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Review Article

Farmers' Awareness and Perceptions of Seasonal Soil Dynamics Across Agricultural Land-Use Systems

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Abstract

Seasonal soil dynamics, expressed through changes in moisture, temperature, structure, porosity, colour and nutrient availability, are central to agricultural productivity and sustainability. These changes are shaped by land-use systems and management practices, yet farmers' understanding and interpretation remain underexplored across agricultural systems. This study comparatively examines farmers' awareness and perceptions of seasonal soil changes across varied land-use systems in southwestern Nigeria. A cross-sectional survey of 700 farmers was conducted using structured questionnaires to capture awareness, perceptions, and information sources related to seasonal soil dynamics. Data were analysed using descriptive statistics and chi-square tests. Results show generally high awareness of seasonal soil variability, with 69.7% of respondents very aware of wet–dry season differences and 58.1% rating their awareness as very high. The dry season was identified as the least productive period by 97.0% of farmers, while 80.9% linked low yields to declining soil conditions. Most farmers relied on personal experience rather than formal extension services. Wet-season improvements in soil properties contrasted sharply with widespread dry-season degradation. The chi-square test indicated a statistically significant deviation in awareness levels ($\chi^2 = 467.93$, $p < 0.05$), highlighting the need to integrate farmers' experiential knowledge with scientific soil assessment and targeted extension support programmes.

Keywords

Seasonal Soil Dynamics, Farmer Awareness, Agricultural Land-Use Systems, Soil Productivity, Sustainable Soil Management

1. Introduction

Soil constitutes the foundation of agricultural production, yet it is not a static medium. Rather, soil is a dynamic and living system whose physical, chemical, and biological properties vary seasonally in response to climatic conditions and land management practices. Seasonal soil dynamics, including fluctuations in moisture, temperature, structure, nutrient availability, and biological activity, exert direct and indirect effects on crop growth, yield stability, and long-term soil sustainability [4]. In tropical agro-ecosystems, where rainfall regimes are strongly seasonal, these variations are particularly pronounced and consequential.

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Agricultural land-use systems, such as annual cropping, agroforestry, and conservation-based systems, differ substantially in how they mediate seasonal soil processes. Management practices, including tillage intensity, residue management, fertilizer application, and crop diversification, influence the extent to which soils retain moisture, resist erosion, and sustain nutrient cycling across seasons [11, 12]. Seasonal changes in soil temperature and moisture further interact with land-use practices to shape nutrient availability, especially nitrogen dynamics, highlighting the sensitivity of soil fertility to both climatic and management factors [7].

Despite extensive scientific understanding of soil processes, the effectiveness of sustainable soil management ultimately depends on farmers' awareness, perceptions, and interpretations of soil change. Farmers' decisions are strongly shaped by experiential knowledge, local beliefs, and socio-economic constraints, which influence how environmental signals are perceived and acted upon [13, 14]. Indigenous and local knowledge systems have historically supported farmers' capacity to manage seasonal variability; however, these systems are increasingly challenged by climate change, agricultural intensification, and shifting socio-economic conditions [9, 14].

Research shows that farmers' awareness of soil dynamics varies widely. Many farmers easily identify visible signs such as soil hardness or surface crusting, but are less aware of slower, hidden processes like organic matter decline or changes in microbial activity [5]. Research from the African Highlands highlights that this focus on surface indicators hinders the adoption of sustainable land management practices, especially when extension services are limited [6]. Additionally, farmers' perceptions are influenced by their access to information, cultural beliefs, economic constraints, and attitudes towards risk, resulting in varied responses even in similar environmental conditions [13].

