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Soil Fertility Management among Cucumber (*Cucumis Sativus* L.) Farmers in Ibadan, South-West Nigeria

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Abstract

Poor soil fertility reduces the yield, market value, and sustainable production of cucumber. This study examined soil fertility practices among cucumber farmers in Ibadan. A purposive sampling method was used to select 10% of cucumber farmers from six blocks, namely Akinyele, Lagelu, Egbeda, Ona-Ara, Oluyole, and Iddo in Ibadan-Ibarapa agricultural zone, Oyo State. A structured questionnaire was administered to obtain information on the soil fertility practices used for cucumber production. The data collected were subjected to descriptive and inferential analysis. A total of 63 respondents were assessed; Akinyele block had the highest representation (20.6%), followed by Egbeda (19%), with Oluyole recording the lowest (11.1%). Improved soil fertility was the primary reason for fertiliser application, cited by 95.2% of farmers. NPK 15:15:15 fertiliser was used by 79.4% farmers, while 4.8% used goat manure. Over half (52.4%) applied fertiliser without prior soil testing; among those, 56.7% testing using physical examination, 26.7% used laboratory procedures, and 16.6% used both physical and laboratory test. Fertiliser were applied at 20g/plant and 10g/plant by 34.9% and 15.9% of farmers, respectively, regardless of cucumber variety or soil nutrient status. Additionally, 61.9% applied fertiliser without nutrient specificity. Fertiliser was applied twice per cropping season by 49.2% of farmers, and once by 30.2%. Socio-economic characteristics of farmers, such as formal training and years of farming experience, showed a significant correlation with soil testing ($r = -0.27$; $r = -0.25$). The findings indicated that cucumber farmers mainly used NPK 15:15:15 fertiliser to improve soil fertility, yet most applied it without prior soil testing or nutrient specificity. Formal training and farming experience did not improve fertiliser and soil testing adoption. Extension programmes should prioritise soil testing, and variety-specific fertiliser rates should be developed to improve nutrient management efficiency among cucumber farmers in Ibadan.

Keywords: Soil fertility management, Cucumber, Ibadan, Small holder farmers, Soil Nutrients

1.0 Introduction

Cucumber (*Cucumis sativus* L.) is a vegetable plant from the Cucurbitaceae family, consumed for the nutritional and medicinal benefits of its fruits. The consumption of cucumber fruits improves metabolic and system functions, alleviates hidden hunger, and lowers disease risks in

humans due to their healthy source of minerals (potassium, phosphorus, sodium, calcium, silicon, magnesium, zinc, etc.) and antioxidants (Abbey *et al*., 2017; Mallick, 2022). High moisture and dietary fibre content of cucumber fruits aid digestion, weight loss, and reduce fat (Uthpala *et al*., 2020; Chakraborty and Rayalu, 2021). Beyond nutrition, Cucumber fruits possess medicinal values for the treatment of cancer (Gao *et al*., 2014) and can be used as raw material in cosmetic industries (Fiume *et al*., 2014; Hooda, 2015; Murad and Nyc, 2016; Uthpala and Navaratne, 2019). The nutritional, medicinal and industrial value drives the increasing global demand for cucumber, underscoring its growing economic relevance.

The rise in demand for cucumbers has increased their production worldwide. Globally, cucumber is the third most-produced vegetable after tomato and onions, with China accounting for approximately 80% of the world's production (FAO, 2021). In Africa, Egypt is the largest producer of cucumber (DALRRD, 2021), with its production in Nigeria being comparatively low and primarily oriented towards local consumption. Cucumber production in Nigeria has been reported to demonstrate profitability, with an estimated return on investment of 67 kobo per naira invested, representing about 55.8% (Adeoye and Balogun, 2016; Jimoh *et al*., 2016; Okonkwo-Emegha, 2025). However, poor soil fertility limits sustainable agricultural production. Soil fertility is the bedrock of agricultural and environmental sustainability, as healthy soils support plant growth, food production, and ecological nutrient balance (FAO, 2022; Adeoluwa *et al*., 2021). In Nigeria, poor soil fertility caused by increased population, unsustainable practices, deforestation, and climate change threatens food security (Afolabi *et al*., 2025; Omali, 2024).

