2021 and 2021/2022 growing seasons. The research compares the costs and yields of green pepper cultivation in these two conditions in the 2020/2021 and 2021/2022 growing seasons. The poly-house environment, despite incurring higher costs (₦160,650 and ₦119,200), consistently produced significantly higher yields than open-field cultivation. The open-field costs were reduced from ₦81,650 to ₦35,705 over the two years. Revenue from poly-house cultivation was higher (₦124,740 and ₦95,040) compared to the open-field method (₦87,300 and ₦64,980). The yields decreased in the second year for both conditions, the poly-house consistently outperformed the open-field in terms of productivity. The study shows that reducing input costs for poly-house cultivation could make it more attractive to farmers, potentially leading to higher yields and revenue. These findings contribute to sustainable agricultural practices by demonstrating how optimizing resource use in different environments can enhance crop resilience and profitability

KEYWORDS: Cost; yield; analysis; drip irrigated; green pepper; poly-house; open field conditions

INTRODUCTION

Green pepper, botanically known as *Capsicum annuum*, is an economically significant crop worldwide, valued for its culinary uses, nutritional benefits, and pharmaceutical properties (Channabasavanna & Setty, 2000). In recent years, with the increasing demand for high-quality produce and the need for sustainable agricultural practices, there has been a growing interest in optimizing cultivation techniques to enhance productivity while minimizing resource use (Aliyu, 2000). Among these techniques, drip irrigation has emerged as a promising method for improving water use efficiency and yield in pepper cultivation, particularly in both poly-house and open-field conditions (Onuigbo et al., 2020).

Traditional methods of irrigation, such as flood irrigation or overhead sprinklers, often lead to water wastage, inefficient nutrient delivery, and increased susceptibility to diseases (Olayemi et al., 2021). In contrast, drip irrigation delivers water and nutrients directly to the root zone of plants, minimizing losses due to evaporation and runoff while promoting healthier root development and optimal growth conditions. This technology has gained popularity

worldwide, especially in regions facing water scarcity or erratic rainfall patterns.

The use of poly-houses in agriculture has revolutionized crop production by providing a controlled environment that shields plants from adverse weather conditions, pests, and diseases (Olayinka et al., 2019). Combined with drip irrigation, poly-house cultivation offers even greater potential for maximizing yields and quality while reducing production risks (Wiltshire, 2007). However, the adoption of these technologies often entails higher initial investment costs, prompting the need for comprehensive cost and yield analyses to assess their economic viability and potential benefits to farmers (Olatunde et al., 2020).

Despite the recognized benefits of drip irrigation and poly-house cultivation, there remains a gap in the literature regarding the cost-effectiveness and comparative performance of these techniques, particularly in the context of pepper production (Aruna & Sudagar, 2010). Limited empirical evidence exists on the economic implications of adopting drip irrigation systems in both poly-house and open-field settings, hindering informed decision-making among growers and policymakers. Furthermore, variations in climatic conditions, soil types, management practices, and market dynamics further complicate the assessment of cost and yield factors in pepper cultivation. The research aims to conduct a cost and yield analysis of drip-irrigated green pepper production under both poly-house and open-field conditions.

This study is of paramount importance to address a critical knowledge gap by providing empirical data on the economic implications of drip irrigation adoption in green pepper cultivation, thereby assisting farmers, agronomists, and policymakers in making informed decisions regarding technology adoption and resource allocation. The research will also compare the performance of drip-irrigated green peppers under poly-house and open-field, elucidating the relative advantages and challenges associated with each approach, and enabling stakeholders to optimize production strategies based on local conditions and objectives. The findings of this study are expected to contribute to the broader discourse on sustainable agriculture and water resource management, as efficient irrigation practices play a crucial role in mitigating the environmental impacts of crop production and ensuring food security in the face of climate change.

MATERIALS AND METHOD

Study location

The study was carried out at the Teaching and Research Farm of the Federal Polytechnic, Ado-Ekiti, Nigeria as shown in Figure 1. The study area is located on Longitude 4^{o} 45^{1} to 5^{o} 45^{1} E and Latitude 7^{o} 15^{1} to 8^{o} 5^{1} N. The mean minimum and the maximum temperatures of the study area are 27 and 30^{o}C, respectively (Olaniyi et al., 2010). The study area is characterized by highly seasonal rainfall with distinct wet (April – October) and dry (November – March) seasons.

