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Adoption of climate-smart microgardening practices for root and tuber crops in urban households: A case of Abia state, Nigeria

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ABSTRACT

This study examined the adoption of climate-smart microgardening practices among urban households, with a focus on the cultivation of root and tuber crops, specifically yam, cocoyam, and cassava. The research highlights innovative approaches to urban farming that align with sustainable development goals in light of climate change. The study surveyed 33 households that practice microgardening in Umuahia and Umudike, Abia state, using a snowball sampling technique. Among the respondents, 57.6% grow yams, while 9% cultivate cocoyam and 3% cassava in mainly bags and tyres. Key findings indicate that microgardening reduces household food expenses (mean = 3.64), and promotes the adoption of climate-smart agricultural practices, such as zero use of inorganic fertilizer (mean = 3.15), organic pest and disease control (mean = 3.36) and the recycling of cultivation materials (mean = 3.15). Social and economic benefits include increased access to fresh and nutritious food (mean = 3.93), improved interaction with neighbors (mean = 3.42), and opportunities for skill development (mean = 3.67). However, challenges such as limited space, difficulty in watering during dry seasons, and the high cost of inputs persist. Regression analysis revealed that socioeconomic factors, like age (10%) and income (5%), positively influenced the adoption of climate-smart practices, while experience in microgardening (5%) has a negative impact on adoption. This study underscores the importance of leveraging climate-resilient technologies to enhance the sustainable management of root and tuber crops in urban environments, contributing to food security, poverty alleviation, and economic development.

KEY WORDS: *Microgardening*; *Climate-smart practices*; *Root and tuber crops*; *Urban households*

1. Introduction

The accelerated urbanization of towns and cities in developing countries has created unprecedented challenges, including food insecurity and malnutrition. By 2050, urban populations in the poorest nations are projected to triple, intensifying the strain on food systems and nutrition. Currently, approximately 815 million people face chronic hunger, with more than half living in urban environments (FAO, 2014). This situation is further exacerbated by the prevalence of overweight and obesity among over 800 million people globally. Addressing the food and nutrition requirements of urban populations is a critical challenge, requiring innovative, sustainable solutions.

Microgardening, a small-scale container-based farming approach, presents a viable solution to

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these challenges. It enables the cultivation of diverse crops, including vegetables, roots, tubers, and herbs, in limited urban spaces such as patios, rooftops, and balconies (FAO, 2014). This method exemplifies resource efficiency, producing higher yields with minimal inputs like water, space, and labor while reducing the reliance on pesticides and mineral fertilizers. By shortening supply chains, microgardens minimize food waste, greenhouse gas emissions, and transportation needs, aligning with climate-smart agricultural practices (Climate Action, 2010).

Specifically, microgardens hold promise for addressing nutritional deficits in urban areas. A one-square-meter microgarden can produce up to 36 heads of lettuce in 60 days, 200 tomatoes annually, or 10 cabbages every 90 days (FAO, 2014). This capability supports low-income families in meeting their dietary needs, particularly for vitamins and minerals, and contributes to achieving the FAO/WHO-recommended daily intake of 400 grams of fruits and vegetables (WHO, 2003).

Beyond nutrition, microgardening offers social, economic, and environmental benefits. It reduces household food expenses, enhances access to fresh produce, and creates opportunities for skill development and community interaction. Environmentally, it promotes sustainable practices such as recycling cultivation materials, zero-tillage, and rainwater harvesting (Ba & Ba, 2007; Metropolis, 2014). As an agricultural innovation, microgardening is especially relevant for densely populated urban areas with limited space and water resources, making it a crucial tool for urban food security and resilience. This study examines the adoption of climate-smart microgardening practices among urban households in Abia State, Nigeria, focusing on root and tuber crops such as yam, cassava, and cocoyam. By highlighting the socioeconomic and environmental impacts, the study underscores the potential of microgardening as a sustainable strategy to enhance food security, reduce poverty, and mitigate climate change in urban contexts.

