



OPEN ACCESS

EDITED BY

Festus A. Asaaga,
UK Centre for Ecology and Hydrology
(UKCEH), United Kingdom

REVIEWED BY

Syam Viswanath,
Indian Council of Forestry Research and
Education (ICFRE), India
Kwabena Asiamah,
Kwame Nkrumah University of Science and
Technology, Ghana

*CORRESPONDENCE

Soulé Akinhola Adéchian
✉ adechians@yahoo.com

RECEIVED 01 May 2025

ACCEPTED 08 September 2025

PUBLISHED 02 October 2025

CITATION

Adéchian SA and Baco MN (2025) How does
land tenure security contribute to the
sustainable development of rural households?
Evidence from Benin (West Africa).
Front. Sustain. Food Syst. 9:1621537.
doi: 10.3389/fsufs.2025.1621537

COPYRIGHT

© 2025 Adéchian and Baco. This is an
open-access article distributed under the
terms of the [Creative Commons Attribution
License \(CC BY\)](#). The use, distribution or
reproduction in other forums is permitted,
provided the original author(s) and the
copyright owner(s) are credited and that the
original publication in this journal is cited, in
accordance with accepted academic
practice. No use, distribution or reproduction
is permitted which does not comply with
these terms.

How does land tenure security contribute to the sustainable development of rural households? Evidence from Benin (West Africa)

Soulé Akinhola Adéchian* and Mohamed Nasser Baco

Laboratoire Société-Environnement, Université de Parakou, Parakou, Benin

In rural economies where land is a critical asset, tenure security plays a pivotal role in sustainable development. While previous research emphasized the economic impacts of secure land rights, their broader social and environmental contributions remain underexplored. This study investigates how land tenure security affects economic, social, and environmental dimensions of sustainable development in rural Benin. Using a mixed-methods approach—household surveys ($n = 372$), focus group discussions, and key informant interviews—and structural equation modeling, the analysis reveals that secure land rights significantly enhance investment, credit access, social cohesion, gender equality, and sustainable land practices such as agroforestry. Stronger legal rights (land titles and ADC/CFR certificates) yield more substantial benefits compared to land use certificates or no documentation. The findings highlight land governance as a cross-cutting driver of SDGs 1, 2, 5, 13, and 15. The study recommends inclusive, gender-sensitive, and context-adapted land policies to foster rural sustainability and resilience.

KEYWORDS

sustainable development, land rights, tenure security, rural household, West Africa

1 Introduction

In rural sub-Saharan Africa, where land remains the most critical productive asset, land tenure security plays a central role in achieving sustainable development. Secure access to land underpins not only agricultural production and household income but also broader goals related to social equity, environmental stewardship, and local governance (Adimassu et al., 2016; Ekpodessi and Nakamura, 2022). Land tenure security refers to the assurance that individuals or groups can use, manage, and transfer land without fear of dispossession (Arnot et al., 2011; Flintan et al., 2024). It is a multidimensional concept that goes beyond the mere legal recognition of land rights. Legal tenure security relates to the formal recognition of rights by the state through official documents such as titles or certificates (Arnot et al., 2011; Keudem et al., 2023), while perceived tenure security reflects landholders' subjective assessment of the likelihood of losing their land based on social legitimacy, regardless of legal documentation (Van Gelder, 2009). Land tenure security also encompasses both individual and collective rights and increasingly emphasizes women's rights as a cornerstone of equity (Flintan et al., 2024). Each form of land tenure security can influence investment decisions, social cohesion, and environmental stewardship in different ways (Ekpodessi and Nakamura, 2022; Valkonen, 2021). Across development discourse, the notion of land tenure security is increasingly framed as a cross-cutting lever for progress toward the Sustainable Development Goals (SDGs),

particularly SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 5 (Gender equality), SDG 13 (Climate action), and SDG 15 (Life on land).

There is robust theoretical and empirical evidence supporting the positive economic implications of secure land rights. Clearly defined and legally recognized tenure arrangements encourage long-term investment in land, enhance access to agricultural credit, and stimulate livelihood diversification (Abdulai et al., 2011; Bambio and Agha, 2018; Barrows and Roth, 1990; Ekpodessi and Nakamura, 2022; Gedefaw et al., 2020; Long et al., 2024). When farmers are confident in their claims to land, they are more willing to adopt strategies such as infrastructure development, tree planting, or soil conservation—actions that often require delayed returns but generate significant productivity gains. These relationships are particularly relevant in the context of land reforms and agricultural transformation processes underway in many African countries, including Benin (Akowedaho et al., 2022; Pierri et al., 2025).

Yet the importance of land tenure security extends beyond economics. Socially, secure land rights have been shown to strengthen social cohesion, reduce disputes, and empower marginalized groups such as women, youth, migrants, and pastoralists (Ajefu and Abiona, 2020; Manara, 2025; Mwangi, 2024; Valkonen, 2021). By legally recognizing the land rights of vulnerable populations, governments can promote equity, reduce land-related conflicts, and support participatory governance mechanisms. Land tenure security also facilitates civic engagement by enabling rural populations to participate in decision-making processes that shape their future (Guinin Asso et al., 2022).

Environmentally, secure land tenure is associated with more sustainable land use. Farmers who are confident that they will not lose their land are more likely to invest in practices that protect long-term soil fertility, water resources, and biodiversity (Asaaga et al., 2020). Recent research has linked tenure security with the adoption of agroecological practices, conservation agriculture, and reforestation (Azadi et al., 2021; Pezzagno et al., 2020; Venkatesh and Velkennedy, 2024). This supports Ostrom's theory of collective action, which posits that well-defined and enforceable property rights foster the responsible governance of natural resources, particularly in contexts where land is communally managed (Ostrom, 1990).

