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Assessment of Production Constraints and Soil Fertility Status in Plantain and Banana Farms in Boki Cross River State

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ABSTRACT

Plantain and banana are vital for food security and income in Nigeria, yet average yields remain significantly below potential, constrained by a complex interplay of factors. This study assessed the socio-economic characteristics of plantain farmers, their agronomic practices, and the corresponding soil fertility status to identify the primary constraints limiting production. A cross-sectional survey of 1000 plantain farmers in Boki Cross River State, Nigeria was conducted to collect data on socioeconomics and farm management practices. Concurrently, 45 composite soil samples were collected from 0-30 cm depth and analyzed for key physico-chemical properties. The typical farmer is a smallholder (>80% with <2 ha), with limited formal education and critically inadequate access to credit. Agronomic practices are largely traditional: farmers primarily use unimproved suckers (95%), practice manual slash-and-burn land preparation, and rarely apply inorganic fertilizers due to high cost. While intercropping and mulching are common, their implementation is often suboptimal. Soil analysis revealed widespread and critical challenges, with 80% of soils being acidic (pH <5.5), 82% low in organic carbon, and over 89% critically deficient in exchangeable potassium. The most severe production constraints were Black Sigatoka disease (reported by 95% of farmers), the high cost of inputs (87%), and low soil fertility (78%). The low productivity of plantain in Nigeria is not due to a single factor but a vicious cycle where socioeconomic limitations prevent the adoption of improved practices, leading to soil nutrient depletion and increased vulnerability to pests and diseases. An integrated intervention strategy is urgently needed, focusing on affordable credit, farmer education on integrated soil fertility management, and the dissemination of disease-resistant planting materials to break this cycle and enhance sustainable production.

Keywords: *Black Sigatoka, integrated soil fertility management, Musa spp., rainforest zone, smallholder farmers, soil degradation.*

Introduction

The backbone of Nigeria's plantain production is the smallholder farmer. Typically, these are individuals managing family plots of less than two hectares, often passed down through generations [1]. A concerning trend is the aging of this workforce; the average farmer is often over 45, as younger generations seek opportunities away from farming [2]. While these farmers possess deep, practical knowledge, limited formal education can sometimes be a barrier to adopting new, science-based techniques [3]. Perhaps the most stifling challenge is financial. Most farmers operate on a shoestring budget, trapped by a lack of access to formal credit. They rely on personal savings or high-interest informal loans, making it nearly impossible to invest in quality inputs that could boost their harvests [4].

The primary source of planting materials is their own farm or a neighbor's, using "suckers" that sprout from the base of mature plants [5].

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While this is cost-effective, it is a double-edged sword, as it inadvertently passes along soil pests and diseases. The promising solution of certified, disease-free tissue-culture plantlets remains out of reach for many, held back by cost, limited supply, and a simple lack of awareness [6]. Land preparation is a testament to hard labor. The common method involves manually clearing the land, burning the debris, and forming mounds or ridges with hoes a practice known as slash-and-burn [7]. While it clears the land quickly, it degrades the soil over the long term. To make the most of their small plots, farmers often practice intercropping. In the first year, plantains share their space with crops like maize, cassava, or beans [2] This clever strategy provides extra food and income and can even benefit the soil when legumes are included. However, if not carefully managed, this can lead to a fierce competition for water and nutrients, ultimately stressing the plantain plants [5].

Soil fertility is one of the biggest challenges in plantain farming. Many farmers apply little to no fertilizer, unable to afford the high cost [8]. When fertilizers are used, they are often not the right type or amount for what the soil truly needs. Similarly, while mulching covering the soil with plantain leaves and other residues is a brilliantly effective practice to conserve moisture and enrich the soil, many farmers struggle to gather enough material [5]. Ultimately, the sector is characterized by nutrient mining as farmers are harvesting more than they are putting back in. For water, the skies are the sole source. The crop is almost entirely rain-fed, leaving it vulnerable to increasingly unpredictable rainfall patterns [2]. The culmination of these socioeconomic and agronomic realities is a sobering yield gap. While the potential is 30-50 tons per hectare, the average farmer in Nigeria harvests only 5-10 tons [9]. This low output is a direct reflection of the soil's health.