Poor soil fertility is a significant challenge for cucumber cultivation in Oyo State, Nigeria (Adeoye and Balogun, 2016). Nutrient-deficient soils produce cucumbers with poor yield and aesthetic value, which often fail to meet consumer satisfaction, thus affecting production and net profit margins adversely. Sustainable and profitable cucumber production requires appropriate soil fertility management (Nweke *et al*., 2014; Nweke and Nsoanya, 2015) through comprehensive evaluation processes. Soil fertility evaluation is the process of assessing soil nutrients and their capacity to support plant growth through soil testing, plant/tissue analysis, and physical observation of crops and soil (Yadav *et al*., 2023). Evaluating soil fertility equips farmers with adequate knowledge to select the appropriate and sustainable management practices that optimise crop performance. These management practices vary with soil type, crop species and production systems, necessitating crop-specific assessments.

Previous studies in Oyo state examined soil fertility management practices deployed within the broader farming context. For instance, Organic fertiliser sources and farming practices, in addition to their socio-economic effects, were assessed among vegetable farmers in peri-urban and rural farming communities of Oyo State (Agboola and Adekunle, 2014; Ogungbaro and Olaiya, 2024). Additionally, Afolabi *et al*. (2025) also evaluated soil fertility practices among arable crop farmers across the agricultural zones of Oyo State. Although these studies provide valuable insights into specific soil fertility management in Oyo State, they did not examine cucumber production systems, nor did they account for the crop-specific nutrient requirements and management decisions unique to cucumber cultivation. However, this study gap is particularly significant given that cucumber consumption and demand are notably higher in Ibadan compared to other agricultural zones in Oyo State. There is a critical absence of empirical data on the soil fertility practices associated

with cucumber production in Ibadan. Thus, this study aims to assess farmers' soil fertility management practices in cucumber cultivation in Ibadan.

2.0 Materials and Methods

2.1 Study Area

The study was carried out in the agrarian areas of Ibadan (latitude 7º 00' and 7º 45' N and longitude 3º 30' and 4º 20' E), the capital of Oyo State, Nigeria. Oyo state comprises two agroecological zones: derived savannah and rainforest. Ibadan falls within the rainforest agroecology and experiences a bimodal rainfall pattern, with annual precipitation ranging from 1617 to 1635mm, occurring between April and November (Dawn Commission, 2025). Annual temperature ranges from 23.6 to 35.7˚C. The dry season spans between November and February and is characterised by the northeast trade wind, harmattan, and the Sahara Desert dust (Sangotegbe *et al*., 2015). This agroecology supports the cultivation of crops such as root and tuber, cereals, trees, and vegetables (Akano *et al*., 2021). The dominant soil orders in the state are Inceptisols and Alfisols formed on basement complex parent rocks. The soils in this location are deep, permeable, and friable, having a finer surface layer (sandy loam) over heavier sandy clay loam or sandy clay (Chude *et al*., 2012).

2.2 Data Collection

Oyo state has four agricultural zones (Saki, Oyo, Ogbomoso, and Ibadan-Ibarapa) under the Oyo State Agricultural Development Programme (OYSADEP), comprising a total of 224 farmers' circles/clusters across the State. Ibadan, which is notable for its comparatively higher cucumber demand and production within the state, falls under the Ibadan-Ibarapa agricultural zone, which has 72 farmers' circles/clusters where each cluster contains at least 10 farmers. The study covered the six blocks of the Ibadan agrarian area, namely, Akinyele, Lagelu, Egbeda, Ona-Ara, Oluyole, and Iddo (Fig. 1). Prior to the main survey, a preliminary questionnaire validation exercise was carried out on cucumber farmers within the University of Ibadan Teaching and Research Farm. This ensured a comprehensive inclusion of pertinent questions and exclusion of ambiguous items, thereby improving the questionnaire's clarity and contextual appropriateness for the target population.