There are still significant knowledge gaps in spite of this expanding body of evidence. First, most of the research that is currently available evaluates land tenure reforms' effects on the economy, society, or environment separately. A comprehensive understanding of how land rights impact sustainable development as a multifaceted and interconnected process is undermined by this disjointed approach (Holden et al., 2017; Jabareen, 2008; Platteau, 1996). Second, few studies examine how the three dimensions of tenure security interact. While legal security is often equated with strong land rights, perceived security may in practice be more decisive for investment and social cohesion when enforcement mechanisms are weak (Lawry et al., 2017). The relative impacts of various land tenure arrangements are not well understood. The contributions of customary land rights or land use certificates are less evident, even though private land titles are frequently thought to offer the highest level of security. This is particularly true in situations where there are multiple legal systems and population pressures (Byamugisha, 2021; Zevenbergen et al., 2013).

This study seeks to address these gaps by adopting an integrated, household-level analysis of land tenure security and its contributions to sustainable development in rural Benin. Using a mixed-methods approach, including surveys, focus groups, and key informant interviews, the study investigates how different forms of land rights influence economic development, social inclusion, and environmental sustainability. Particular attention is given to the strength of land rights and their impact on gender equity, intergenerational security, and climate-resilient land practices.

By anchoring the analysis within the broader global agenda for sustainable development, this research provides empirical evidence to inform land governance strategies in Benin and beyond. It contributes to a systemic understanding of land tenure security as a catalyst for transformative rural development and supports the design of inclusive, gender-sensitive, and ecologically sound land policies aligned with the SDGs.

2 Literature review and hypothesis

2.1 Land rights and economic development

The relationship between land rights and economic development has been widely studied, with numerous scholars highlighting its positive and significant impact on economic outcomes (Abdulai et al., 2011; Ho, 2021). Secure land tenure is generally associated with increased agricultural investment, improved access to credit, and enhanced economic stability for farming households (Platteau, 1996). By reducing uncertainty regarding land ownership, tenure security encourages long-term investments in land improvement, mechanization, and sustainable farming practices, thereby fostering rural economic growth (Akowedaho et al., 2022; Gedefaw et al., 2020).

Private land ownership has been particularly emphasized in the literature as a key driver of economic development. According to the Byamugisha (2013), land ownership enhances collateral value, allowing farmers to access financial resources necessary for agricultural expansion and entrepreneurship. Studies by Bambio and Agha (2018) further highlight the role of secure land tenure in facilitating land transactions and boosting informal asset values. However, it is crucial to contextualize these findings, particularly in rural settings where customary and communal land tenure systems remain prevalent.

Despite the widely acknowledged benefits of land tenure security, the link between private property rights and investment remains contested. Ho (2021), drawing on evidence from Vietnam, argues that the magnitude of this impact is sensitive to both observed and unobserved confounding factors, making the overall effect modest. Similarly, Platteau (1996) contends that the benefits attributed to private or legal land rights are often overestimated, emphasizing the high costs and limited effectiveness of formal titling programs in rural settings. Instead, he advocates for alternative solutions that integrate existing informal tenure arrangements and community-based mechanisms. In this regard, the relationship between perceived tenure security and investment is complex and influenced by various factors, including legal frameworks, social dynamics, and economic conditions (Liu et al., 2023; Sun et al., 2025). Households with a strong perception of tenure security are more likely to invest in land management (Liu et al., 2023). Conversely, low perceived security can

discourage such long-term investments, even when legal documentation is present (Van Gelder, 2009).

A critical factor influencing the economic impact of land tenure security is the strength of land rights. Bambio and Agha (2018) suggest that the causality between land tenure and investment is contingent on the robustness of land rights. Their findings indicate that stronger land rights correlate with increased agricultural investment, while weaker rights—such as customary land tenure—may provide limited economic benefits. These insights underscore the importance of considering the diversity of tenure systems when evaluating land policies.

Building on this perspective, the present study aims to assess the differential impacts of various land tenure arrangements on rural economic development.

Unlike conventional approaches that focus primarily on agricultural investment, this research adopts a multidimensional view of economic development at the farm household level, considering not only investment but also income diversification, market participation, and financial resilience. This broader lens contributes to a more systemic understanding of how land rights affect economic outcomes, thereby addressing an important gap in the literature, where economic effects are often treated in isolation from social and ecological dynamics (Guinin Asso et al., 2022; Naude, 2021). By contextualizing economic development within the realities of rural livelihoods, this study seeks to provide a more nuanced understanding of land tenure security and its economic implications.

H1.1: Land tenure rights positively influence the economic development of farm households.

H1.2: The positive impact of land tenure on agricultural investment increases with the strength (nature) of land tenure.

2.2 Land rights and environmental sustainability

The relationship between land tenure security and environmental sustainability has garnered increasing attention in recent years. While empirical evidence remains fragmented, a growing body of research underscores the role of secure land rights—particularly collective and community land rights—in the sustainable management of natural resources, including rural land (Azadi et al., 2021). Sustainable land use and management are now widely recognized as key drivers for poverty reduction and long-term environmental sustainability (Asaaga et al., 2020). Secure land tenure provides landowners and communities with the incentives to engage in conservation efforts, adopt agroecological practices, and invest in soil and water conservation techniques (Azadi et al., 2021; Aznar-Sanchez et al., 2019).

Collective and community land tenure systems, in particular, have been associated with improved environmental stewardship. Research suggests that when communities have legally recognized rights over land and natural resources, they are more likely to implement sustainable management practices that ensure the long-term viability of these resources (Guinin Asso et al., 2022). This aligns with Ostrom's (1990) theory of collective action, which highlights the effectiveness of locally governed land systems in preventing resource depletion and promoting sustainable land use.

However, while collective land rights demonstrate clear environmental benefits, the impact of individual land rights on sustainable land management remains ambiguous. Some scholars argue that formalized individual land tenure can promote better land use practices by increasing the accountability of landholders and encouraging long-term investments in conservation (De Zeeuw, 1997). On the other hand, studies also suggest that insecure or fragmented land tenure can lead to environmentally detrimental behaviors, such as deforestation, overgrazing, and excessive chemical input use (Adechian et al., 2020). Farmers experiencing tenure insecurity may prioritize short-term gains over long-term sustainability, leading to land degradation and resource depletion.