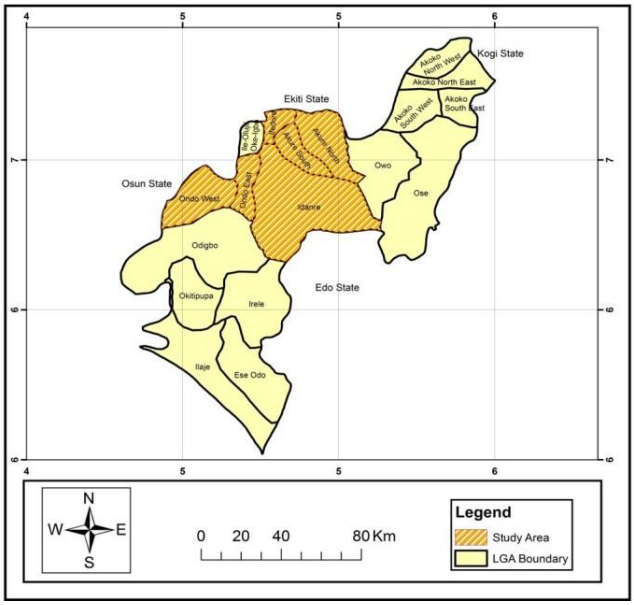
While seasonal soil dynamics have been widely documented in soil science literature [2, 3], integrated analyses that link land-use systems, farmer awareness, and perceptions of seasonal soil change remain limited. This knowledge gap restricts effective communication between scientific research and farm-level decision-making. Having insight into how farmers perceive and interpret seasonal soil dynamics across different land-use systems is therefore essential for designing context-appropriate soil management strategies.

This study addresses this gap by comparatively analysing farmers' awareness and perceptions of seasonal soil dynamics across varied agricultural land-use systems in some parts of Ondo State, southwestern Nigeria. Specifically, the study aims to (i) assess farmers' awareness of seasonal soil changes, (ii) examine their perceptions of how these changes affect soil productivity and crop performance, and (iii) evaluate the implications for sustainable soil management and climate adaptation. By grounding analysis in farmers' lived experiences, the study seeks to inform the co-design of extension strategies and policies that enhance soil resilience and agricultural sustainability.

2. Materials and Methods

2.1. Study Area

The study was conducted in six Local Government Areas (LGA) of Ondo State, southwestern Nigeria. Ondo State lies within the tropical rainforest zone and experiences a humid climate characterized by distinct wet and dry seasons. The region is underlain by diverse soil types, predominantly Alfisols, which support crops such as cocoa, cassava, and maize. Geological formations include Precambrian Basement Complex rocks in the northern parts and sedimentary formations in the south, contributing to spatial variability in soil properties and agricultural potential. Agriculture constitutes the dominant livelihood activity, complemented by forestry and trading.



Source: Modified After Ondo State Survey Department, Akure

Figure 1. *Map of Ondo State showing the study Areas.*

2.2. Research Design and Sampling

A cross-sectional survey design was adopted to capture farmers' awareness and perceptions at a single point in time. A stratified random sampling approach ensured representation across different agricultural land-use systems and socio-demographic categories. A total of 700 farmers participated in the study. The sample size was determined using Yamane's (1967) formula and supported by convenience sampling to ensure adequate statistical power.

2.3. Data Collection

Primary data were collected through face-to-face administration of structured questionnaires. The instrument captured information on socio-demographic characteristics, observations of seasonal soil changes, perceived impacts on crop productivity, awareness of soil indicators, and sources of information regarding soil dynamics.

2.4. Variables and Data Analysis

Farmers' awareness levels were measured on a five-point Likert scale ranging from "not aware" to "very aware." Perceptions of seasonal soil change were recorded using categorical responses. Data were analysed using descriptive statistics and chi-square tests to examine deviations in awareness levels. Statistical significance was assessed at $p < 0.05$ using SPSS version 23.

3. Results

3.1. Awareness of Seasonal Soil Changes

Farmers demonstrated a high level of awareness of seasonal soil changes (Table 1). A majority (69.7%) reported being very aware of differences in soil quality between the wet and dry seasons, while 23.0% indicated moderate awareness. Only a small fraction (7.2%) reported low awareness, and 2.1% were unsure.

