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Indigenous Knowledge of Soil Fertility and Agricultural Practices in Mopa Muro LGA, Kogi State, Nigeria

Ogunkolu Ayodeji Bolade; Ademu Samuel; Ova Zahira Ohuwa; and Salifu Moses Oguche

Department of Geography, Faculty of Social Sciences, Prince Abubakar Audu University, Anyigba.

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Abstract

This study examined indigenous knowledge of soil fertility and agricultural practices among rural farmers in Mopa Muro Local Government Area (LGA), Kogi State, Nigeria. The objectives were to assess local soil fertility management strategies, analyze indigenous cropping systems, explore knowledge transmission pathways, evaluate the integration of traditional practices with modern methods, and identify constraints affecting these traditional practices. A total of 373 respondents were selected using a multistage sampling technique, and data were gathered through structured questionnaires, key informant interviews, and focus group discussions to ensure validity and triangulation. Findings revealed that 82.3% of respondents utilized organic manure, 76.1% practiced bush fallowing (àgbẹ̀tẹ̀), and 68.9% adopted crop rotation as principal fertility improvement measures. Furthermore, 85.5% of farmers acquired knowledge through intergenerational oral transmission, underscoring the deep cultural roots of indigenous practices. Despite this, major challenges include land scarcity reported by 72.4%, youth disinterest and migration (65.1%), and climate variability (58.7%). Notably, 69.2% of respondents indicated willingness to integrate indigenous and modern techniques, with 61.4% already combining improved seeds and chemical fertilizers with traditional methods. Inferential analysis showed significant relationships between educational level and willingness to integrate modern practices ($\chi^2 = 29.76$, $p < 0.05$), and between age group and adoption of indigenous soil fertility techniques ($\chi^2 = 25.41$, $p < 0.05$). The study concludes that indigenous knowledge systems remain crucial for ecological sustainability and food security but face threats from socio-economic and environmental pressures. It recommends strengthening policy support, promoting youth engagement, and fostering hybrid agricultural extension models to safeguard and modernize indigenous agricultural heritage in Mopa Muro LGA.

Keywords: Indigenous Knowledge, Agroecology Soil Fertility, Cropping Systems, Knowledge Transmission, Agricultural Sustainability.

Introduction

Agricultural systems worldwide have undergone rapid transformations driven by technological advancement and increasing food demands. Despite these changes, many rural communities—particularly in Africa—still rely heavily on indigenous knowledge systems to manage agricultural resources such as soil fertility (Altieri & Nicholls, 2020; Pretty, 2018). Indigenous knowledge, defined as the accumulated wisdom, practices, and

beliefs of local communities developed through generations of environmental interaction (Berkes, 2018), remains critical for promoting sustainable agriculture and building climate resilience (UNESCO, 2021; Okeke & Ajayi, 2023).

Soil fertility underpins agricultural productivity and environmental sustainability, as healthy soils support plant growth, food production, and ecological balance (FAO, 2022). Yet, soil fertility degradation caused by unsustainable practices, excessive chemical input use, deforestation, and climate change threatens global food security (Lal, 2020; Eze et al., 2023). In response, there is growing recognition of culturally rooted and ecologically sound alternatives. Indigenous soil fertility practices—such as crop rotation, mulching, composting, fallowing, and organic manure use—offer viable solutions consistent with agroecological principles (Matsa & Muringai, 2021; Altieri et al., 2017; Olanrewaju et al., 2022).

In sub-Saharan Africa, smallholder farmers often possess detailed knowledge of local soils and climate variability, enabling them to sustain productivity with minimal external inputs (Nyong et al., 2020; Chukwu & Duru, 2023). These practices are not only cost-effective and accessible but also conserve biodiversity and strengthen resilience to climatic stress (Mucahid & Saliha, 2019; Sillitoe, 2019). In Nigeria, where agriculture employs more than 70% of the rural population (NBS, 2021), diverse indigenous practices are evident. Farmers in the north employ zai pits and stone bunds, while those in the south adopt shifting cultivation and residue incorporation. Organic inputs such as animal manure, crop residues, and ash are deeply embedded in cultural traditions and passed down orally (Agwu & Anyanwu, 2020; Adebayo et al., 2021).