The complexity of these interactions highlights the need for context-specific and integrated approaches to land tenure security. However, most studies treat environmental sustainability as a secondary outcome of land tenure reforms, without systematically examining how different tenure types shape long-term land stewardship. This study explicitly models these effects in conjunction with economic and social dimensions, thus contributing to a more comprehensive analytical framework for understanding the sustainability implications of land governance reforms.

H2.1: Land tenure has a positive impact on environmental sustainability.

H2.2: The positive impact of land tenure on environmental sustainability increases with the strength (nature) of land tenure.

2.3 Land rights and social development/pro-poor growth

The social implications of land rights have been widely debated in the literature, particularly regarding their role in fostering inclusive development. Secure land tenure is a key driver of social stability, reducing conflicts, and promoting equitable access to resources. Valkonen (2021) highlights that land rights enhance participation in decision-making processes, empowering marginalized groups such as women, youth, and indigenous communities. By providing legal recognition of ownership, land tenure security strengthens individuals' bargaining power, enabling them to claim their rights and actively engage in economic and social activities.

Empirical evidence suggests that land tenure security contributes to social security by fostering stability, social cohesion, and integration of vulnerable groups. Guinin Asso et al. (2022) demonstrate that secure land rights improve accessibility, land use efficiency, and the social inclusion of women, young people, herders, and migrants.

However, while these studies confirm the positive role of land tenure in social development, they often fail to distinguish between different types of land rights and their interactions with economic and environmental conditions. Most importantly, the lack of integrative frameworks limits our ability to capture the full potential of land tenure security to drive pro-poor and inclusive rural development. This study addresses that gap by exploring the synergistic effects of land rights on social inclusion, ecological protection, and economic empowerment.

A pro-poor approach to land registration is essential for ensuring rapid and cost-effective land security for marginalized populations.

[Zevenbergen et al. \(2013\)](#) argue that accessible land registration systems can facilitate land security for the poor, allowing them to establish legal ownership and participate in property markets. Understanding whether all forms of land tenure are equally effective in fostering social inclusion and reducing inequalities is critical for designing inclusive land policies.

Additionally, several studies emphasize the role of secure land rights in preventing and managing land conflicts, reducing gender disparities, and improving food security. [Deininger et al. \(2021\)](#); [Handoko \(2020\)](#); [Kehinde et al. \(2021\)](#) highlight that clearly defined land rights mitigate disputes, promote gender equity by granting women formal ownership, and enhance household food security by incentivizing sustainable agricultural investments.

H3.1: Land rights have a positive influence on social development/pro-poor growth.

H3.2: The positive impact of land tenure on social development (pro-poor growth) increases with the strength (nature) of land tenure.

2.4 The impact of land rights: toward holistic impact measurement

The literature reviewed above demonstrates that land tenure security has significant economic, social, and environmental implications. However, these impacts are often analyzed in isolation, making it difficult to comprehensively assess the role of land rights in sustainable development. While some studies focus on land tenure's influence on economic development—primarily through investment—others examine its environmental sustainability contributions, particularly through community-based land management. Additionally, social development aspects, such as conflict resolution, gender equity, and empowerment, have received considerable attention.

Despite these contributions, the fragmented nature of existing research limits a holistic understanding of land rights' overall impact. Most studies adopt sectoral approaches that separately assess economic, environmental, or social effects, often using unrelated conceptual or methodological frameworks. This compartmentalized perspective overlooks the interdependencies and feedback loops that define sustainable development in practice. This study addresses this critical gap by using structural equation modeling to assess simultaneously the pathways linking land tenure to each pillar of sustainable development. By doing so, it advances the empirical literature and contributes to a theory-informed, system-based framework for analyzing land governance reforms in the Global South.

[Jabareen \(2008\)](#) highlights the absence of a comprehensive theoretical framework for understanding sustainable development as a multifaceted concept. Effective land tenure policies should contribute to sustainable development by addressing fundamental human needs, integrating economic progress with environmental protection, fostering social equity, and ensuring cultural and self-determination rights ([Tomislav, 2018](#)).

This study aims to bridge the gap by adopting a systemic approach that examines land tenure's interconnected effects on economic, social, and environmental dimensions. By modeling the impact of land rights

on sustainable development as a whole, the research seeks to provide nuanced insights that inform more effective and inclusive land policies.

While the economic, social, and environmental effects of land tenure security have been documented separately, little effort has been made to integrate them into a unified analytical framework. This study fills that gap by providing empirical evidence on the multidimensional effects of land tenure security using a mixed-methods design and structural modeling. It offers a novel contribution to sustainable development research by clarifying how land governance reforms can simultaneously promote inclusive growth, environmental protection, and social equity.

3 Methodology

3.1 Study context

This research analyzes the effects of land rights on rural households in the department of Borgou in Benin, located in West Africa ([Figure 1](#)). Borgou has been the focus of several land tenure reforms since 2007, including the Rural Land Plans (PFR) and the Systematic Cluster Approach (ASG), implemented through various land programs ([Guinin Asso et al., 2022](#)). More recently, the department has also benefited from the national Cadaster initiative.

Since 2007, several types of land certificates have been promoted in Borgou, including the Certificate of Rural Land (CFR), the Customary Tenure Certificate (ADC), standardized use contracts (CT), local conventions for collective land rights, and pastureland protection agreements. Borgou also hosts the largest reserve of agricultural land in Benin, making it an ideal setting to assess the impact of land rights on sustainable development among farming households. Data for this study were collected in the district of N'Dali, which, according to local government records, has issued the highest number of land tenure documents in the department.

It is important to note that both the CFR and ADC serve as presumptions of private ownership based on customary rights, while the standardized use contract (CT) represents a rental or usage agreement, all governed by Benin's land tenure law. In contrast, the Land Title (TF) offers the highest level of land security, conferring incontestable private ownership.

3.2 Data collection

The data collection process consists of two phases. The first phase focuses on constructing locally accepted indicators for measuring sustainable development based on rural households' perspectives. The second phase assesses the impact of land rights on each dimension of sustainable development.