A purposive sampling method was employed to select respondents, targeting farmers who cultivated cucumbers commercially and possessed verifiable practical experience. The inclusion criteria were: (i) a minimum of two years' experience in cucumber cultivation and (ii) cultivation on at least one plot of land. These criteria were deliberately set to ensure that only farmers engaged in cucumber production primarily for commercial purposes were captured, thereby improving the relevance and reliability of the data collected. Using these criteria, 10% of cucumber farmers were systematically selected from each of the six blocks, a total sample of 63 respondents across the study area were obtained. Data were collected on farmers' socio-economic characteristics, soil fertility management practices, yield and profit margins associated with cucumber cultivation using a structured questionnaire.

2.3 Statistical Analysis

The data collected were analysed using descriptive and inferential statistics. Descriptive statistics (frequencies, percentages, means). Inferential statistics, including correlation coefficient, were used to assess relationships and associations between categorical variables. Statistical significance was set at $\alpha = 0.05$.

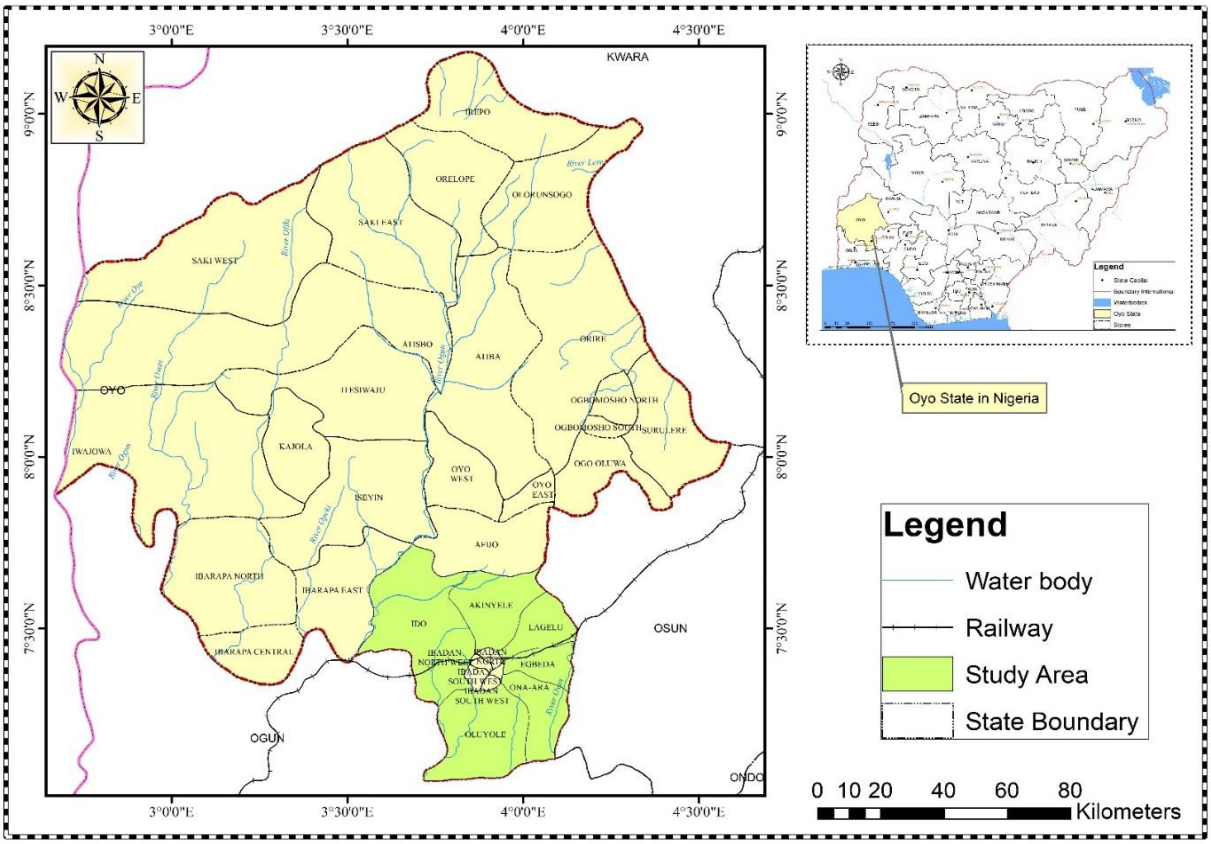


Fig. 1: Map of Oyo State Showing the Surveyed Area

3. 0 Results and Discussion

3.1 Socio-Economic Characteristics of Farmers

The highest distribution of respondents was from Akinyele Local Government (20.6%), while the least of 11.1% was from Oluyole Local Government (Table 1). The gender distribution of respondents in this study was highly skewed, with significantly more men (87.3%) involved in cucumber farming compared to women (12.7%). This report aligns with the findings of Adeoye and Balogun (2016), who stated that more men are involved in the cultivation of cucumber in the Iseyin Local Government Area of Oyo State, Nigeria. Anderson *et al*. (2021) opined that the involvement of women is crucial for gender equality and improved cucumber productivity as they can enhance the agricultural workforce, knowledge and innovations in the study area.