Studies consistently show that these farms are struggling with acidic soils that are low in organic matter and critically deficient in vital nutrients, particularly phosphorus and the potassium that is so essential for plantain development [10][11].

Pests and disease like the shadow of Black Sigatoka, a devastating leaf spot disease, looms large, capable of decimating yields by attacking the plant's food-producing leaves [12]. Similarly, economic pressures such as the high cost of inputs and a lack of credit create a vicious cycle of poverty and low investment. On the other hands, ecological decline such as the declining soil fertility forms a foundational constraint, weakening plants and making them more susceptible to other pressures [8].

Materials and Method

Boki Local Government Area (LGA) is situated in the central part of Cross River State, in the South-South geopolitical zone of Nigeria. It has common boundaries with Bekwarra Local Government Area in the North, Ikom Local Government Area in the East, Etung Local Government Area and the Republic of Cameroon in the South and Ogoja Local Government Area in the West. The area lies approximately between Latitude 6° N and 6.5° N and Longitude 8.7° E and 9.2° E. The administrative headquarters is located in Boje. Boki LGA experiences a tropical humid climate, characterized by high temperatures, heavy rainfall, and high relative humidity throughout most of the year. It falls within the AW (Tropical Savannah) climate classification, but its proximity to the equator and elevated terrain gives it strong affinities with the equatorial climate. Temperatures are consistently high with minimal variation. The average annual temperature ranges from 25°C to 30°C (77°F to 86°F). The hottest months are typically February and March. The area experiences a distinct wet and dry season. It receives very high annual rainfall, often exceeding 2,500 mm (98 inches). The rainy season spans from March to October, with a peak between July and September. The dry season, from November to February, is relatively short but pronounced. Relative humidity is consistently high, typically ranging from 70% to 90% year-round. It is highest during the rainy season, creating a humid and often misty environment, especially in the mornings.

Boki is predominantly located within the Tropical Rainforest belt of Nigeria. However, due to extensive human activities, particularly agriculture, much of the primary rainforest has been replaced by secondary forest and farmlands. The area is part of the Cross River National Park, which contains one of the oldest and most biologically diverse rainforests in Africa. The vegetation features. The soils of Boki LGA are predominantly deep, weathered, and well-drained soils, which are typical of rainforest regions. The main types include: Ultisols (Acid Sands). These are the most widespread soils. They are deeply weathered, acidic, and have low to moderate fertility. While not inherently rich, they can be productive for agriculture when managed with organic manure and fertilizers. Lithosols/Shallow Stony Soils: Found on hilly and steeply sloping terrain, these are shallow soils overlying bedrock. Alluvial Soils: Found along the floodplains of rivers and streams, these soils are more fertile and are highly valued for cultivation. The climate and soil conditions of Boki LGA make it a prime agricultural zone, and the cultivation of plantain (*Musa paradisiaca*) and banana (*Musa sapientum*) is a major economic activity for the local population. The high rainfall, constant warm temperatures, and high humidity provide an ideal environment for the growth of these Musa species. They thrive in the deep, well-drained ultisols, especially when soil fertility is maintained.

A cross-sectional survey of 1000 plantain farmers in Boki Cross River State, Nigeria was conducted to collect data on socioeconomics and farm management practices. Concurrently, 45 composite soil samples were collected from 0-30 cm depth and analyzed for key physico-chemical properties. Data obtained were analyzed using descriptive statistics.