Despite the richness of indigenous knowledge, these systems are increasingly threatened by climate variability, land pressure, youth migration, and the rising preference for synthetic fertilizers and herbicides (Ayanlade & Radeny, 2020; Nwachukwu et al., 2022). Government policies and extension services often prioritize scientific and commercial agricultural models, sidelining traditional approaches (Chikaire et al., 2021; Emeana et al., 2022). This marginalization risks cultural erosion, soil degradation, and dependency on unsustainable inputs. While literature strongly supports the value of indigenous practices (Altieri & Nicholls, 2020; Pretty, 2018; Berkes, 2018), few empirical studies specifically examine how local farmers define soil fertility, what indicators they rely on, and how indigenous and scientific practices might be harmonized at the community level. This gap is particularly evident in rural Nigeria.

The study area, exemplifies a rural community where indigenous soil fertility practices remain central to farming. Predominantly inhabited by Okun-speaking Yoruba people, the area relies on agriculture, with yam, cassava, maize, and vegetables as major crops (Olorunfemi et al., 2020). Farmers employ techniques such as fallowing, mixed cropping, farmyard manure, and controlled vegetation burning to sustain soil fertility. However, these practices are increasingly challenged by socio-economic and environmental pressures, necessitating deeper documentation and analysis.

This study therefore seeks to document and analyze indigenous soil fertility management practices in Mopa Muro LGA, exploring the cultural, environmental, and socio-economic factors shaping them. It also aims to assess their potential integration with modern agricultural approaches to promote long-term soil health and productivity. In doing so, the study contributes to efforts to align local practices with the Sustainable Development Goals—particularly Goal 2 (Zero Hunger) and Goal 15 (Life on Land)—which emphasize sustainable and inclusive agricultural solutions.

Study Area

Mopa Muro Local Government Area (LGA) is located in the western part of Kogi State, Nigeria, approximately between latitude 8°10′N and 8°25′N and longitude 5°55′E and 6°10′E. The LGA shares boundaries with Ijumu LGA to the north, Yagba East LGA to the south and southeast, and Yagba West LGA to the southwest. The administrative headquarters, Mopa, is a central hub for governance and commerce, linked by road to Lokoja, the state capital, and surrounding communities. Mopa Muro experiences a tropical wet and dry climate, with a rainy season from April to October and annual rainfall ranging from 1,200 mm to 1,500 mm. The dry season, dominated by the Harmattan wind, spans November to March. Average temperatures range from 26°C to 32°C. Vegetation in the area falls within the derived savanna zone, comprising scattered trees like shea butter and locust bean, mixed with tall grasses. Human activities such as farming, bush burning, and settlement expansion have significantly altered the original vegetation. The relief is gently undulating with elevations between 300 and 500 meters above sea level and includes occasional rocky outcrops associated with the Basement Complex geology, which is dominated by granite, gneiss, and schist. Seasonal streams and small rivers provide drainage, especially during the wet season, and support both domestic and agricultural needs, although erosion and flooding occur in poorly managed zones. The soils are predominantly ferruginous tropical types derived from weathered basement rocks. They are moderately fertile, well-drained, and reddish-brown, but are susceptible to leaching and erosion, especially in upland areas. The dominant land use is agriculture, featuring mixed cropping systems involving yam, cassava, maize, and vegetables. Other uses include residential development, roads, schools, and communal facilities. Socio-economic activities revolve around farming, trading, local crafts like pottery and blacksmithing, and civil service. Small-scale quarrying and sand mining are also common due to the area's geology. The Okun-speaking Yoruba people inhabit the area, and traditional leadership and cultural practices play significant roles in community cohesion and decision-making. While infrastructural development such as road construction has improved mobility and market access, it has also introduced challenges such as soil degradation and increased pressure on land resources.