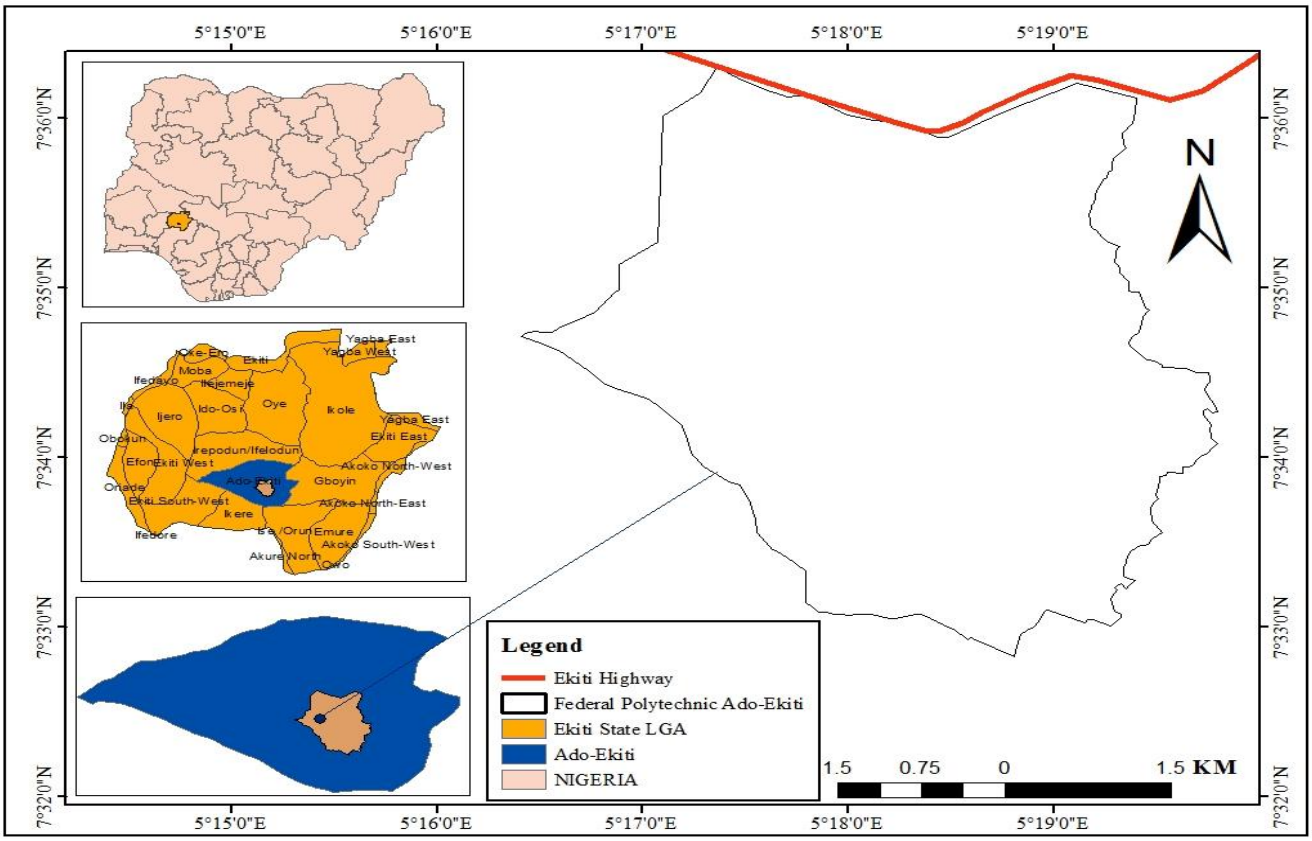

Figure 1: Map of the study area (Source: Office of the Surveyor General, Ekiti State, 2018)

Experimental design

The study employed a randomized complete block design (RCBD) with three replications for each treatment. Two main treatments were investigated: drip-irrigated green pepper cultivation in poly-house conditions and open-field conditions.

Plant material

Healthy and uniform pepper seeds of a *California Wonder* variety obtained from Dizenghoff West Africa Limited, Ibadan were transplanted into both poly-house and open-field plots. The California *Wonder* was chosen for its adaptability and high-yield potential.

Drip irrigation system

A drip irrigation system was installed in both poly-house and open-field plots to deliver water and nutrients directly to the root zone of the pepper plants. The drip lines were installed on the raised beds and connected to a water source.

Cultural practices

Standard agronomic practices were followed throughout the experimental period, including land preparation, bed preparation, transplanting, weeding, and pest management. Fertilizer application rates and schedules were based on soil test results and crop nutrient requirements. Table 1 showed that weed presence contributed to lower yields in the open field during both growing seasons. The open field is more prone to weed, insect, and pest infestations compared to a poly-house, leading to a reduction in crop yield and an increase in weeding and pest management costs.