Results and Discussion

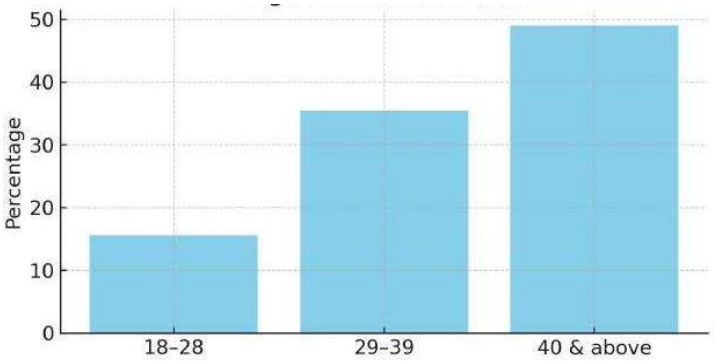

Fig 1: Age Distribution

Figure 1 results shows the findings on age distribution which indicate that 49.0% of the interviewees were 40 and above years and a considerable percentage (35.4%) were 29–39 years, whereas only 15.6% were 18–28 years. However, the mean was 52.3 years, indicating a quite old farming population. The implication of this finding is that he predominance of older farmers suggests that plantain production is under the control of those on the verge or in older middle age. While rich experiential knowledge may be suggested by this, this does raise questions regarding the sustainability of farm labor in the plantain. The ratio of young farmers being male was quite low, and this may be due to the perception that farming as a career is not profitable or attractive or because one cannot acquire land or lack government incentives. This would be a long-term issue to the aptness of plantain farming unless youth-in-agriculture programs and incentives are created.

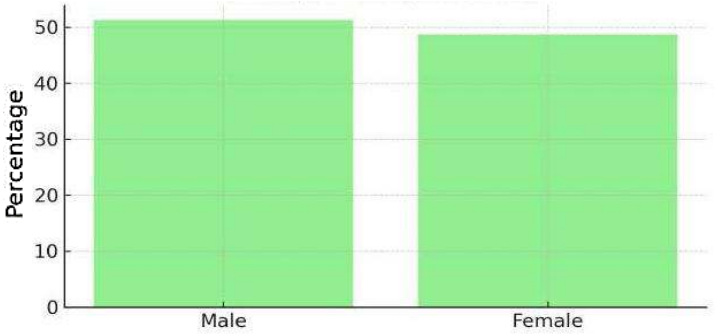

Fig 2: Gender Distribution

The result of Figure 2 on gender distribution shows that males accounted for 51.3% while females accounted for 48.7% of the respondents, indicating near gender equality. The proximate equal participation means that both men and women are participating equally in plantain production. However, gendered access to credit, extension services, land, and inputs may be very dissimilar despite equal participation. The interventions must be gender-sensitive in a way that policies and programs do not reinforce existing gender inequalities but instead empower both sexes equally, especially women who may have other systemic barriers.

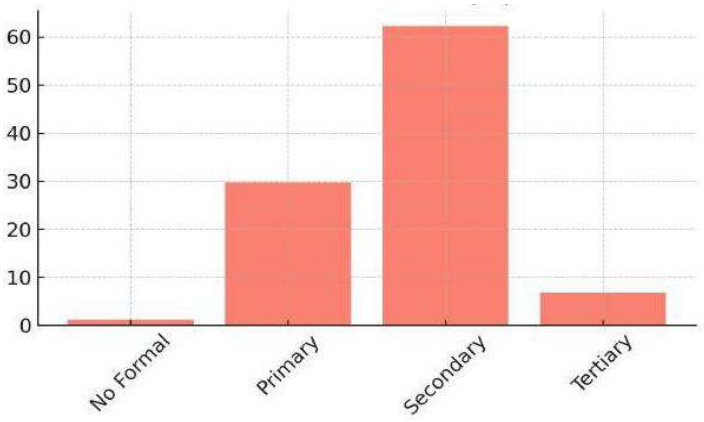

Fig 3: Educational Level

Figure 3 result on educational level shows a high proportion of the plantain farmers had secondary education (62.3%); 29.7% had primary education, and 6.8% had tertiary education, while 1.2% had no education. It is assumed that the generally high level of literacy among farmers is a welcome development for agricultural extension and technology transfer. Because most of the farmers are literate, agricultural innovations can be encouraged through print materials, ICT platforms, and participatory learning processes. Low level of tertiary education, however, could imply low exposure to the advanced agronomic or soil fertility information and hence the potential for the necessity of simplified but functional training materials.