2. Material and Methods

The study was conducted in Umuahia (Urban Area) and Umudike (Peri-urban Area)**,** in Abia State, Nigeria. These locations were purposively selected due to their growing involvement in urban agriculture and microgardening activities. The increasing urbanization of these areas make them suitable setting for exploring the adoption of climate-smart microgardening practices.

A cross-sectional survey design was adopted to collect data from urban households practicing microgardening.

The study employed a snowball sampling technique to identify and interview participants. This approach was chosen due to the relatively small and dispersed population of households actively engaged in microgardening in the study area. The snowball technique relied on initial respondents referring other eligible households, enabling access to a network of participants. A total of 33 households practicing microgardening participated in the study. Data were collected using a structured questionnaire.

The collected data were analyzed using descriptive and inferential statistical tools. A linear regression model was employed to examine the relationship between socioeconomic characteristics (age, income, experience) and the adoption of climate-smart practices**.**

2.1 Model specification

The regression model was specified as:
$Y=\beta0+\beta1X1+\beta2X2+\beta3X3+\beta4X4+\beta5X5+\epsilon Y$
Where:

- Y = Adoption of climate-smart microgardening practices
- β0 = Constant term
- X1 = Age
- X2 = Sex
- X3 = Years of Experience
- X4 = Income Realized from Microgardening
- X5 = Level of Education
- ϵ = Error term

3. Results and Discussion

Table 1 shows the socioeconomic profile of the respondents.

The study reveals that women (57.6%) who were mostly married (78.8%) dominate microgardening, underscoring its potential as a family-centered and gender-sensitive practice. The majority of respondents are middle-aged (63.6%, mean age 41.9 years), with larger households (average of six members) relying on microgardening for food security. High educational attainment (average 18 years) supports the adoption of climate-smart technologies, though moderate experience levels (average 8 years) highlight the need for continuous learning. Low cooperative membership (27.3%) indicates untapped opportunities for collective benefits, while limited access to extension services (75.8% without contact) highlight a critical gap in technical support and outreach efforts. By implication, the socioeconomic profile suggests that microgardening is particularly relevant to middle-aged, educated women in urban settings. Challenges such as limited cooperative membership and lack of extension service visits hinder broader adoption.

Table 1: Socioeconomic characteristics of the respondents

Option	Frequency	Percentages	Mean
Age			
21-35	7	21.2	
36-50	21	63.6	
51-65	5	15.2	
			41.9
Sex			
Male	14	42.4	
Female	19	57.6	
Marital status			
Married	26	78.8	
Not married	7	21.2	
Education level			
Non formal	0	0	
Primary	2	6.1	
Secondary	6	18.2	
Tertiary	25	75.7	
			18
Household size			
1-5	18	54.5	
6-10	15	45.5	
			6
Years of microgardening experience			
1 – 10	23	69.7	
11 – 20	9	27.3	
21 – 30	1	3.00	
			8
Cooperative membership			
Yes	9	27.3	
No	24	72.7	
Extension contact			
Yes	8	24.2	
No	25	75.8	

Source: Field Survey, 2024

The materials used for microgardening in the surveyed households show that bags are the most commonly used material (Table 2), adopted by 84.8% of the respondents. This is followed by tyres at 12.12%, and plastics at 9.09%. Notably, no respondents reported using wood for microgardening, indicating a preference for easily accessible and durable materials like bags and tyres.

Table 2: Materials used for microgardening

Type of Material	Frequency	Percentage
Plastic		
Yes	3	9.09
No	30	90.9
Tyres		
Yes	4	12.1
No	29	87.9
Bags		
Yes	28	84.8
No	5	15.2

Source: Field Survey. 2024

Results of the 5-point Likert scale revealed that the respondents perceived that microgardening offers significant economic, social, and environmental benefits to households (Table 3). These include:

Economic Benefits: It reduces household food expenses (Mean = 3.64), increases access to fresh, nutritious food (Mean = 3.93), and ensures year-round food production and availability (Mean = 3.42) (Table 3).