According to the reports of Dyussenbayev (2017), the ages of 25-44, 44-60, 60-75, 75-90 and after 90 are described as youths, middle age, elderly age, senile age and long-livers, respectively. The result revealed that 47.6% of the respondents were youth, while 42.9% and 9.5% were middle-aged and elderly, respectively. The higher involvement of youth in cucumber production, as observed in this study, benefits the sector, given that youth are key drivers of economic and social transformation. Young individuals are productive, energetic, more resilient and receptive to innovative technologies (Yami *et al.,* 2019). Moreover, youth engagement in food system structures strengthens the agricultural value chain, entrepreneurial activities, policy formulation, and advocacy (Madu and Ogbunugwor, 2025).

The survey revealed that 61.9% of farmers have obtained formal training

(degree/diploma) in agriculture, with 61.5% having 1-5 years of training. Among the respondents, 88.8% had ≤ 10 years of experience in cucumber farming, while 11.2% had >10 years of experience. The years of training and experience of respondents portrayed the good educational level required for agricultural activities. A good educational level, farming experiences, and productive age are vital in enhancing farmers' efficiency, management skills, and adaptation to innovations (Busari *et al*., 2013; Elum *et al*., 2016; Kabiru, 2020). Most respondents were smallholder farmers, as 65.1% have 0.1- and 1.0-acre farmland sizes, and only 34.9% had >1 acre. The use of small land size for cucumber farming may be due to urbanisation, limited access to credit facilities, and Nigeria's land tenure system. Improving access to credit and revising the land tenure system could encourage and expand cucumber farming.

Table 1: Socio-Economic Characteristics of Cucumber Farmers in Ibadan

Variables	Frequency	Percentage
Farm Location		
Akinyele	13	20.6
Egbeda	12	19
Ido	11	17.5
Lagelu	10	15.9
Oluyole	7	11.1
Ona Ara	10	15.9
Farmers' Gender		
Male	55	87.3
Female	8	12.7
Famers' Age (years)		
25-44 (Young)	30	47.6
45-60 (Middle age)	27	42.9
≥61 (Elderly)	6	9.5
Formal training (Degree/Diploma) in agriculture		
Yes	39	61.9
No	24	38.1
Duration of Training (years)		
1-5	24	61.5
6-10	13	33.3
11 and above	2	5.2
Experience in cucumber cultivation (years)		
1-5	41	65
6-10	15	23.8
>10	7	11.2
Farm Size (acres)		
0.1-0.5	22	34.9
0.6-1	19	30.2
1.1-5.0	22	34.9