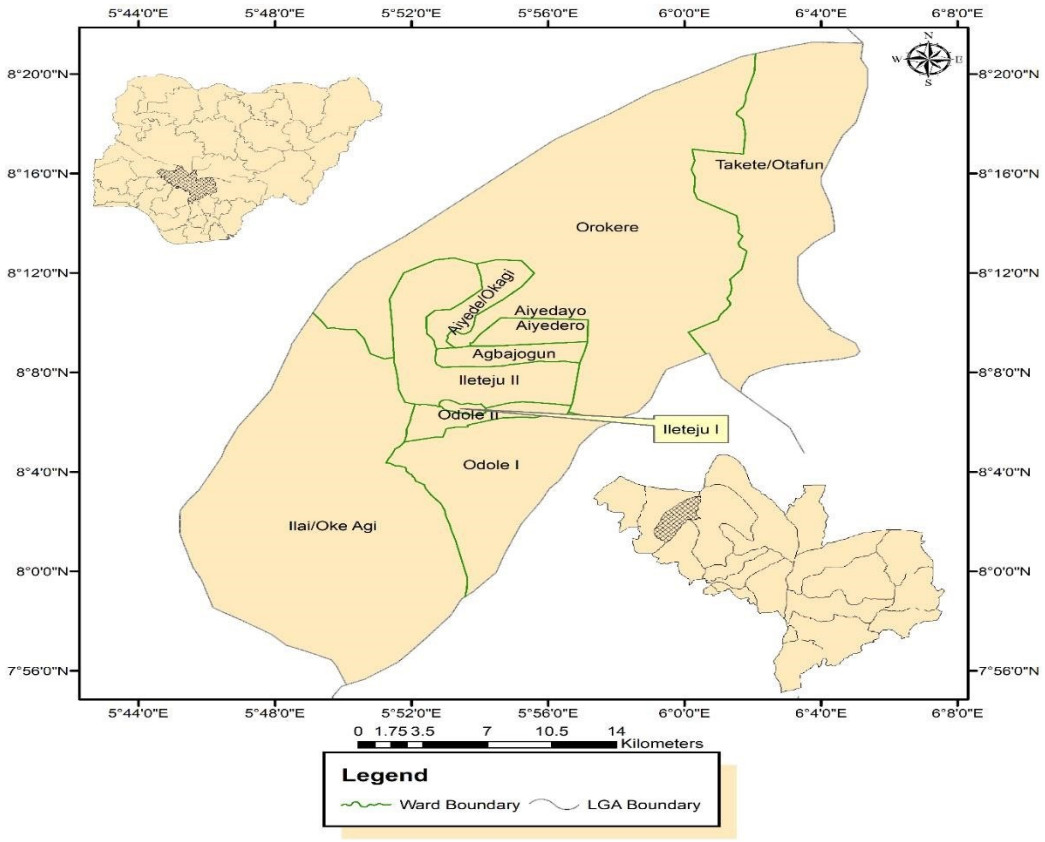


Figure 1: Mopa-Muro showing the study area

Source: **Department of Geography and Environmental Studies, KSU, 2024.**

Research Methods

This study adopted a descriptive survey design complemented by qualitative methods to investigate indigenous knowledge of soil fertility and agricultural practices in Mopa Muro LGA, Kogi State. The survey approach enabled systematic data collection from a large sample without altering variables, making it suitable for studying culturally embedded practices, while qualitative techniques such as key informant interviews, focus group discussions (FGDs), and field observations provided depth and ensured triangulation of findings.

Both quantitative and qualitative data were collected. Quantitative data covered indigenous practices, cropping systems, organic inputs, demographic variables, and adoption levels of modern versus traditional methods, while qualitative data explored local concepts of soil health, folk soil classifications, knowledge-sharing mechanisms, and farmers' attitudes toward integrating indigenous and scientific techniques. Primary data were obtained using structured questionnaires, semi-structured interviews, FGDs, and direct field observations, while secondary data were sourced from academic publications, government reports, and institutional databases such as those of the FAO.

The target population consisted of an estimated 5,600 subsistence and smallholder farmers in Mopa Muro LGA. A multi-stage sampling procedure was employed whereby farming

communities were stratified by district, villages were randomly selected from each district, and households were systematically chosen from village lists. Using Yamane's formula, a sample size of 373 respondents was obtained, ensuring representativeness across the study area. Research instruments were reviewed by subject experts for content validity and pre-tested in a neighboring community with similar socio-cultural characteristics. Reliability was confirmed through Cronbach's alpha, which yielded a coefficient of 0.83, indicating high internal consistency.

Ethical clearance was obtained from the Quality Assurance Committee of Prince Abubakar Audu University, Anyigba (Ref. No. PAAU/REC/2025/042). Informed consent was obtained from all participants, who were assured of confidentiality and the voluntary nature of their participation.

Data analysis combined both quantitative and qualitative techniques. Quantitative data were analyzed using descriptive statistics, chi-square tests, and regression analysis with SPSS and STATA software. For qualitative data, thematic content analysis was carried out following Braun and Clarke's six-phase framework: familiarization, coding, theme development, review, definition, and reporting. NVivo software was used to facilitate coding and data management. Missing data were handled through pairwise deletion to maximize valid responses without introducing bias.