Phase 1: Co-construction of sustainable development Indicators that make sense for rural household.

The measurement of sustainable development dimensions varies significantly across communities and must reflect local realities. According to [Joumard \(2019\)](#), sustainable development should be socially constructed based on community aspirations. Therefore, this study relies on stakeholder perceptions to define relevant measurement indicators for each sustainable development dimension influenced by land rights.

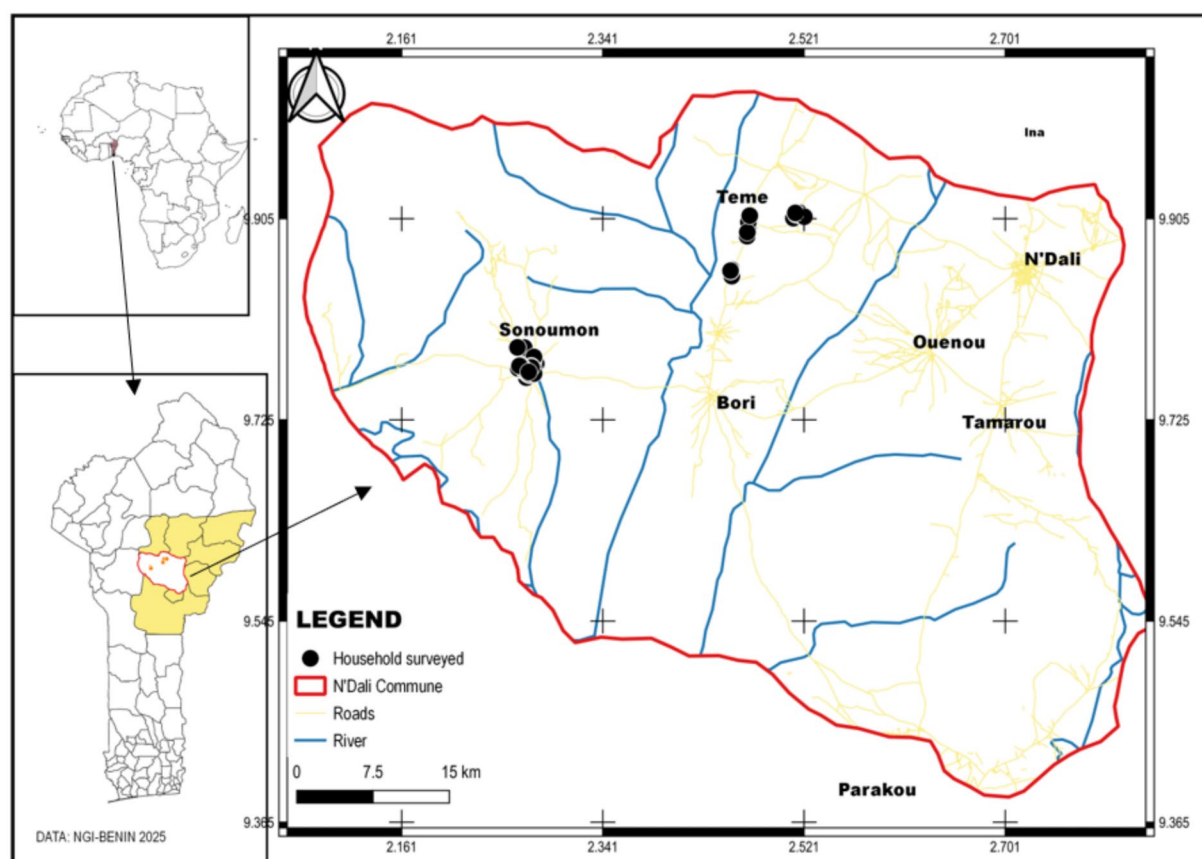


FIGURE 1
MAP showing study area in Borgou, Benin. Source: Authors.

Focus group discussions (FGDs) were conducted to collaboratively identify measurable indicators for each dimension of sustainable development: (i) economic development, (ii) environmental sustainability, and (iii) social development. Participants were asked to identify key aspects of sustainable development that they believe are influenced by land rights.

The FGDs were conducted in villages benefiting from land tenure security interventions in the municipality of N'Dali (Borgou). Three categories of stakeholders were involved:

- Farming households with secured land rights.
- Local land governance institutions: Village Land Management Section (SVGF), Land Management Committee (CoGeF), and Conciliation Tribunal (TC).
- Cooperatives and farmer organizations: representatives of women's groups, livestock herders, farmers, and youth associations.

A separate FGD was held for each stakeholder category to ensure that all groups, particularly women and youth, could freely express their point of views.

Data from this phase were synthesized to identify different changes in sustainable development based on the perceptions of stakeholders. The results were validated through a village assembly to ensure they accurately reflected community perceptions. The validated

indicators were then used in the second phase as measurement items for sustainable development dimensions.

Phase 2: Measuring the impact of land rights on sustainable development.

The study investigates farming households in Borgou and classifies them into four categories based on their land tenure status:

- Households with Land Titles (TF).
- Households with Customary Tenure Certificates (ADC).
- Households with Standard Contracts (CT).
- Households without any formal land tenure documents.

We determined the sample size using the formula:

$$\frac{z^2 \cdot p(1-p)}{e^2} \div \left(1 + \frac{z^2 \cdot p(1-p)}{e^2 N} \right)$$

where:

N = total number of farming households (11,293, RNA, 2022).

e = margin of error.

z = critical value.

Using this formula, the required sample size was calculated as 372 farming households. Household heads were randomly selected to participate in the study.

3.3 Variable measurement

Table 1 presents the specifications of the variables included in the analysis model. We designed a structured questionnaire for data collection.

To ensure data reliability and validity, a pilot test was conducted with a small subset of households before full-scale data collection. Adjustments were made to improve clarity and relevance. This step helps us to validate constructed items before data collection. In Appendix 2, we present the measurement indicators of development pillars.

3.4 Data analysis

Data analysis followed a systematic approach using both descriptive and inferential statistical techniques.