Social Benefits: It fosters better interaction with neighbors (Mean = 3.42), creates opportunities for skill development (Mean = 3.67), increases sense of fulfillment (Mean = 3.42) and reduces the stress of field cultivation (Mean = 3.27) (Table 3).

Environmental Benefits: Households acknowledged the environmental value of microgardening such as zero use of synthetic fertilizers (Mean = 3.15), organic pest control (Mean = 3.36) and biodiversity (Mean = 4.40) (Table 3).

Resource Management: Efficient use of small space (Mean = 3.97), recycling of waste (Mean = 4.18), and re-use of old materials like plastics, bags (Mean = 3.15) (Table 3).

Table 3: Benefits of adopting climate-smart agricultural practices

S/N	Benefits	Total	Mean
1	Reduces household food expenses	3.64	1.29
2	Increases interaction with neighbors	3.42	1.54
3	Opportunity for urban dwellers to learn new skills	3.67	1.47
4	Increases sense of fulfillment	3.42	1.52
5	Reduces stress of cultivating in the field	3.27	1.63
6	Increases access to fresh and nutritious food within the household	3.94	1.71
7	Improves food production and availability all year round	3.42	1.60
8	Increases efficiency in use of little space	3.97	1.72
9	Zero use of synthetic fertilizer	3.15	1.82
10	Use the microgarden waste e.g leaves, grass clippings or straw as mulch	4.18	0.88
11	Re-use of old materials e.g plastics, bags	3.15	1.66
12	Management of weeds, pest and diseases without using synthetic chemicals.	3.36	1.56
13	Biodiversity	4.39	0.93

Source: Field Survey; Mean score= 3.00: N = 33

With all variables scoring above the mean score of 3.0, the respondents perceive microgardening as highly beneficial. The practice not only supports food security but also enhances social, personal, and environmental well-being, making it a valuable climate-resilient strategy for urban households.

Financial Constraints: These are constraints related to financial resources for expanding operations, purchasing inputs, and managing activities. The constraints include: "Money to adopt new recommendations," "Lack of financial support," "Lack of funds to expand," "Problem of finance," "Finance for pest and disease control," "Lack of funds for acquiring more bags, and poultry manure." Financial constraints (21.2%) are the most significant challenge faced by respondents (Table 4).

Resource Access: Challenges with obtaining seeds, soil, and other essential inputs. These constraints include “Accessing good and healthy seeds”, “Gathering of soil”, “Insufficient nutrients for crops”, “Some microgarden requirements are difficult to obtain” (Table 4).

Infrastructure and Space: Challenges related to land space, storage, and structural requirements. These include “Lack of space to keep bags”, “Space to plant”, “Land space and livestock menace (e.g., goats and sheep)”, “Bags tear and require replacement”. Infrastructure and space issues (15.2%) and resource access (12.1%) follow closely, indicating operational and structural barriers (Table 4).

Environmental Challenges: These are issues with water supply, irrigation, and nutrient depletion during farming. These include: "Irrigation will always be a problem during the dry season," “Water supply”, “Dry season causes plants to dry up”, “Soil loses nutrients at a fast rate” (Table 4).

Pest and Disease Control: These are challenges in managing pests and diseases. These include: “Controlling pests and diseases”, “Lack of skills in pest control for peppers and vegetables” (Table 4).

Production and Operational Challenges: These are miscellaneous production-related challenges. These include: “Meeting demands”, “They require more special attention”, “Weed control”. Environmental challenges, production difficulties, and pest/disease management are also notable, each constituting 12.1%, 12.1% & 6.1% of the total responses respectively (Table 4).

Other Specific Challenges: “Gathering soil”, “Livestock menace, and theft” (Table 4).