Initial Investment Costs

The costs associated with installing drip irrigation systems in both poly-house and open-field plots were recorded, including equipment purchase, installation labour, and infrastructure expenses.

Operational costs

Costs incurred during the production cycle, such as the cost of procuring the poly-house, cost of procuring the irrigation system, cost of installing the drip irrigation system, weeding, labour costs for maintenance and management, and expenses for fertilizers and agrochemicals, were documented.

Yield parameters

Yield-related data, including total fruit yield and marketable yields, were documented.

Data analysis

Collected data were subjected to statistical analysis using the appropriate Statistical Package for Social Scientists (SPSS v. 20) software. Analysis of variance (ANOVA) was performed to determine significant differences between treatment means, and means were separated using Tukey's Honestly Significant Difference (HSD) test at a predetermined 5% significance level.

Replication and statistical analysis

Data from the replicated experimental units were statistically analyzed to assess the significance of treatment effects on cost parameters, yield components, and water productivity indicators. The results were interpreted to conclude the economic feasibility and performance of drip-irrigated pepper cultivation under poly-house and open-field conditions.

RESULT AND DISCUSSION

The results presented in Table 1 showed a comparative analysis of the costs and yields associated with green pepper production in poly-house and open-field conditions during the 2020/2021 and 2021/2022 growing seasons. The data highlight significant differences in production costs, revenues, and resulting profits or losses between the two environments and across the two years.

Table 1: Cost and yield analysis of green pepper grown in poly-house and open-field conditions during 2020/2021 and 2021/2022 growing seasons

Environment	Poly-house			Open field	
Production year	2020/2021	2021/2022		2020/2021	2021/2022
Poly-house (Lease)	110,000	110,000	Land lease	24,000	24,000
Green pepper seed	600	600	Green pepper seed	600	600
Drip line	20,000	-	Drip line	20,000	-
Connector	750	-	Connector	750	-
Land and bed preparation	3,000	3000	Land and bed preparation	6,000	6,000
Fertilizer	1,750	1,750	Fertilizer	1,750	1,750
Potting soil	2,250	2,250	Potting soil	2,250	2,250
Seed tray	3000	-	Seed tray	3000	-
Sprayer	1,200	-	Sprayer	1,200	-
Insecticide	1,100	1,100	Insecticide	1,100	1,100

Storage tank	5,000	-	Storage tank	5,000	-
Stanchion	4,000	-	Stanchion	4,000	-
Well water	7,500	-	Well water	7,500	-
Weeding	500	500	Weeding	4500	4.500
Total cost	160,650	119,200	Total cost	81,650	35,705
Revenue @ 1,800/kg			Revenue		
Fruit weight @ 15, 20.3kg	36540		Fruit weight @ 15, 13.3kg	23940	
Fruit weight @ 16, 29.2kg	52560		Fruit weight @ 16, 21.0kg	37800	
Fruit weight @ 17, 19.8kg	35640		Fruit weight @ 17, 14.2kg	25560	
Fruit weight @ 15, 14.6kg		26280	Fruit weight @ 15, 9.5kg		17100
Fruit weight @ 16, 23.5kg		42300	Fruit weight @ 16, 17.8kg		32040
Fruit weight @ 17, 14.7kg		26460	Fruit weight @ 17, 8.8kg		15840
Total Revenue	**124,740**	**95,040**		**87300**	**64,980**
Profit / Deficit	-35,910	-24,160		5,650	29,276

Cost analysis

In the poly-house environment, the total production costs for both years remained consistent at ₦160,650 in 2020/2021 and ₦110, 200 in 2021/2022 reflecting stable expenses across various input categories such as land lease, seeds, drip line, fertilizers, and equipment. Conversely, in the open-field setting, total costs varied substantially between the two years, with a notable decrease from ₦81,650 in 2020/2021 to ₦35,705 in 2021/2022. This reduction can be attributed to changes in input costs, weeding, and other operational expenses.

Yield and yield components analysis

Regarding yield, the poly-house environment consistently outperformed the open field in terms of total revenue generated from green pepper sales. Despite facing higher production costs, the poly-house cultivation yielded significantly higher revenues, indicating better productivity and marketable yields. However, it is worth noting the variability in fruit weight across different years and environments, which may impact overall profitability and market competitiveness.