We perform descriptive statistics by calculating frequencies, percentages, and measures of central tendency (mean, median, standard deviation) to summarize household characteristics and tenure status. We also conducted reliability analysis by calculating Cronbach's alpha. This allows to assess the internal consistency of measurement constructs related to economic, social, and environmental dimensions of sustainable development.

We perform Structural Equation Modeling (SEM) to analyze the relationships between land tenure security and sustainable development indicators. The Diagonally Weighted Least Squares (DWLS) method was employed due to the ordinal nature of the data (DiStefano and Morgan, 2014). Model fit was evaluated using key indices, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA).

We finally used thematic analysis using qualitative data from interviews and FGDs to identify recurring patterns and contextual nuances regarding land tenure security.

The combination of these analytical techniques provided a robust framework for understanding the multifaceted impact of land rights on sustainable rural development. The findings from the analysis informed key policy recommendations aimed at enhancing land governance and tenure security in Benin.

4 Results

4.1 Descriptive statistics of rural households

The descriptive statistics of the rural households that participated in the study are shown in Table 2, emphasizing important land-related, economic, and demographic traits. Eighty-six percent of the sample is male, and 62 % of the adults in the sample are between the ages of 36 and 55. Of these, 62 % do not have a formal education. A smaller percentage (11 percent) manage <2 hectares, while the majority (58

percent) own between 2 and 20 hectares. While 39 percent of households are able to save to some degree, 40 percent of households struggle to meet their expenses, either through borrowing or using savings. Significant tenure insecurity is highlighted by the distribution of land rights, which shows that 34% rely on customary land rights, 45% lack formal land certificates, and 3% have formal land titles. These results highlight important issues that affect land tenure security and sustainable rural development, such as gender inequality, low levels of education, economic vulnerability, and limited formal land ownership.

4.2 Measurement model

The measurement model, which looks at the connection between latent variables and their measures, is an essential part of the SEM. We used Cronbach's α to measure the convergent validity. Table 3 showed that a value of α near one indicated good convergent validity. Table 3 also displays the items' standard deviation and average value.

We used the Diagonally Weighted Least Squares (DWLS) method as the method effectively handles ordinal or non-normal data (DiStefano and Morgan, 2014). As presented in Tables 4, a good fit was demonstrated across a number of indices, such as the Tucker-Lewis Index (TLI) and the Comparative Fit Index (CFI), with value approaches of 1 for the Goodness of Fit Index (GFI) (Savalei, 2021). In addition, the SRMR and RMSEA values are within the excellent range of <0.05 (Iacobucci, 2010).

The R-squared values indicate the variance in the endogenous (dependent) variables accounted for by the exogenous (independent) variables in the model. Behavior predictions with $R^2 = 0.37$ for EcD, $R^2 = 0.23$ for SoD, and $R^2 = 0.27$ for EnD are acceptable; however, $R^2 = 0.18$ for Land right, respectively, is slightly low (Table 5).

4.3 Structural relationships

We illustrate in this section the results of the structural equation model that shows how the rural household profile affects land security and the impact of land security on each aspect of sustainable development. Figure 2 synthesizes the significant structural relationships while the Table 6 contains the overall parameter estimates.

4.4 Factors involved in land tenure security in rural areas

The Figure 2 provides insight into the key factors influencing land tenure security (Land_Right). Among demographic factors, gender/sex plays a significant role, with males having a positive and strong association ($\beta = 0.27$, $p < 0.001$), indicating that men are more likely to secure land rights compared to women. This result highlights gender disparities in access to land ownership, often driven by cultural and institutional biases that disadvantage women in rural areas.

The level of education significantly influences land tenure security. Households with post-secondary education (Education3) exhibit the strongest positive effect ($\beta = 0.22$, $p < 0.001$), followed by basic formal education (Education1) ($\beta = 0.14$, $p = 0.027$). In contrast, secondary

TABLE 1 Variable measurement.

Category of variable (type)	Variables	Definition
Household characteristics (exogenous variables)	Extension Service	Access to government agricultural extension services: 1 if household has access; 0 if otherwise
	Age of Head (years)	1 if young: under 35 years of age 2 if adult: between 35 and 54 years of age 3 if old: 55 and over
	Sex (gender)	A binary indicator of gender of household head: 1 if male headed; 0 if female-headed
	Formal education	An ordinal variable indicating the level of the formal education of household head: 0 if no formal education 1 if basic/primary formal education 2 if secondary formal education 3 if post-secondary formal education
	Arable land size	An ordinal variable indicating the size of arable land size of the household head: 1 if land size is less than or equal to 2 ha 2 if land size is between 2.1 and 20 ha 3 if land size is between 21 and 100 ha 4 if land size is more than 101 ha
Land tenure right (endogenous variables)	Land tenure right	An ordinal variable indicating the level of land tenure right held by the household head: 1 No land certificate 2 Land use certificate 3 Customary land right 4 Land Title
Sustainable development (endogenous variables)	Economic development	A five-point Likert scale variable based on the economic effect of holding land tenure right ranging from: 1 strongly disagree to 5 strongly agree.
	Social development	A five-point Likert scale variable based on the social effect of holding land tenure right ranging from: 1 strongly disagree to 5 strongly agree.
	Ecologic sustainable	A five-point Likert scale variable based on the investment in environmentally sustainable practices because of holding land tenure right ranging from: 1 strongly disagree to 5 strongly agree.

education (Education2) does not have a significant effect ($p = 0.108$). These results underscore the importance of education in facilitating knowledge about formal land registration processes and navigating land governance systems. Higher education levels empower individuals to claim and secure land rights more effectively. It facilitates the collaboration with institutions involved in land registration process.

Land size has a negative association with land tenure security, particularly for households with moderate to large landholdings. For instance, households with 2.1–20 ha (Land_size1) ($\beta = -0.29$, $p = 0.026$) and those with 21–100 ha (Land_size2) ($\beta = -0.40$, $p = 0.002$) report significantly lower land tenure security compared to those with small landholdings (≤ 2 ha). This unexpected finding could reflect disputes or challenges associated with larger landholdings, such as conflicts over ownership, boundary disputes, or the lack of formal documentation for inherited or acquired land. In addition, it has revealed that the negative effect of land size on land tenure security is linked to the high cost and complexity of formal land registration processes.