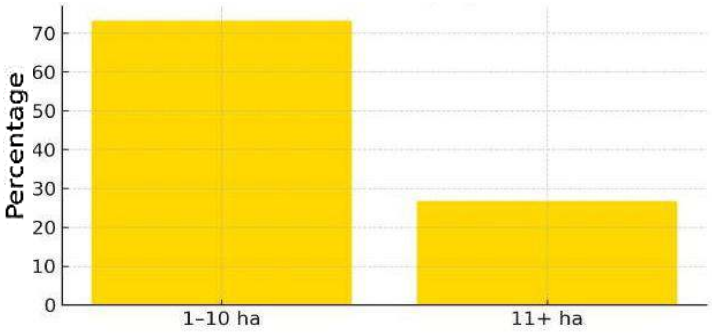

Fig 4: Farm Size

The result of figure 4 on farm size shows that majority of plantain farmers (73.2%) planted 1–10 hectares and were therefore smallholder farmers, while only 26.8% planted more than 10 hectares. Prevalence of smallholders implies limited economies of scale, low mechanization, and vulnerability to shocks. These farmers also may be limited to use soil-enhancing technologies such as organic manures, cover cropping, and fallowing due to land scarcity. Low-cost, scalable soil fertility technologies, land management technical skills, and facilitating community-based extension systems need to be intervened.

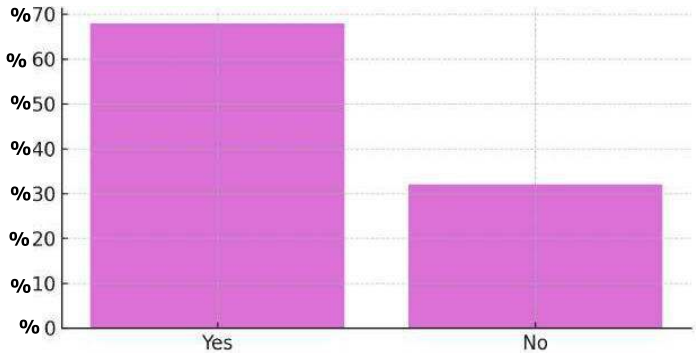

Fig 5: Access to Extension services

Figure 5 shows the result of access to extension services which is one of the critical elements in plantain production. The result shows that 67.9% accessed extension services, while 32.1% had no access. The implication is that while many have some access, the large percentage with no access is cause for concern, especially for improving soil fertility management. The effectiveness of the extension system may also be questioned because access does not guarantee information quality or content suitability. There is a need to improve extension institutions, with ICT-based services included, and endow extension agents with expertise in soil health and plantain-specific constraints. In summary, the socioeconomic characteristics of the plantain farmers in the study area paint the picture of an experienced yet aged, educated yet non-highly specialized, small-scale yet highly motivated and farm-majority-dependent population for livelihood.

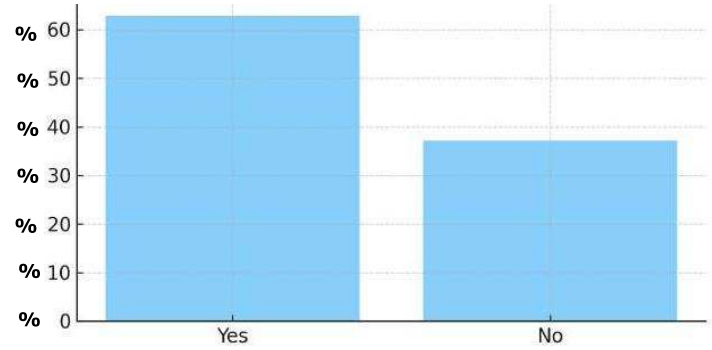

Fig 6: Membership of Farmers' Association

The result for membership of farmers associations on figure 6 indicates 62.8% of them are members of farmers' associations. Group membership offers a useful means of passing on innovations, training, and collective action (e.g., collective procurement of inputs or marketing). It also offers chances to develop peer learning, collective voice, and bargaining capacity. For the other 37.2% who are not members, special campaigns may promote greater membership by emphasizing the benefits of association membership.