Table 1. *Farmer awareness of seasonal soil changes.*

Awareness level	Frequency	Percentage (%)
Very aware	488	69.7
Moderately aware	161	23.0
Not very aware	36	5.1
Not sure	15	2.1
Total	700	100.0

Author's Analysis, 2025

When asked to rate their overall awareness of soil changes across seasons (Table 2), 58.1% reported very high awareness, 20.0% reported high awareness, 19.3% moderate awareness, and 2.6% low awareness.

Table 2. *Self-rated awareness of soil changes across seasons.*

Self-rated awareness level	Frequency	Percentage (%)
Very high	407	58.1
High	140	20.0
Moderate	135	19.3
Low	18	2.6
Total	700	100.0

Author's Analysis, 2025

3.2. Seasonal Productivity Perceptions

Farmers were asked which season they considered least productive (Table 3). An overwhelming majority (97.0%) identified the dry season as the period of lowest soil productivity.

Table 3. *Seasonal soil productivity perceptions.*

Least productive season	Frequency	Percentage (%)
Dry season	679	97.0
Planting season	11	1.6
Harvesting season	10	1.4
Total	700	100.0

Author's Analysis, 2025

When asked whether low crop yields were associated with poor seasonal soil conditions, 80.9% agreed, while 19.1% did not make this connection.

3.3. Sources of Information

Farmers largely relied on personal experience as their primary source of information about how soil changes (Table 4). Experiences accounted for 69.0% of responses, while extension programmes (9.7%), community meetings or seminars (10.4%), school (1.9%), and media (1.1%) were less commonly cited.

Table 4. *Sources of information about soil changes.*

Source of information	Frequency	Percentage (%)
Personal experience	483	69.0
Community meetings/seminars	73	10.4
Extension programme	68	9.7

Source of information	Frequency	Percentage (%)
School	13	1.9
Media	8	1.1
Combination (others)	55	7.9
Total	700	100.0

Author's Analysis, 2025

3.4. Seasonal Soil Property Observations

During the wet season, 81.6% of farmers observed increased soil moisture, whereas a smaller proportion (18.4%) noted erosion as a prominent characteristic. Observations of improved soil physical properties, including texture, structure, porosity, and nutrient availability, reflected a positive view of wet-season conditions.

3.5. Seasonal Changes in Soil Physical Properties

Farmers reported pronounced seasonal differences in soil physical properties across land-use systems. During the wet season, most respondents perceived improvements in soil condition (Table 5). Improved soil texture was reported by 97.7% of farmers, while soil structure (91.4%), nutrient status (96.0%), porosity (93.3%), and color (83.6%) were also widely perceived to improve. These responses suggest that rainfall plays a critical role in enhancing soil physical quality and productivity.

Table 5. *Perceived soil changes during the wet season (n = 700).*

Soil property	Improved (%)	Constant (%)	Declined (%)
Texture	97.7	1.7	0.6
Structure	91.4	7.9	0.7
Nutrients	96.0	3.9	0.1
Porosity	93.3	5.9	0.9
Colour	83.6	14.7	1.7

Author's Analysis, 2025

In contrast, the dry season was associated with widespread soil degradation (Table 6). A majority of farmers reported declines in soil texture (85.9%), structure (91.0%), nutrients (85.0%), porosity (95.9%), and color (74.1%), reflecting the negative impacts of moisture stress.

Table 6. *Perceived soil changes during the dry season (n = 700).*

Property	Improved (%)	Constant (%)	Declined (%)
Texture	0.4	13.7	85.9
Structure	0.3	8.7	91.0
Nutrients	0.1	14.9	85.0
Porosity	1.3	2.9	95.9
Colour	0.1	25.7	74.1

Author's Analysis, 2025

Farmers also showed strong awareness of climate-related soil challenges, with most attributing soil degradation to inadequate rainfall, shortened wet seasons, prolonged dry seasons, and increased temperatures. Rising temperature was strongly linked to soil compaction and nutrient decline. In addition, 75.3% of farmers associated cattle invasion during dry periods with soil degradation.