Household income is positively associated with land tenure security, particularly for those with higher financial stability. Households where income “allows strengthening savings” (Revenue4, $\beta = 0.22$, $p = 0.012$) or “simply meets expenses” (Revenue2, $\beta = 0.18$, $p = 0.028$) are more likely to secure land rights. This result indicates

that financial stability facilitates formal land registration processes, which often involve costs such as legal fees, surveys, or administrative procedures.

4.4.1 Impact of land rights on sustainable development

The results show that land rights positively influence all four dimensions of sustainable development: economic, social, and environmental development (EcD, SoD, EnD).

4.4.1.1 Economic development (EcD)

Land rights have positive impact on economic development ($\beta = 0.61$, $p < 0.001$), highlighting the critical role of secure land tenure in improving economic outcomes. Households with formal or secure land rights are more likely to invest in agricultural productivity, access credit, and engage in income-generating activities. This result emphasizes the economic value of land security in rural areas, where land often serves as the primary asset for livelihoods.

Secure land rights through formal certificates like ADC and TE, provide landholders with a sense of stability and protection from land disputes or expropriation. This security incentivizes individuals to make long-term investments in their land, such as improving

TABLE 2 Characteristic of rural households involved in the research.

Variables	Modalities	Frequency	%
Sex (gender)	Female	30	14
	Male	192	86
Age	Young: under 35 years of age	40	18
	Adult: between 36 and 55 years of age	138	62
	Old: 56 and over	44	20
Formal education	No formal education (Education 0)	137	62
	Basic formal education (Education 1)	32	14
	Secondary formal education (Education 2)	46	21
	Post-secondary formal education (Education 3)	7	3
Land size	Land size is less than or equal to 2 ha (Land size 0)	24	11
	Land size is between 2.1 and 20 ha (Land size 1)	128	58
	Land size is between 21 and 100 ha (Land size 2)	59	27
	Land size is more than 101 ha (Land size 3)	11	5
Income of household	Your income is really not sufficient, so you need to borrow to meet expenses (Income 0)	44	20
	Your income is not sufficient, so you need to use your savings to meet expenses (Income 1)	45	20
	Your income simply meets your expenses (Income 2)	47	21
	Your income allows you to save a little (Income 3)	47	21
	Your income allows you to strengthen your savings (Income 4)	39	18
Land Right level	No land certificate	101	45
	Land use certificate	39	18
	Customary land right certificate	75	34
	Land Title	7	3

TABLE 3 Convergent validity.

Latent variables	Mean	SD	Cronbach's α
EcD	3.85	0.82	0.96
SoD	3.82	0.81	0.93
EnD	3.79	0.71	0.87

TABLE 4 Fit indices.

Label	Value	Reference value
CFI	0.98	Close to 1
TLI	0.971	Close to 1
GFI	0.991	Close to 1
SRMR	0.045	<0.05
RMSEA	0.044	<0.05

TABLE 5 R-squared.

Endogenous variables	R ²	95% confidence intervals	
		Lower	Upper
EcD	0.37	0.27	0.47
SoD	0.23	0.14	0.33
EnD	0.27	0.17	0.37
Land_Right	0.18	0.10	0.28

agricultural practices, infrastructure, or equipment, ultimately boosting productivity and income. Land right security facilitates the access to credit and financial Services to owners. Formal land rights serve as collateral for credit from banks and microfinance agencies. This access allows individuals to invest in businesses, improve agricultural yield, or pursue other income-generating activities that contribute to economic development, as shown by the following statement.

I was the first to do the ADC in this village (Tebo). I earned a lot from it. The advantage I had was the credit at the bank (PADME). When I had not done that, I was in debt and the credit I found at the bank was insufficient to carry out my farming activities. But when I did the ADC, I went to the bank and they took me on like a big person and granted me the amount of credit I requested. This allowed me to do a lot of acreage and earn a lot. I've been able to pay off my debts and do a lot of things. Even the armchairs in my room were bought with my production profits from the credit I found.

Source: B. SAKA GOUNOU, Male household head, age 56, Tebo (Nikki), october 2024.

Finally, secure land rights help build wealth for landowners by protecting their primary asset. As wealth accumulates, landowners can pass down assets to future generations, contributing to long-term economic development. In Benin, this generational wealth-building strengthens economic stability and community resilience. Evidences