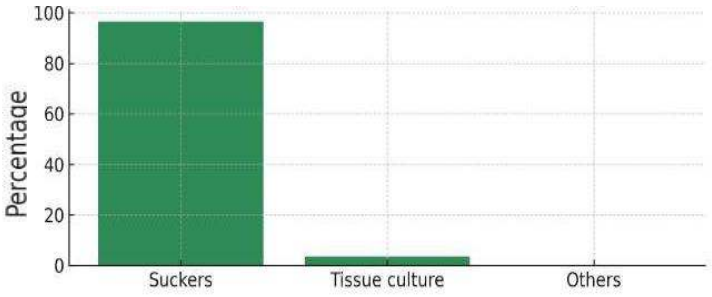

Fig 7: Primary Source of Planting Materials

The result on figure 7 on primary source of planting materials shows that majority of plantain farmers (96.4%) utilized suckers, while only 3.6% used tissue culture. The wide application of the traditional suckers shows limited access to or information on improved planting materials such as tissue culture plantlets, which are disease-free and of higher productivity. It can increase the risk of exposure to pests and diseases and decrease the genetic diversity in plantation. There must be targeted interventions focusing on advocacy for tissue culture technology through extension services and public-private partnerships.

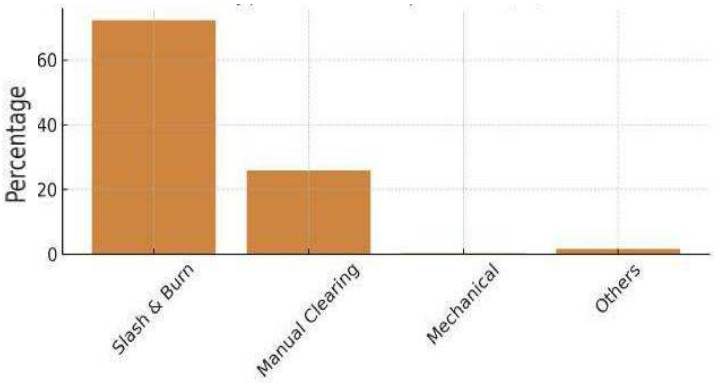

Fig 8: Type of Land Preparation

The result of figure 8 revealed types of land preparation, far as land preparation types in plantain cultivation are concerned, slash and burn: 72.2% was the most highly used techniques followed by hand clearing 25.9%; mechanical clearing 0.3% and other techniques 1.6%. The slash and burn dominance has long-term negative impacts on soil productivity, diversity, and carbon yield, and potentially result in land degradation. Hand clearing, though less harmful, is inefficient and labor-intensive while the low rate of mechanized land preparation is due to restricted capital and equipment availability. Capacity building and support for climate-resilient land preparation practice are essential to ensure soil productivity and health.

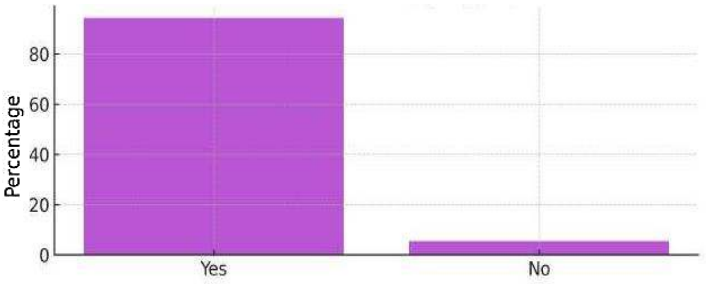

Fig 9: Practice Intercropping

Figure 9 result on practice of intercropping shows that majority of respondents 94.4% intercropped while only 5.6% do not. The high rate of intercropping suggests that farmers are maximizing land use, enhancing income diversity, and reducing risks. However, without proper management, intercropping may lead to nutrient competition, especially on already low-fertility soils. Extension services should offer guidance on compatible intercropping systems that enhance soil fertility, such as combining plantain with legumes.