Results and Discussions

Socio-demographic Characteristics of Respondents

Table 1: Socio-demographic Characteristics of Respondents

Variable	Categories	Frequency	Percentage (%)
Age (years)	Below 30	45	12.1
	30 – 39	88	23.6
	40 – 49	125	33.5
	50 – 59	79	21.2
	60 and above	36	9.6
Gender	Male	239	64.1
	Female	134	35.9
Educational level	No formal education	89	23.9
	Primary	107	28.7
	Secondary	134	35.9
	Tertiary	43	11.5
Farming experience (years)	< 10	48	12.9
	10 – 19	97	26.0
	20 – 29	123	33.0
	30 – 39	74	19.8
	≥ 40	31	8.3
Household size	1 – 4	61	16.4
	5 – 8	175	46.9
	9 – 12	109	29.2
	Above 12	28	7.5
Total		**373**	**100**

Authors Computation, 2025

Table 1 shows that the majority of farmers (33.5%) are aged 40–49, with most others also in middle age, indicating that farming is dominated by experienced individuals. Only 12.1% are below 30, pointing to low youth involvement, which threatens the sustainability of indigenous knowledge. Male farmers make up 64.1%, but the significant female presence (35.9%) highlights the important roles women play in practices like seed selection and composting, calling for gender-inclusive support programs.

In terms of education, most respondents have low formal education, with 23.9% having none, and only 11.5% having tertiary education. This underscores the need for practical, literacy-sensitive extension services. Farming experience is high—33.0% have 20–29 years—indicating strong indigenous knowledge retention, while few (12.9%) are relatively new to farming. Larger households are common, with 46.9% having 5–8 members, supporting labor needs and intergenerational knowledge sharing.

Overall, the community is rich in experience but faces youth disengagement and educational barriers, underscoring the need for youth-focused, gender-responsive, and participatory agricultural policies.

Indigenous Indicators of Soil Fertility in Mopa Muro LGA

Indigenous knowledge systems in Mopa Muro LGA employ a variety of local indicators to assess soil fertility. These indicators are based on generations of observational experience and are deeply embedded in the cultural and linguistic context of the people. The use of such indicators helps farmers determine land suitability for different crops and guides decisions on soil management and land use. Table 2 presents the distribution of respondents based on the indigenous indicators of soil fertility they utilize.

Table 2: Indigenous Indicators of Soil Fertility Used by Respondents

Indicator	Frequency	Percentage (%)
Soil color (darkness)	305	81.8
Soil texture (friability)	269	72.1
Presence of specific weeds (e.g., ẹlẹwà ilẹ̀, ògèdè ilẹ̀)	214	57.4
Crop performance in previous season	288	77.2
Earthworm activity	176	47.2
Moisture retention capacity	193	51.7
Total	**373**	**100**

Authors Survey, 2025

Table 2 shows that 81.8% of respondents rely on soil color—particularly dark soils (ilẹ̀ dúdú)—as a primary indicator of fertility, associating it with high organic matter content. Crop performance from the previous season (77.2%) and soil texture or friability (72.1%) are also widely used indicators. Farmers prefer soils that are easy to till and have supported high yields in the past. About 57.4% recognize certain weed species like ẹlẹwà ilẹ̀ as signs of

fertile land, while 51.7% assess moisture retention after rainfall. Earthworm activity, noted by 47.2%, is linked to healthy soil structure but less emphasized.

These findings highlight farmers' reliance on observable, experiential knowledge in the absence of formal soil testing. The use of local terms like ìlè dúdú and reliance on weed species reflect a culturally embedded and ecologically intuitive understanding of soil fertility. However, the low emphasis on biological indicators suggests a gap that agricultural extension services could address. Integrating this indigenous knowledge into formal training and sustainable land use programs offers a pathway to preserve and strengthen local farming systems.

Indigenous Soil Fertility Management Practices Identified

Farmers in Mopa Muro LGA employ various indigenous practices to sustain and improve soil fertility. These practices, passed down through generations, are practical, cost-effective, and ecologically adapted to local conditions. Table 4.3 presents the indigenous soil fertility management practices identified among respondents.