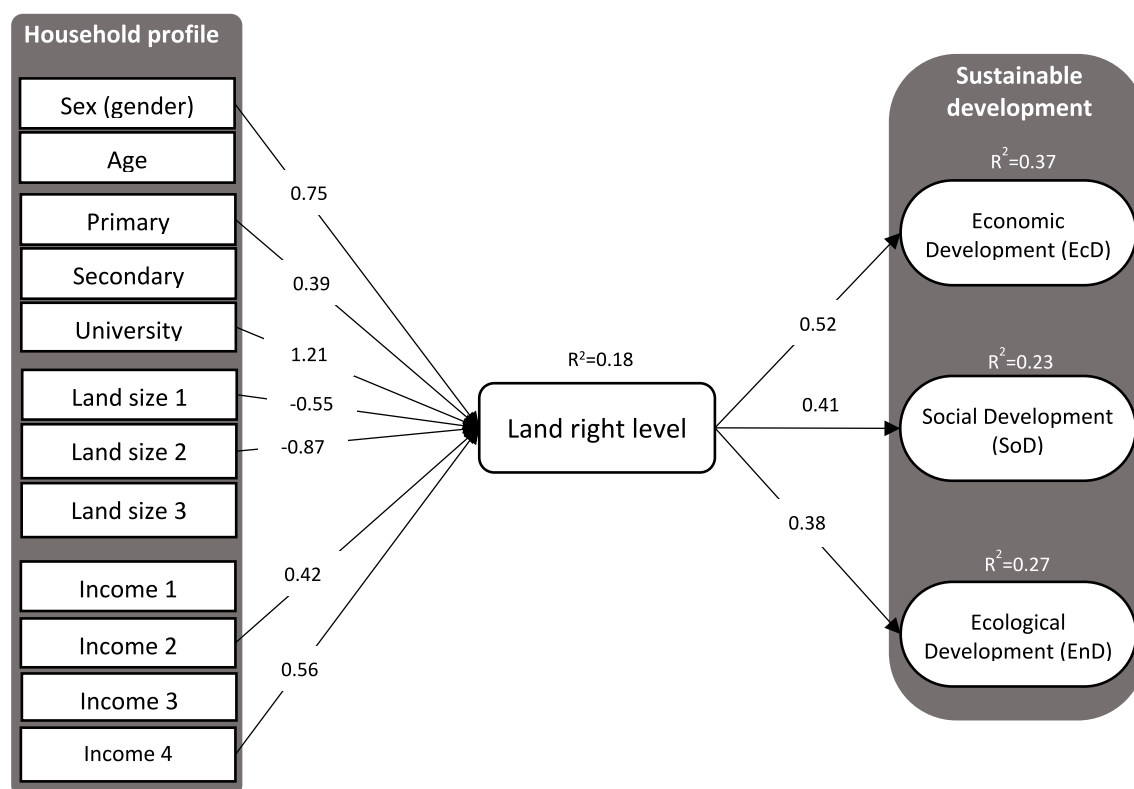


FIGURE 2
Significant structural relationships between household profile, land right and sustainable development.

show that formally securing land rights not only increases individuals' economic security, but also promotes overall economic development by supporting investment and access to credit in rural Benin.

4.4.1.2 Social development (SoD)

Land rights also positively and significantly contribute to social development ($\beta = 0.48, p < 0.001$). Secure land tenure enhances social stability, reduces conflicts over land, and fosters community trust. Moreover, households with land rights are better positioned to participate in local governance and decision-making processes, which strengthens social cohesion and inclusiveness in rural communities.

Furthermore, the social impacts of land security include gender equality and women's empowerment. When women secure land rights, they gain greater control over household resources and decision-making processes. This empowerment is accompanied by improved family wellbeing as women are more likely to invest in their children's education, health and nutrition. For example, one head of household explained:

I used to go through my husband to get access to inorganic fertilizer from their cooperative (farmers' association), or sometimes, if he got credit from a bank, he gave me a little. Now that I have my ADC, I do not wait for him anymore. My husband and his brothers respect me now. I do not depend on him anymore; I make my own crops and process the rice (parboiling). By the grace of God, my daughter is getting married soon. If I did not have this business, what would I do? Cannot my husband do everything?

Source: Z. K. Female household head, age 49, Kossou (Bembereke), october 2024.

Community stability and conflict reduction is revealed as an aspect of social development of household induced by land security. Secure land tenure reduces disputes over land, a common source of conflict in regions with ambiguous land ownership. Reduced conflict enhances social cohesion and fosters peaceful communities. In Benin, formal land rights are associated with greater community harmony, as they provide clear boundaries and discourage encroachment or disputes, thereby supporting social development.

Rural household also highlighted intergenerational security and social continuity as key ways in which land rights security contributes to social development. Formal land rights ensure that assets can be transformed to future generations, providing families with a sense of stability and continuity. This intergenerational security strengthens family and community ties, as land inheritance reinforces familial bonds and offers young generations a foundation for both social and economic advancement.

4.4.1.3 Environmental development (EnD)

A positive association is also observed between land rights and environmental development ($\beta = 0.51, p < 0.001$). This result suggests that secure land tenure encourages sustainable land management practices, such as soil conservation, afforestation, and reduced land degradation. When households have guaranteed long-term land access, they are more likely to adopt environmentally sustainable practices to protect their land resources.

TABLE 6 Parameter estimates.

Dep	Pred	Estimate	SE	β	z	p
EcD	Land_Right	0.52	0.05	0.61	11.38	< 0.001
SoD	Land_Right	0.41	0.05	0.48	8.12	< 0.001
EnD	Land_Right	0.38	0.04	0.51	8.94	< 0.001
Land_Right	Sexe1	0.75	0.22	0.27	3.37	< 0.001
Land_Right	Age1	−0.24	0.16	−0.12	−1.46	0.144
Land_Right	Age2	0.05	0.20	0.02	0.27	0.79
Land_Right	Education1	0.39	0.18	0.14	2.21	0.027
Land_Right	Education2	0.24	0.15	0.10	1.61	0.108
Land_Right	Education3	1.21	0.35	0.22	3.42	< 0.001
Land_Right	Land_size1	−0.55	0.25	−0.29	−2.22	0.026
Land_Right	Land_size2	−0.87	0.28	−0.40	−3.06	0.002
Land_Right	Land_size3	−0.56	0.38	−0.13	−1.46	0.144
Land_Right	Revenue1	0.07	0.19	0.03	0.37	0.713
Land_Right	Revenue2	0.42	0.19	0.18	2.20	0.028
Land_Right	Revenue3	0.15	0.20	0.06	0.76	0.447
Land_Right	Revenue4	0.56	0.22	0.22	2.53	0.012

Various empirical evidences are mentioned by rural household to explain this positive relationship between land right security and environmental development. First, land right security encourages the adoption of agroforestry practices on secured land. Agroforestry practices were most commonly mentioned by households through investments in permanent crops such as cashew and teak trees. For households, this practice not only improves soil quality but also diversifies sources of income. Agroforestry practices are also applied on leased land based on land use certificate. In this case, tree planting, a practice previously developed by landowners only, is currently possible with leases in northern Benin.

Second, environmental development, as an impact of land tenure security is recorded through the reduction of inorganic fertilizer, the use of organic agricultural pesticides, and the investment in fertilizing plants such as mucuna (*Mucuna pruriens*), pigeon pea (*Cajanus cajan*), etc. Thirdly, long-term fallows are being reintroduced into farming practices in northern Benin. Because of land tenure security, farmers have peace of mind when they leave their land fallow for long periods, as highlighting from this statement.