Regarding soil fertility management, most farmers relied on visual observation (83.7%) to assess soil fertility, and soil compaction was identified as the major dry-season challenge (64.6%). Most respondents (79.4%) recognized soil differences across land-use types, while fertility management was dominated by inorganic fertilizer use (58.7%), with limited application of organic amendments.

3.6. Statistical Difference in Farmers' Awareness and Perception of Seasonal Soil Dynamics

A chi-square test results in Table 7, revealed a statistically significant deviation from the expected distribution, χ^2 (3, N = 700) = 467.93, $p < 0.05$. Specifically, the majority of farmers (n = 407) reported a "Very High" level of awareness, which is considerably higher than the expected count of 175. Conversely, only 18 farmers reported "Low" awareness, which is substantially below the expected frequency. The categories "High" and "Moderate" also showed smaller but notable deviations from expectation, with 140 and 135 responses, respectively.

Table 7. Contingency Table: Rating of Awareness of Soil Changes.

Awareness Level	Observed (O)	Expected (E = 700/4)	(O - E)^2 / E
Very High	407	175	303.88
High	140	175	7.00
Moderate	135	175	9.14
Low	18	175	147.91
Total	700		467.93

Author's Analysis, 2025

4. Discussions

The findings demonstrate a high level of farmer awareness of seasonal soil dynamics, particularly the contrast between wet and dry seasons. The predominance of "very high" awareness reflects the strength of experiential knowledge accumulated through long-term engagement with local agro-ecosystems. Similar studies emphasize that repeated exposure to climatic variability sharpens farmers' ability to interpret environmental change [10, 16].

The widespread identification of the dry season as the least productive period aligns with established evidence linking moisture deficits to soil compaction, reduced porosity, and nutrient decline [1, 4]. Farmers' attribution of yield losses to poor seasonal soil conditions further underscores the salience of soil moisture as a key driver of productivity in rain-fed systems.

However, the heavy reliance on personal experience as the primary information source highlights a critical gap in formal knowledge dissemination. While experiential knowledge enables farmers to respond to visible soil changes, it may limit awareness of less observable processes such as organic matter depletion or microbial dynamics [5]. This pattern echoes findings from Okoro & Tordue, who emphasize the need to integrate scientific soil assessment with farmers' local observations [8].

Perceived wet-season improvements in soil texture, structure, and nutrient status are consistent with evidence that adequate moisture enhances aggregation and nutrient cycling [15]. Conversely, widespread reports of dry-season degradation reflect processes such as crusting and compaction under moisture stress [1]. Farmers' limited recognition of erosion during the wet season suggests potential underestimation of long-term soil loss risks, supporting earlier observations by Yusuf [17].

The significant variation in awareness levels indicates that land-use systems and management practices influence how farmers perceive seasonal soil change. Diversified systems may buffer climatic extremes, while monoculture systems expose farmers to more pronounced degradation signals. These findings reinforce the importance of tailoring extension interventions to specific land-use contexts.

5. Implications for Sustainable Soil Management

The results highlight the need for soil management strategies that build upon farmers' existing knowledge while addressing identified gaps. Extension programmes should link scientific soil indicators with observable field-level signs to enhance relevance and adoption. Climate-smart practices, such as residue retention, cover cropping, and organic amendments, can be more effectively promoted when framed in terms of farmers' experiences with moisture retention and soil degradation.

6. Conclusion

This study demonstrates that farmers across different agricultural systems possess a high level of awareness of seasonal soil dynamics and their implications for crop productivity. While experiential knowledge forms a strong foundation for soil management decisions, limited engagement with scientific insights constrains the adoption of sustainable practices. Bridging local knowledge with science-based soil management through targeted extension support is essential for enhancing soil resilience, climate adaptation, and long-term agricultural sustainability.

Abbreviations

LGA Local Government Area

Author Contributions

Olukemi Abimbola Funmilayo: Conceptualization, Project administration, Supervision, Validation

Temidayo Michael Fapohunda: Funding Acquisition, Writing – review & editing

Albert Orodena Aweto: Conceptualization, Project administration, Supervision, Validation, Visualization

Conflicts of Interest

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