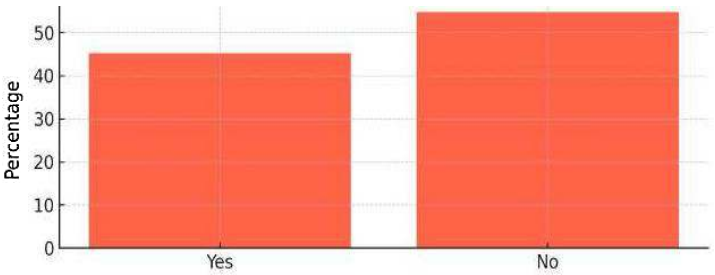

Fig 10: Fertilizer Application

Figure 10 result indicates fertilizer application, where, the majority (54.8%) do not apply inorganic fertilizer and 45.2% applied fertilizers. For frequency of application, 26.1% once, 11.8% twice and 7.3% more than twice in a season. More than half of the farmers don't apply fertilizers, maybe because it's too costly, there is poor access, or because they don't know how. However, most of the users fertilize only once, which may be inadequate to meet the nutrient need of plantain, especially on low soils. Low fertilizer use is consistent with the low average yield (3.4 tons/ha) reported, which is far below the potential yield (10–20 tons/ha). There is an urgent need for soil testing, fertility mapping, and subsidized fertilizer programs to take yield to the maximum.

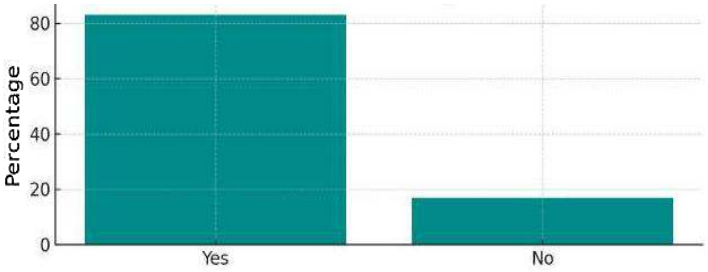

Fig 11: Practice Mulching

The result of figure 11 is on mulching practice where majority of the plantain farmers 83.1% employed mulching practices while 16.9% did not. Substantial application of mulching is a commendable practice since it allows conservation of water, weed control, and enhancement of organic matter. This shows that farmers are aware and implement at least some of sustainable soil management practices. Promotion of organic mulch materials and extension of best practices can promote more benefits.

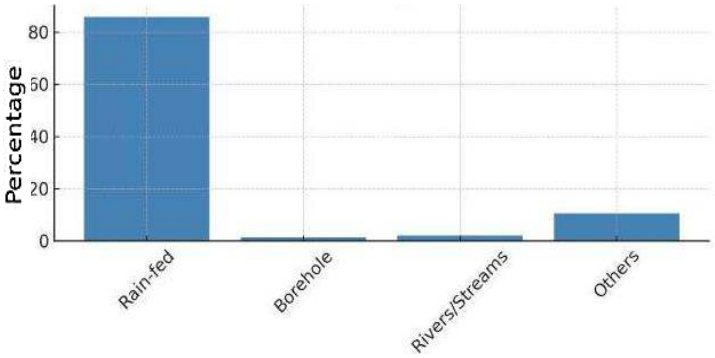

Fig 12: Source of Irrigation

Results of figure 12 on sources of irrigation show that rain-fed irrigation 85.9% was the most utilized by respondents, followed by other irrigation practices 10.6%, rivers/streams 2.1% and least utilized was borehole 1.4%. The high dependency on rain-fed agriculture exposes plantain production to climate variability and unpredictable rain patterns, resulting in variable yields. Conversely, very low utilization of irrigation technologies indicates the necessity for climate-resilient infrastructure like drip irrigation or community-managed water schemes. Policies supporting cheap irrigation technologies and water harvesting systems can bring great productivity enhancement. The finding on plantain yield indicates that mean plantain yield in the study area was 3.4 tons/ha. This is much below optimum levels of commercial yields, which reflect the combined effect of unfavorable soil fertility status, low fertilizer use, and climatic reliance. To address this, there must be a comprehensive approach that entails improved planting materials, soil fertility management, irrigation, and capacity improvement programs. Findings suggest traditional and low-input systems of production with important constraints in land preparation, input use, and water management. This has imperative implications for soil fertility and plantain productivity, and therefore necessitates enhanced extension and advisory services, promotion of climate-smart agriculture, innovative,

sustainable methods adoption and intervention and policy approaches that ensure farmer capacity, access to inputs and resilience are enhanced.