The results of the yield and yield components of the green pepper crop cultivated in both poly-house and open-field conditions during the 2020/2021 and 2021/2022 growing seasons are presented in Table 2 and Plate 1.

Table 2: Yield traits of green pepper grown in poly-house and open-field conditions

		2020/2021		2021/2022	
		Total No of Fruit -	Fruit Weight, kg/m^2	Total No of Fruit -	Fruit Weight kg/m^2/mm
Poly-house	I5	226.3b	20.3b	166.7b	14.6b

	I6	296.7a	29.2a	212.7a	23.5a
	I7	227.7b	19.8b	160.0b	14.7b
	SEM	3.45	0.66	2.70	0.46
Open-field	I5	160.0b	13.3b	126.3b	9.5b
	I6	224.3a	21.0a	155.3a	17.8a
	I7	163.0b	14.2b	120.0b	8.8b
	SEM	3.41	0.33	3.57	0.21
Poly x	PH	250.2A	23.1A	179.8A	17.6A
Open-field	OF	182.4B	16.2B	133.9B	12.0B
	SEM	11.19	1.40	7.18	1.47

I_5: five irrigations per week; I_6: six irrigations per week; I_7: seven irrigations per week; PH: poly-house; OF: open-field~ SEM: standard error of the mean. Values in a column followed by different letters differed significantly at a 5% level of probability by the Tukey test.

Plate 1: Harvested fresh fruits of green pepper

In the 2020/2021 growing season, the total number of fruits was significantly ($p < 0.05$) higher in the I_6 treatment compared to I_5 and I_7 treatments by about 23% in the poly-house and 28% in the open-field. Similarly, fruit weight was higher ($p < 0.05$) in the I_6 treatment than from the I_5 and I_7 treatments by about 31% in the poly-house and 37% in the open field. In the second growing season, a similar trend was observed however the fruit weight increased further in I_6 treatment by 7% (poly-house) and 13% (open-field) compared to I_5 and I_7 treatments.

The poly-house had a total number of fruits and fruit weight significantly higher ($p < 0.05$) by about 27% and 30%, respectively than the open-field in the 2020/2021 growing season. In the 2021/2022 growing season, the difference in the total number of fruits between the two cropping environments decreased by about 2% while the difference in fruit weight increased by about 2% in comparison to the previous growing season.

Profitability analysis

This study investigates the economic viability and productivity of drip-irrigated pepper cultivation in Nigeria, comparing pol-house and open-field environments. Drip irrigation, which efficiently delivers water to plant roots, is increasingly important due to water scarcity in agriculture. The research assesses the costs and yields of pepper cultivation across two seasons (2020/2021 and 2021/2022). The findings reveal that pol-house cultivation, despite higher costs (N160, 650 and N119, 200), consistently produced greater yields than open-field

cultivation, where costs were lower and declined from N81, 650 to N35, 705. Revenue from pol-house cultivation (N124, 740 and N95, 040) also exceeded that from open-field methods (N87, 300 and N64, 980). The pol-house cultivation incurs higher initial expenses, and its substantially higher yield suggests the potential for increased profitability, particularly if input costs are reduced. The study highlights the importance of optimizing resource use for sustainable agriculture and suggests that enhancing cost efficiency in pol-house cultivation could encourage wider adoption and boost overall agricultural productivity.

The higher crop performance observed in the poly-house condition shows the potential advantages of controlled environments for promoting plant growth. These findings align with the results of Rameshi and Arunugam (2010); Patil et al. (2020), Shende et al. (2020), and Joshi et al. (2019) on capsicum, sweet pepper, tomato, cucumber, and other vegetables grown under poly-house and open-field conditions.

CONCLUSIONS AND RECOMMENDATIONS

The cost and yield analysis of drip-irrigated pepper production under poly-house and open-field conditions reveals distinct advantages and challenges associated with each environment. While poly-house cultivation offers higher yield potential and marketability, it entails higher initial investment and operational costs. Conversely, open-field cultivation presents cost-saving opportunities but is more vulnerable to yield variability and market risks. Based on these findings, it is recommended that farmers carefully assess their specific production objectives, resources, and risk tolerance when choosing between poly-house and open-field cultivation methods. Additionally, strategies to optimize resource use efficiency, minimize production costs, and mitigate yield variability should be prioritized through proper irrigation management, integrated pest management practices, and market-oriented crop planning. Further research and extension efforts are warranted to provide tailored recommendations and support to pepper growers for sustainable and profitable production practices. The use of poly-house is therefore recommended for the production of green pepper in the study area.

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