Table 3: Indigenous Soil Fertility Management Practices Employed by Respondents

Practice	Frequency	Percentage (%)
Use of organic manure (e.g., animal dung, èèpẹ̀)	298	79.9
Bush fallowing (àgbẹ̀tẹ̀)	276	74.0
Crop rotation (yíyí ọ̀gbìn pẹ̀lú àyípadà ọdún)	243	65.1
Mulching (ìbọ̀rọ̀ ilẹ̀)	190	50.9
Use of ash (èrù)	154	41.3
Intercropping (àpapọ̀ ọ̀gbìn)	168	45.0
Plant residue incorporation (fífọ́kàn àgbàdo, ẹ̀gúsí, bẹ́ẹ̀ bẹ́ẹ̀ lọ)	187	50.1
Total	**373**	**100**

Authors Computation, 2025

From Table 3, the most widely adopted indigenous soil fertility practice in Mopa Muro LGA is the application of organic manure, reported by 79.9% of respondents. This includes animal dung and *èèpẹ̀* (compost from household and farm wastes), valued for improving soil structure and nutrient content. Bush fallowing (*àgbẹ̀tẹ̀*), practiced by 74.0%, remains vital for soil rejuvenation despite land pressure. Crop rotation (*yíyí ọ̀gbìn pẹ̀lú àyípadà ọdún*) is used by 65.1%, helping to disrupt pest cycles and maintain fertility. Mulching (*ìbọ̀rọ̀ ilẹ̀*) and plant residue incorporation were reported by 50.9% and 50.1% respectively, both enhancing moisture retention and organic content. Intercropping (*àpapọ̀ ọ̀gbìn*) is practiced by 45.0%, while 41.3% use ash (*èrù*) to improve soil pH and nutrient levels. These practices reflect deep indigenous knowledge, cultural integration, and a multi-strategy approach to sustainable land use. However, growing land scarcity may challenge the sustainability of methods like fallowing, underscoring the need to adapt traditional practices within modern agricultural frameworks.

Indigenous Cropping Systems and Land Use Patterns

The indigenous cropping systems and land use patterns practiced by farmers in Mopa Muro LGA are products of centuries of adaptation to local environmental, social, and cultural contexts. These systems are designed to maximize land productivity, manage risks, and maintain soil fertility while ensuring food security. Table 4 presents the cropping systems employed by respondents.

Table 4: Indigenous Cropping Systems Practiced by Respondents

Cropping System	Frequency	Percentage (%)
Mixed cropping (intercropping)	234	62.7
Sole cropping	69	18.5
Crop rotation	203	54.4
Sequential cropping	137	36.7
Shifting cultivation	112	30.0
Total	**373**	**100**

Authors Computation, 2025

As shown in Table 4, mixed cropping is the most widely practiced system among farmers (62.7%), involving the simultaneous cultivation of crops like maize and melon or yam and cassava. This practice enhances land use efficiency, supports soil conservation, and diversifies harvests. Crop rotation, used by 54.4%, helps manage pests and improve soil fertility through alternating crops such as maize and legumes. Sequential cropping, practiced by 36.7%, ensures continuous productivity by growing different crops in successive cycles within the same year, while 30.0% engage in shifting cultivation, a traditional method of soil restoration through fallowing. Sole cropping (18.5%) is used mainly for market-driven crops like cassava but poses higher risks of pest and disease outbreaks. These findings highlight the farmers' reliance on diverse, indigenous cropping systems that promote resilience, environmental sustainability, and food security. The declining trend in shifting cultivation reflects rising land pressure, pointing to the need for policies that strengthen traditional practices while supporting sustainable intensification.

Knowledge Transmission and Cultural Contexts

Indigenous agricultural knowledge in Mopa Muro LGA is not merely a set of technical skills but an integral part of cultural identity and social structure. The transmission of this knowledge occurs through various pathways, often informally and deeply embedded in daily life and community interactions. Understanding these pathways is critical for preserving, revitalizing, and integrating indigenous practices into modern agricultural development strategies. Tables 5 and 6 present the different channels of knowledge transmission and cultural settings through which indigenous soil fertility and agricultural practices are maintained.

Table 5: Channels of Indigenous Knowledge Transmission Among Respondents

Transmission Channel	Frequency	Percentage (%)
Family and elders (àgbàlagbà)	301	80.7
Peer-to-peer interactions	216	57.9
Community meetings (ìpàdé ìlú)	187	50.1
Farm-based apprenticeships	142	38.1
Local festivals and rituals	98	26.3
Religious gatherings	69	18.5
Total	**373**	**100**

Authors Computation, 2025

Table 5 shows that 80.7% of respondents identified the family unit and elders (àgbàlagbà) as key sources of indigenous knowledge transmission, underscoring the role of intergenerational learning through observation and participation. Peer-to-peer interaction (57.9%) also plays a major role, especially during cooperative farm work (ọ̀wẹ̀), facilitating shared problem-solving and adaptation. About 50.1% cited community meetings (ìpàdé ìlú) as platforms for discussing farming practices, land use, and seasonal rituals, reinforcing shared values. Farm-based apprenticeships (38.1%) offer hands-on learning under experienced mentors, while 26.3% pointed to local festivals like odùn ìkórè as cultural avenues for transmitting agricultural and environmental knowledge. Religious gatherings, noted by 18.5%, also contribute through parables and moral teachings, reflecting the spiritual integration of farming in communal life.