Table 1: Soil Fertility Status and Management

Variable	Frequency	percentage
Soil texture		
Sandy	6	0.6
Loamy	814	81.4
Clay	155	15.5
Soil testing		
Yes	290	29.0
No	710	71.0
Soil fertility management practices		
Use of organic manure	117	11.7
Crop rotation	20	2.0
Cover cropping	50	5.0
Green manure	130	13.0
Application of chemical fertilizers	83	8.3
Agroforestry	600	60.0
Soil fertility issues		
Soil erosion	164	16.4
Low soil moisture	108	10.8
Soil acidification	180	18.0
Low organic matter	350	35.0
Soil comparison	198	19.8
Management of soil erosion		
Terracing	200	20.0
Mulching	250	25.0
Cover cropping	140	14.0
Agroforestry	400	40.0
Others	10	1.0

Source: *Field survey 2025*

1. Soil Texture

The result on Table 1 shows that the majority of the study area's soil texture was loamy soil with 81.4%, followed by clay soil 15.5% and the lowest being sandy soil with 0.6%. The Implication is that the abundance of loamy soils, which are generally fertile and well-drained, presents a favorable base for plantain cultivation. However, the later entry on soil fertility issues in the table suggests that it is not the inherent soil texture that guarantees productivity, but management does. On the side of soil testing, the findings indicate that 71.0% of the respondents do not conduct soil testing but 29.0% of them do. This indicates that most farmers do not conduct soil testing, an indication of poor awareness or access to diagnosis services. This restricts evidence-based nutrient management and leads to fertilizer under- or overuse, with the ultimate impact on yields and soil health.

With regards to soil fertility management activities, several responses indicate that agroforestry was the dominant practice at 60.0%, green manure 13.0%, organic manure 11.7%, chemical fertilizers 8.3%; cover cropping 5.0% and crop rotation 2.0%. This indicates that high agroforestry adoption is worthy of commendation and points towards incorporating sustainable practices such as shade management and nutrient cycling. Conversely, low application of fertilizer and other agronomic options like cover cropping and rotation are a cause of concern, demonstrating poor soil nutrient replenishment. This explains the persistent soil fertility constraint and necessitates the ability to enhance on integrated soil fertility management (ISFM)

Findings on soil fertility issues reveal low organic matter: 35.0%, soil acidification: 18.0%, erosion: 16.4%; low moisture: 10.8% and the lowest issue was compaction: 19.8%. The implication is that the widest spread issue, low organic matter reveals reduced soil health, most likely caused by intensive cropping, burning, and inadequate residue return.

Compaction and erosion issues contribute to the need for conservation agriculture, mulching, and reduced tillage practices. Result on soil erosion management shows that agroforestry: 40.0%, mulching: 25.0%; terracing: 20.0% and cover cropping: 14.0% which means again agroforestry and mulching are widely practiced, favoring ecosystem-based soil conservation. But the restricted application of terracing and cover cropping point towards a deficiency in sloping or degraded land erosion control. Extension services must encourage locally adapted soil conservation technologies.

Table 2: Production constraints in plantain farming

Variable	Frequency	percentage
Challenges		
Poor soil fertility	500	50.0
Pest and disease infestations	750	75.0
High cost of input	680	68.0
Poor market access	710	71.0
Unfavorable weather	620	62.0
Limited access to extension	860	86.0
Poor infrastructure	920	92.0
Major plantain pests		
Banana weevils	564	56.4
Nematodes	344	34.4
Thrips	86	8.6
Others	6	0.6
Major plantain disease		
Black sigatoka	683	68.3
Bunchy top	183	18.3
Fusarium wilt	127	12.7
Others	7	0.7
Management pests & diseases		
Chemical control	632	63.2
Biological control	220	22.0
Cultural control	112	11.2
Others	36	3.6
Climatic challenges		
Drought	188	18.8
Flooding	102	10.2
High temperature	127	12.7
Erratic rainfall	583	58.3
Access to credit facilities		
Yes	403	40.3
No	597	59.7
Extension services received		
Soil management	105	10.5
Pest & diseases control	75	7.5
Post-harvest handling	66	6.6
Market access	59	5.9
None	695	69.5