3.2 The Use of Fertiliser in the Cultivation of Cucumber in Ibadan

Fertiliser application was a common practice among cucumber farmers in Ibadan, as 95.2% of them used it (Table 2). This near-universal adoption of fertiliser among the sampled farmers underscores the recognised importance of soil nutrient supplementation in sustaining cucumber yield and quality in Ibadan. The high fertiliser adoption rate observed in this study aligns with the report of Okafor and Yaduma (2021), reflecting the growing awareness among smallholder farmers of the critical role of soil fertility management in achieving commercially viable yields. The result also shows the inherent nutrient demand of cucumber to sustain fruit set, size, and marketable quality, making fertiliser application a practical necessity rather than an optional input for most commercial farmers (Mohammed *et al*., 2021).

Farmers' reasons for fertiliser use, rated on a five-point Likert scale, are presented in Table 4. Improving the yield of cucumber was the top-ranked reason for fertiliser application, recording the highest mean score ($\bar{x}$ = 3.8) and ranked first, with 71.4% and 27.0% of respondents strongly agreeing and agreeing, respectively. This result is expected where maximising crop output per unit of input remains central to production decisions for commercial farmers, particularly under conditions of resource constraint and market pressure (Vanlauwe *et al*., 2014; Sheahan and Barrett, 2017). Improving soil fertility was ranked second ($\bar{x}$ = 3.7), with 63.5% and 34.9% of respondents strongly agreeing and agreeing, respectively, and only 1.6% disagreeing. Improving fruit taste and improving resistance to pests both ranked fifth ($\bar{x}$ = 2.2), with relatively low agreement and notable proportions of indifferent and disagreeing respondents across both variables. While fertiliser application can improve fruit taste and resistance to pest infestation (Michael *et al*. 2018; Pereira *et al*., 2021), it doesn't necessarily form the farmers' priority when it comes to the choice of fertiliser.

The correlation analysis between some farmers' socio-economic characteristics and fertiliser use reveals that formal training ($r = 0.1$, $p = 0.06$) in agriculture and years of farming experience ($r = -0.28$, $p = 0.08$) showed no significant correlation with fertiliser use (Table 4). These findings suggest that neither accumulated farming experience nor formal agricultural training reliably predicted fertiliser use behaviour among cucumber farmers in Ibadan. This may be because fertiliser adoption and use are more strongly governed by external factors such as input affordability, market accessibility, and availability of extension services than by farmer human capital characteristics (Ahmad *et al*., 2025). Also, the years of experience may result in prolonged reliance on familiar practices, reducing acceptance of alternative and superior input management strategies (Mgbenka and Mbah, 2016). These results highlight that improving fertiliser use behaviour among cucumber farmers in Ibadan may require interventions targeted towards structural and economic barriers that constrain informed input management decisions. The result obtained from this study differs from the report of Obisesan *et al* (2013) that years of education were significant in the adoption of fertiliser use.

Among the fertiliser sources assessed, poultry manure, cow manure and NPK 15:15:15 were known by 96.8%, 87.0%, 87.0% of respondents, respectively (Fig. 2). However, NPK 15:15:15 and urea were used by 79.4% and 52.2% of respondents, respectively, while goat manure was used by 4.8%. The survey revealed that farmers' knowledge of a given fertiliser did not necessarily translate to its use. The preferred use of NPK 15:15:15 by most respondents is consistent with the widespread adoption among cucumber farmers in Nigeria (Okafor and Yaduma, 2021). This may be

largely driven by its multiple nutrient composition and widespread availability/access through government-subsidised input programmes or agric-input outlets (Olayide *et al*., 20009; Liverpool-Tasie *et al*., 2017; Nyondo *et al*., 2025).