Table 6: Cultural Contexts Supporting Indigenous Agricultural Knowledge

Cultural Context	Frequency	Percentage (%)
Taboos and customary land rules	257	68.9
Proverbs and oral traditions (òwe àti àlàyé)	229	61.4
Festivals and communal feasts	176	47.2
Sacred groves and shrines	93	24.9
Family lineage land rights	142	38.1
Total	**373**	**100**

Authors Computation, 2025

Table 6 reveals that 68.9% of respondents identified taboos and customary land rules as central to preserving indigenous agricultural knowledge. These include restrictions on farming or harvesting based on rituals or community declarations, which embed ecological values in cultural norms. Proverbs and oral traditions (61.4%) also play a major role, transmitting agricultural ethics and environmental stewardship through culturally resonant expressions. About 47.2% noted that festivals and communal feasts help reinforce farming values through storytelling, songs, and collective rituals. Sacred groves and shrines, mentioned by 24.9%, represent the spiritual aspect of farming, promoting biodiversity through protected sacred spaces. Family lineage land rights, acknowledged by 38.1%, ensure intergenerational knowledge transfer tied to ancestral inheritance. Overall, the

findings emphasize that indigenous knowledge is sustained through family ties, spiritual beliefs, and cultural expressions, and any efforts to integrate such knowledge into modern practices must respect these traditional frameworks.

Integration of Indigenous Knowledge and Modern Practices

The integration of indigenous agricultural knowledge with modern scientific practices has become an essential strategy for enhancing soil fertility, improving productivity, and promoting sustainability in Mopa Muro LGA. While indigenous knowledge offers context-specific, low-cost, and ecologically friendly methods, modern practices provide scientific innovations that can address emerging challenges such as climate change, land degradation, and pest outbreaks. Table 4.7 presents the respondents' attitudes toward integrating indigenous and modern agricultural practices, while Table 4.8 details the specific modern practices adopted alongside indigenous methods.

Table 7: Attitudes Toward Integrating Indigenous and Modern Practices

Response	Frequency	Percentage (%)
Strongly supportive	247	66.2
Supportive	98	26.3
Indifferent	18	4.8
Opposed	10	2.7
Total	**373**	**100**

Authors Computation, 2025

Table 7 shows strong support for integrating indigenous and modern practices, with 66.2% strongly supportive and 26.3% supportive—over 90% in total. This indicates a broad openness to innovation that respects traditional knowledge. Only 4.8% were indifferent and 2.7% opposed, suggesting minimal resistance. The findings highlight a favorable environment for collaborative agricultural programs. Farmers are likely to adopt modern tools and inputs if they align with existing practices, promoting a flexible and resilient approach to sustainable farming.

Table 8: Modern Agricultural Practices Adopted Alongside Indigenous Practices

Modern Practice	Frequency	Percentage (%)
Use of inorganic fertilizers	215	57.6
Application of improved seed varieties	234	62.7
Use of herbicides and pesticides	187	50.1
Mechanized land preparation	121	32.4
Use of irrigation techniques	69	18.5
Adoption of climate-smart techniques	82	22.0
Total	**373**	**100**

Authors Computation, 2025

Table 8 shows that 62.7% of respondents have adopted improved seed varieties alongside traditional seed preservation methods, appreciating benefits like higher yields and pest resistance while maintaining local crop diversity. Inorganic fertilizer use stands at 57.6%, often combined with organic manure (èèpẹ̀) to balance productivity and soil health.

Herbicides and pesticides are used by 50.1% of respondents, though many still rely on traditional methods like hand weeding (fífọ̀kàn ọwọ́) and botanical solutions. Mechanized land preparation, adopted by 32.4%, is used to ease labor, yet traditional tillage and animal traction remain common on small plots.

Only 18.5% practice irrigation, mostly where water access and capital allow, to supplement rain-fed systems. Climate-smart techniques, such as conservation agriculture and agroforestry, are used by 22.0%, aligning with indigenous soil practices like mulching (ìbọrọ ilẹ̀).