Table 4: Constraints to the adoption of climate-smart agricultural practices

Constraint category	Frequency	Percentage
Financial Constraints	7	21.2
Resource Access	4	12.1
Infrastructure and Space	5	15.2
Environmental Challenge	4	12.1
Pests and Diseases	2	6.1
Production and Operational	4	12.1
Others	3	9.1
Total	33	100

The linear regression analysis presented in Table 5 examines the relationship between selected socioeconomic factors and the adoption of climate-smart microgardening practices among urban households in Abia State, Nigeria. The regression model demonstrates a moderate explanatory power**,** with an R-squared value of 0.5823, indicating that approximately 58.2% of the variability in the adoption of climate-smart practices is explained by the independent variables included in the model. The Adjusted R-Squared value (0.4058**)** suggests a moderate fit after adjusting for the number of predictors in the model. The F-ratio (2.17) is statistically significant at 10% level of significance, indicating that the model is a good fit for explaining the relationship between socioeconomic factors and adoption practices.

Age: Age shows a positive and significant relationship with adoption at 10% level of significance. This indicates that older farmers are slightly more likely to adopt climate-smart practices. Older farmers may have more experience or greater awareness of the benefits of sustainable agricultural practices. This aligns with findings of Gudina and Alemu (2024) indicating that age can have a positive impact on the adoption of certain agricultural practices, such as agroforestry, where older farmers may recognize the long-term benefits.

Years of Experience: Contrary to expectations, years of experience has a negative but a statistically significant relationship at 5% level of significance. The negative coefficient of years of experience indicates that more years of farming experience are associated with a decreased likelihood of adopting climate-smart practices. This may suggest that experienced farmers are more accustomed to traditional methods and may be resistant to change. However, other studies have found that farming experience can have a positive effect on the adoption of climate-smart agriculture, as farmers become more conscious of the relevance of good agricultural practices over time (Aniche & Mckee, 2023).

Amount Realized: The amount realized from microgardening activities has a positive and statistically significant relationship at 5% level of significance with the adoption of climate-smart practices. This suggests that as income generated from microgardening increases, there is a corresponding increase in the likelihood of adopting climate-smart practices. This finding implies that households earning higher income from microgardening are more motivated and capable of investing in climate-smart technologies and practices. Financial benefits serve as an incentive, enabling households to purchase necessary inputs, adopt improved techniques, and sustain their microgardening efforts. This finding is consistent with the findings of Agbenyo *et al*. (2022) that show that the adoption of climate-

Table 5: Linear Regression results for socioeconomic factors affecting the adoption of Climate-smart Practices.

Variables	Coefficient	Std. Error	P-value
Constant	1.3265	0.7931	1.67
Sex	0.3330	0.2648	1.26
Age	0.0416	0.0219	1.90*
HHS	0.0769	0.0683	1.13
Level of Edu	-0.0071	0.0478	-0.15
Yrs of Experience	-0.0460	0.0214	-2.15**
Amount Realized	5.84e-06	2.22e-06	2.63**
No. of observations	33		
F-ratio	2.17*		
R- Squared	0.5823		
Adjusted R-Squared	0.4058		

Source: Field Survey, 2024, *** Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level smart practices can lead to significant income increases, suggesting a reinforcing cycle where higher income enables further adoption of beneficial practices.

In summary, the analysis reveals that age and income positively influence the adoption of climate-smart practices, while more years of farming experience may hinder it. These insights can inform targeted interventions to promote sustainable agricultural practices among urban microgardeners.

4. Conclusion and Recommendations

The study highlights the significant potential of climate-smart microgardening in addressing food security, environmental sustainability, and social well-being among urban households in Umuahia and Umudike, Abia State, Nigeria. Key benefits include reduced household food expenses, improved access to fresh and nutritious food, efficient resource management, and enhanced social interactions. However, adoption is hindered by financial constraints, limited access to resources, space limitations, environmental challenges, and pest and disease control issues.

To address these barriers, the study recommends:

1. Provision of subsidies, microcredit schemes, and affordable inputs to microgardeners.
2. Strengthen extension services, offer regular training, and build capacity for effective adoption of climate-smart practices.
3. Promotion of microgardening and other innovative gardening techniques, such as vertical gardening, and provision of durable planting materials to microgardeners.
4. Encourage cooperative formation and collective resource sharing to enhance knowledge and market access.
5. Development of urban agriculture policies to integrate microgardening into urban planning frameworks.

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