Table 2: Fertiliser Use among Cucumber Farmers in Ibadan

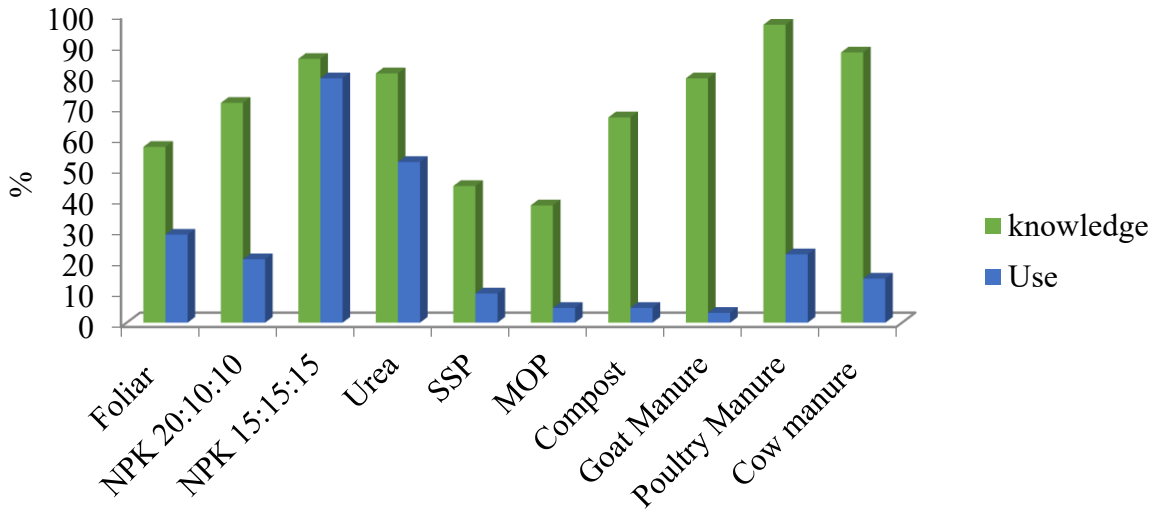
Yes	No
(%)	
95.2	4.8

Table 3: Reasons for Fertiliser Use among Cucumber Farmers in Ibadan

Reasons for fertiliser use	Strongly Agree	Agree	Indifferent	Disagree	Strongly Disagree	Mean ($\bar{x}$)	Rank
			%				
Improve crop yield	71.4	27	-	-	1.6	3.8	1
Improve soil fertility	63.5	34.9	-	1.6	-	3.7	2
Improve fruit taste	7.9	23.5	30.2	19	6.3	2.2	5
Improve resistance to disease	15.9	38.1	20.6	14.3	11.1	2.5	3
Improve resistance to pests	9.5	41.3	20.6	17.5	11.1	2.2	5
Improve shelf life	9.5	34.9	30.2	22.5	3.2	2.3	4

Table 4: Relationship between some Farmers' Socio-Economic Characteristics and Fertiliser Use in Cucumber Production

Variables	Correlation Coefficient (r)	p-value
Formal training in agriculture and Fertiliser Use	0.1	0.06
Years of experience in farming and fertiliser Use	-0.28	0.08



NPK- Nitrogen, Phosphorus and Potassium , SSP- Single super phosphate, MOP- Muriate of potash

Fig. 2: Farmers' Knowledge and Use of Fertiliser for Cucumber Cultivation in Ibadan