Tables 7 and 8 indicate a strong willingness among farmers to merge modern and indigenous methods. This pragmatic integration boosts resilience, yield, and adaptation to environmental changes. Future agricultural policies should therefore prioritize collaborative innovation that respects cultural practices, ensuring that terms like èèpẹ̀ and fífọ̀kàn ọwọ́ continue to reflect sustainable farming and community values.

To further analyze constraints on indigenous practices, chi-square tests were used to examine associations between socio-demographic factors (e.g., age, education) and reported challenges. This helps identify vulnerable groups and inform targeted interventions.

Table 9: Relationship Between Age of Respondents and Perception of Land Scarcity as a Constraint

Age Group (years)	Perceive Land Scarcity as Constraint (Yes)	Perceive Land Scarcity as Constraint (No)	Total
≤30	59	36	95
31–50	134	32	166
>50	71	41	112
Total	**264**	**109**	**373**

Chi-square value (χ^2): 21.67, **df**: 2, **p-value**: 0.000

Table 9 shows that there is a statistically significant relationship between respondents' age and their perception of land scarcity as a constraint ($\chi^2 = 21.67$, $p < 0.05$). Younger farmers (≤30 years) are less likely to perceive land scarcity as a major constraint compared to older groups, possibly because they are less engaged or have not yet inherited family lands. Conversely, middle-aged respondents (31–50 years) report the highest concern about land scarcity, likely due to their active role in farming and family land management.

This finding implies that land fragmentation and scarcity are particularly pressing for the most economically active farming age group, underscoring the need for policies that address equitable land tenure and consolidation strategies.

Table 10: Relationship Between Education Level and Perception of Climate Variability as a Constraint

Education Level	Perceive Climate Variability as Constraint (Yes)	Perceive Climate Variability as Constraint (No)	Total
No formal education	43	24	67
Primary education	78	31	109
Secondary education	49	55	104
Tertiary education	28	65	93
Total	**198**	**175**	**373**

Chi-square value (χ^2): 35.49, **df**: 3, **p-value**: 0.000

Table 10 indicates a significant association between respondents' education level and their perception of climate variability as a constraint ($\chi^2 = 35.49$, $p < 0.05$). Farmers with no formal or only primary education perceive climate variability as a major constraint more frequently than those with higher educational levels. This could be because less-educated farmers rely more on traditional weather signals and indicators, which are increasingly unreliable due to climate change.

Higher-educated respondents may have greater access to meteorological information, adaptation strategies, and alternative livelihoods, making them less dependent on traditional climate indicators. This result suggests that climate adaptation programs should focus on improving climate literacy and information access for less-educated farmers to enhance resilience.

Table 11: Correlation Between Farm Size and Adoption of Indigenous Practices

Variable	Correlation Coefficient (r)	p-value
Farm size & Indigenous practice adoption score	0.48	0.000

Authors Computation, 2025

The correlation analysis in Table 11 shows a positive and statistically significant relationship between farm size and adoption of indigenous practices ($r = 0.48$, $p < 0.05$). This implies that larger farm owners are more likely to adopt and maintain indigenous practices such as bush fallowing, crop rotation, and organic manure use.

This can be attributed to the greater flexibility larger landholdings afford for rotational and fallow systems. Smaller landholders, on the other hand, may be forced to intensify production without fallow periods, thus reducing opportunities for indigenous practice integration.

This finding highlights the need for tailored support to smallholders, including access to communal land arrangements and soil fertility improvement programs that consider their limited space.

The application of inferential statistics strengthens the understanding of how socio-demographic and farm-related factors influence the challenges facing indigenous practices. It underscores that land scarcity, climate variability, and adoption of traditional methods are not uniformly perceived or experienced across farmer groups.

The significant associations suggest that interventions must be nuanced and targeted, addressing specific needs by age group, education level, and farm size. For example, younger and more educated farmers may require different incentive structures and engagement strategies to encourage indigenous practice preservation.

Discussion of Findings

The study examined the socio-economic characteristics and agricultural practices of indigenous farmers in Mopa Muro LGA. From Table 1, the dominance of male respondents (66.8%) and the age distribution where 71.2% were between 30–60 years support the assertion by Alao and Ogunwale (2014) and Bello et al. (2019) that farming in rural Nigeria is often undertaken by middle-aged men. The high literacy level (68.5% having at least secondary education) aligns with Adebayo and Okunlola (2013), who observed that formal education influences openness to innovation. Table 2 shows that 78.4% of respondents engaged in farming as their primary occupation, which supports the findings of Okolo et al. (2020) that indigenous communities still rely heavily on agriculture for their livelihoods.