Source: *Field survey 2025*

Table 2 results on key challenges facing plantain production indicate poor infrastructure: 92.0%, limited extension access: 86.0%, pest and diseases: 75.0%, poor market access: 71.0% and high cost of inputs: 68.0%. In addition, others are bad weather: 62.0% and poor soil fertility: 50.0%. The implication being that the challenges are multi-faceted, cutting across institutional (extension), infrastructural, biological (pests), and weather factors. The persistence of low fertility and pest problems in the soil is the direct consequence of poor soil management and low input application. The information emphasizes the need for systemic, holistic intervention to raise productivity. From the result on Table 2, the most important plantain pests are banana weevils 56.4%, nematodes 34.4% and thrips 8.6% respectively, and diseases include black Sigatoka: 68.3%, bunchy top: 18.3% and fusarium Wilt: 12.7%. The infestation of banana weevils and Black Sigatoka indicates considerable threats to yield and quality. They are said to reduce root and leaf activity, inhibiting growth and fruiting. This requires integrated pest and disease management (IPDM) like employing resistant varieties and improved cultural practices. Pest and disease control measures findings show that chemical control: 63.2% were the most common control measures

complemented by biological control: 22.0% and cultural control: 11.2%. The extensive application of chemical control is detrimental to environmental degradation, cost, and resistance. Low application of biological and cultural practices reflects inadequate training and sensitization. Extension services require enhancing sustainable pest management practices like trap cropping, biological agents, and sanitation Climatic Challenges affecting plantain farm. Findings of Table 2 pinpointed a number of climatic challenges in plantain production with the most common being erratic rainfall: 58.3%, drought: 18.8%, hot temperature: 12.7% and flooding: 10.2%. Erratic rain represents the most pressing climatic challenge, in accordance with significant dependence on rain-fed agriculture (see above finding.). Climate variability has an impact on flowering, fruiting, and disease epidemics, and calls for irrigation investments and climate-smart agriculture (CSA) practices.

Table 2 findings showed access to credit facilities by respondents with majority not accessing credit facilities at 59.7% and only 40.3 access credit facilities. Poor access to credit prevents farmers from investing in quality inputs, machinery, irrigation, and soil amendments. There is strong argument for promotion of inclusive agricultural financing packages for smallholder plantain farmers. Results on received extension services show that 69.5% of the respondents never had access to any extension service while those who did gain some services in soil management: 10.5%, pest/disease management: 7.5%, post-harvest: 6.6% and market access: 5.9%. This would imply that the lack of extension services for nearly 70% of the farmers severely limits the use of good agricultural practices. Inadequate outreach affects not only productivity but also market orientation and adaptability. This calls for a reformulation of the extension system through the use of both traditional and ICT-based models to provide more support to farmers.

This study outcomes indicate that plantain low productivity is linked with correlated constraints in soil fertility and conservation, pest and disease pressure; poor access to services and inputs; as well as access to credit constraints and climatic variability. The study warrants the importance of integrated interventions such as: improved extension delivery, access to credit and quality inputs, climate-smart agricultural practices and technologies, improved rural infrastructure and participatory soil fertility and pest management programs. In conclusion, the story of plantain production in Nigeria is one of interconnected challenges. The farmer's limited resources and access to credit prevent the adoption of better planting materials and soil management practices. This, in turn, leads to poor soil health and high pest pressure, which results in low yields that reinforce poverty. Breaking this cycle requires a holistic approach that sees the farmer not just as a producer, but as a central agent in a complex system where financial, agronomic, and environmental solutions must be woven together.

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