3.3 Conducting Soil Test

A higher frequency of farmers (52.4%) do not perform soil examination before applying fertiliser, while 47.6% do (Table 4). Although 47.6% carried out soil examination, 56.7% of this population analysed their soil through physical examination, 26.7% through laboratory test, while 16.6% use both physical and Laboratory test. Soil test is essential for appropriate fertiliser use, and higher productivity of the soil and cucumber (Okafor and Yaduma, 2021). The reason why most farmers do not conduct soil tests may be due to on knowledge from experience, the cost of soil testing and limited access to testing facilities. The use of physical examination and knowledge from experience to evaluate soil fertility is limited in its effectiveness. Physical examination depends on deficiency symptoms, and deficiencies may be difficult to detect or invisible, as in the case of hidden hunger. Also, when deficiency symptoms appear, the crop and soil have undergone marked fertility decline, and the ameliorative measures taken at that time may not achieve immediate optimum yields (Yadav *et al*., 2023). Laboratory soil test before applying fertiliser is more effective since it provides an accurate assessment of the soil's current fertility status, enabling proper management.

The correlation between farmers' socio-economic characteristics and soil testing practice is presented in Table 5. Years of experience in cucumber cultivation ($r = -0.25$, $p = 0.05$) and formal training in agriculture ($r = -0.27$, $p = 0.03$) showed a significant negative correlation with soil testing. This result indicates that farmers with more years of formal training and experience were less likely to test their soil before fertiliser application. This result is consistent with evidence from smallholder farming systems in sub-Saharan Africa, where experienced farmers often substitute formal diagnostic tools with experiential heuristics, particularly when soil testing services are perceived as costly (Nyondo e*t al*., 2025).

3.4 Fertiliser Application

Generally, most respondents (61.9%) did not consider any nutrient as the most limiting when applying fertiliser, while 20.6% considered nitrogen as such (Table 6). The lack of nutrient specificity (blanket fertiliser application) was also evident in the quantity of fertiliser they usually apply, as 34.9% of farmers applied fertiliser at 20g

per plant, 27% had no specific rate, and 1.6% applied at 50 or 100g/plant, irrespective of the cucumber variety, fertiliser, and soil type. Applying fertilisers without considering specific nutrient needs is a blanket approach that can lead to low nutrient use efficiency, nutrient imbalances, pollution, and possible crop yield decline (Ezui *et al*., 2016; Gruda *et al*., 2017). Alabi (2016) recommended 30kg of N for the production of Greengo and Kayin cucumber varieties under a controlled environment in Ibadan. However, there is a dearth of information on recommended nutrient rates (especially the primary macro nutrients combinations) for the cultivation of cucumber in the study location, also contributing to blanket fertiliser use. Additionally, the results in Table 6 also revealed that 61.9% of farmers applied fertiliser using the ring method, while 6.3% of the respondents used the broadcast method of fertiliser application. According to Okafor and Yaduma (2021) and Meena (2022), fertiliser application by the ring method is the most suitable for cucumber plants' to optimise nutrients.

3.5 Yield and Profit Margin

Results obtained showed that the average yield obtained by 73% of farmers was <100 kg/ha, while 19% achieved 100-200 kg/ha and >200kg/ha by 8% (Table 7). The highest yield obtained in this study is lower than the average estimated yield of 291.78 to 581.59 kg/ha obtained in Nigeria (Okafor and Yaduma, 2021). The profit margin of 71.4% of respondents was ₦50,000 and below per cropping season, while 25% made between ₦51,000 and ₦100,000 profit.

The highest profit margin recorded in this survey is low compared to reports of cucumber farmers in Rivers (N1,909,292) and within the range of ₦243,235.70; ₦239,440 and ₦62,602.90k reported in Oyo and Osun state, Nigeria (Elum *et al*., 2016; Jimoh *et al*., 2016; Adeoye and Balogun, 2016). The low yield and profits of cucumber in this survey may be due to small farm sizes and poor technical efficiencies in management practices required to improve yield. This result is consistent with the findings of Adeoye and Balogun (2016) on the low yield/profitability of cucumber cultivation in the Iseyin Local Government Area of Oyo State, Nigeria.