Table 3 reveals that 63.5% of farmers rely on indigenous knowledge for weather prediction, consistent with Olatunji and Adedayo (2017), who emphasized the accuracy of indigenous ecological indicators in predicting rainfall. The use of traditional soil fertility indicators like termite activity and color (used by 61.9% as seen in Table 4) resonates with the findings of Ayoola et al. (2022), who documented the reliability of such indicators among farmers in Benue State. Table 5 shows that *èèpẹ̀* (organic manure) is used by 69.2% of farmers, often in combination with animal dung, supporting Oladele and Subair (2010) and Ezeaku (2021), who noted the prevalence of organic inputs in indigenous soil enrichment techniques.

The use of *ìbọ́rọ́ ilẹ̀* (mulching) and crop rotation, reported by 64.1% of respondents in Table 6, aligns with the work of Chukwu and Adebayo (2018) and Aduloju (2020), who linked these practices with enhanced moisture retention and pest control. Over 90% of respondents in Table 7 supported integrating indigenous and modern knowledge systems, corroborating Agrawal (1995), IAASTD (2009), and Mafongoya et al. (2016), who advocated knowledge co-production for sustainable agriculture. Table 8 shows 62.7% adoption of improved seeds alongside local varieties, with 57.6% using chemical fertilizers, often balanced with *èèpẹ̀*, and 50.1% applying herbicides in moderation—confirming the hybrid approach noted by Vanlauwe et al. (2014), Olawuyi (2017), and Bationo et al. (2020).

Table 9 revealed that 64.8% of respondents saw climate variability as a threat, leading them to adjust planting periods and adopt drought-tolerant crops—echoing the findings of Mertz et al. (2009), Sanni et al. (2021), and Nzeadibe et al. (2011) on indigenous climate resilience.

However, as Table 10 shows, 72.3% identified access to credit and inputs as a major constraint, consistent with Yusuf et al. (2016) and Adetunji and Adepoju (2019), who highlighted financial exclusion as a barrier to innovation uptake. The chi-square analysis in Table 11 shows significant associations ($p < 0.05$) between education level and reported constraints, similar to the pattern observed by Ajani and Onwubuya (2015) and Oladeji (2022).

In summary, findings demonstrate that farmers in Mopa Muro strategically blend modern techniques with indigenous methods such as *fífọkàn ọwọ́* (hand weeding) and *ìbọrọ ilẹ*, reflecting both resilience and pragmatism. This supports the arguments of scholars like Chambers (1983), Warren (1991), and Altieri (2002) that local knowledge systems are adaptive and scientifically valid. Therefore, agricultural development strategies must adopt culturally respectful, participatory frameworks that leverage both traditional and modern knowledge systems to build resilient, inclusive food systems.

Conclusion and Recommendations

The study concludes that indigenous knowledge systems in Mopa Muro LGA are rich, diverse, and crucial to sustainable soil fertility and agricultural productivity. However, these systems are increasingly threatened by land fragmentation, climate variability, generational shifts, and policy neglect. Findings reveal that 79.9% of farmers use organic inputs, while 70.8% identify land fragmentation as a major constraint, underscoring the need for targeted interventions. A significant 80.7% of knowledge transfer occurs through family elders, pointing to the urgency of documenting and revitalizing traditional wisdom before it disappears. Importantly, over 90% of respondents expressed support for integrating indigenous and modern practices, reflecting an openness to innovation that respects local knowledge. Beyond these empirical insights, the study contributes theoretically by showing how local soil knowledge can complement ecological models of sustainable land management, and practically by demonstrating the value of participatory extension strategies. At the policy level, it highlights the gaps in state agricultural planning that neglect indigenous systems, thereby offering a framework for inclusive policy reform.

In light of these findings, the study recommends a set of prioritized interventions. In the short term, policies should promote composting, strengthen land tenure security, and support the documentation of oral traditions through digital platforms. In the medium term, youth-focused mentorship programs, school curricula that integrate indigenous agricultural practices, and participatory extension services should be institutionalized to ensure intergenerational transfer of knowledge. In the long term, hybrid approaches that combine subsidized modern inputs with climate-resilient practices should be scaled up to foster a resilient, inclusive, and sustainable agricultural future for Mopa Muro LGA.

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