The relationship examined between farm size ($r = 0.65$, $p = 0.001$), Experience in cucumber farming ($r = 0.31$, $p = 0.02$) and cucumber yield (Table 6) revealed a significant positive correlation. The result aligns with the report that the yield of cucumber is directly influenced by farm size and farming experience (Adeoye and Balogun, 2016). Larger farms may have easy access to credit facilities, enhancing the use of improved technologies and reducing per-unit production costs. However, the fragmented land tenure system in Nigeria limits farmers from realising these potential gains.

Table 5: Soil Test Evaluation by Farmers in Ibadan

Variables	YES (%)	NO (%)
Soil nutrient evaluation test	47.6	52.4
	Method of nutrient evaluation	
Physical evaluation	36.5	
Laboratory soil test	31.7	
Physical and Laboratory Test Evaluation	16.6	
	Correlation Coefficient (r)	**p-value**
Experience in Cucumber cultivation and soil test	-0.25	0.05
Formal Training in Agriculture and Soil Test	-0.27	0.03

Table 6: Fertiliser Application by Cucumber Farmers in Ibadan

Variables	YES (%)	NO (%)
Most Limiting Nutrient considered during fertiliser application		
Nitrogen	20.6	79.4
Phosphorus	Nil	Nil
Potassium	17.5	82.5
Not specific	61.9	38.1
Method of fertiliser application		
Ring	61.9	38.1
Broadcast	6.3	93.7
Spot	25.4	74.6
Pre-planting incorporation	7.9	92.1
Top dress	38.1	61.9
Frequency of fertiliser application per cropping season		
Once	30.2	NA
Twice	49.2	NA
Thrice	9.5	NA
None	11.5	NA
Rate of fertiliser application per plant (g)		
Not specific	27	NA
8	3.2	NA
10	15.9	NA
15	1.6	NA
20	34.9	NA
30	12.7	NA
50	1.6	NA
100	1.6	NA

*NA- not applicable

Table 7: Yield and Profit Margin for Cucumber Production in Ibadan

Estimated yield (kg/ha)	**Population (%)**	**Estimated profit (₦/ha)**	**Population (%)**
<100	73	< 50,000	71.4
100-200	19	50,000-100,000	25
>200	8	>100,000	3.2
Variable		**Correlation Coefficient (r)**	**p-value**
Farm Size and Yield		0.65	0.001
Experience in Cucumber Cultivation and Yield		0.31	0.02
Formal Training and Yield		0.26	0.07^{NS}

NS-Not Significant

4.0 Conclusion

The study revealed that soil fertility management practices among cucumber farmers in Ibadan are mainly characterised by blanket fertiliser use, largely driven by yield improvement and soil fertility enhancement purposes. These management practices are undermined by critical deficiencies in diagnostic soil tests and nutrient specificity. The paradoxical low

relationship between farmers' socio-economic characteristics with fertiliser use, soil testing and cucumber yield collectively indicates that human capital alone is insufficient to drive evidence-based soil fertility management. Furthermore, low average yields and profit margins recorded reflect structural constraints, including limited access to soil testing facilities, crop-specific nutrient rate recommendations for the study location, a fragmented land tenure system, and restricted access to credit facilities.

Addressing these challenges requires a coordinated, multi-staged policy response. Extension programmes should be redesigned to prioritise practical soil testing literacy, moving beyond general fertiliser awareness to demonstrate the economic value of laboratory-based soil diagnostics within the specific context of cucumber production in Ibadan. Variety and location-specific fertiliser rates should be recommended for cucumber cultivation in the study location to limit blanket fertiliser use. Government-subsidised input programmes should be expanded and better targeted to ensure that a wider diversity of fertiliser types for smallholder cucumber farmers at affordable prices. Additionally, land tenure reforms and improved access to agricultural credit are essential to enable farmers to scale production beyond subsistence-level farm sizes, thereby improving yield potential, input use efficiency, and profitability. Gender-sensitive extension interventions that actively engage women and youth in cucumber production systems would further strengthen the agricultural workforce and accelerate the adoption of improved soil fertility management practices across the Ibadan-Ibarapa agricultural zone.

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