When your land becomes infertile and you leave it fallow for several years, people generally think that the land no longer has an owner. This is what happened to a friend of mine, Y. G. who left his 9-hectare property fallow for twelve years to work in another village. When he returned, he discovered that the property had been occupied by another person for four years. So far, the problem is still ongoing. This has made some people fearful of leaving their land fallow. But I am not afraid because I have my ADC. My property has been fallowing for three years and I plan to let it lie fallow for at least ten years. The local government knows that the property belongs to me.

Source: Y. B. G., Male, 50, Kossou (district of Bembereke), october 2024.

In addition, some cases were reported in which vulnerable people, especially women and young people, were dispossessed of their land following rehabilitation through the use of fertilizer crops such as mucuna and pigeon pea due to a lack of land legal security.

In summary, the impact of land rights security on sustainable development varies across its dimensions, with the strongest effect on economic development ($\beta = 0.61, p < 0.001$), followed by environmental development ($\beta = 0.51, p < 0.001$) and social development ($\beta = 0.48, p < 0.001$). Secure land rights play a critical role in fostering economic growth by enabling investments in agricultural productivity, improving access to credit, and encouraging income-generating activities. The positive effect on environmental development reflects the adoption of sustainable land management practices, such as soil conservation and reduced land degradation, when households have long-term land security. Similarly, social development benefits from reduced land-related conflicts, enhanced social cohesion, and greater participation in community governance. Together, these findings emphasize that land rights security is a fundamental driver of economic prosperity, environmental sustainability, and social stability in rural areas.

5 Discussion

5.1 Confirming the role of household profile in land tenure security

Our findings reveal that gender, education, and land size significantly influence land tenure security among rural households. Specifically, male-headed households and those with higher education levels are more likely to hold formal land rights. These results align with earlier evidence from Doss et al. (2015) and Slavchevska et al. (2021), who emphasized persistent gender inequalities in access to land. The positive relationship between education and land security reinforces findings by Goldstein et al. (2018) showing that formal

education enhances awareness of legal rights and increases the capacity to navigate complex land governance systems.

On the other hand, households that owned more land expressed less security about their land tenure. Despite its apparent surprise, this result is in line with Muchomba (2017) and Deininger et al. (2021), who noted that in situations with weak institutions, larger land parcels are frequently more vulnerable to land disputes and administrative delays. Large landholdings are, in fact, more noticeable and more likely to be the target of conflicting claims from other parties. These findings demonstrate that, especially for large or valuable landholdings, land registration programs ought to be paired with strong dispute resolution mechanisms and more straightforward administrative processes. The high expense of land registration, which frequently deters owners of sizable landholdings from registering them, is another factor contributing to this circumstance (Guinin Asso et al., 2022). These observations highlight how household characteristics—such as the size of land owned—can shape access to land rights and the sense of security attached to them. Our results support that household characteristics influence access to land rights. They underscore the importance of implementing pro-poor and gender-sensitive land registration programs tailored to the realities of different household profiles.

5.2 Land tenure security as a driver of sustainable development

This study confirms that land tenure security contributes significantly to the three pillars of sustainable development. Specifically, the results validate hypothesis H1.1, which posits that land tenure rights positively influence the economic development of farm households. They also support hypothesis H2.1, indicating that land tenure has a positive impact on environmental sustainability. Finally, the findings confirm hypothesis H3.1, which suggests that land rights have a positive influence on social development and pro-poor growth. Then our results highlight that secure land rights are a fundamental asset for rural communities. By strengthening household stability, encouraging investment, and fostering social cohesion, they provide a solid foundation for rural transformation.

Economically, our results show that tenure security encourages households to invest more confidently in agricultural inputs, equipment, and infrastructure. This finding demonstrates that secure land rights reduce uncertainty and stimulate long-term planning (Abdulai et al., 2011; Bambio and Agha, 2018; Deng et al., 2020; Long et al., 2024). Additionally, improved access to credit following land certification observed in our data highlighted the role of land documentation in unlocking financial services for smallholder farmers (Zhao and Guo, 2022).

Socially, land security enhances gender equality, community cohesion, and intergenerational transfer of land. However, these outcomes largely depend on the type and strength of tenure security (Sun et al., 2025; Van Gelder, 2009). Even where legal tenure security is high through formal titles, weak perceived security—arising from boundary disputes, elite capture, or poor enforcement—may limit women's effective control over land and discourage youth from long-term investments (Liu et al., 2023; Sun et al., 2025; Van Gelder, 2009). Conversely, strong perceived security within community-based tenure systems can foster social cohesion and facilitate land transfers even in the absence of formal documentation (Van Gelder, 2009; Flintan et al.,

2024). These effects align with Valkonen (2021) and Pellissery and Lødemel (2020) who view land ownership as a cornerstone of social citizenship. The legal recognition of women's land rights contributes to greater agency and household welfare (Bayisenge, 2015; Nguyen and Le, 2023). Youth also benefit from secure tenure through improved inheritance channels and long-term access to productive assets.

Environmentally, tenure security promotes the adoption of sustainable land use practices, including agroforestry, long-term fallowing, and organic soil amendments. These practices reflect a commitment to stewardship that is facilitated by well-defined property rights (Adechián et al., 2020; Adimassu et al., 2016; Azadi et al., 2021). The reintegration of fallows and tree crops into farming systems aligns with the principles articulated by Ostrom (1990) who emphasize the importance of secure tenure for effective collective resource management. Furthermore, improved environmental stewardship directly enhances long-term food security and resilience to climate variability.

Our findings affirm the integrative role of land tenure security in fostering economic opportunity, social inclusion, and environmental sustainability in rural contexts.

Our findings should also be interpreted in light of the multidimensional nature of land tenure security. Legal, perceived, and de facto tenure security can each influence sustainable development outcomes in different ways (Arnot et al., 2011; Fenske, 2011). For example, legal rights may strengthen access to formal credit but may not reduce land-related conflicts if perceived security remains low (Akowedaho et al., 2022; Arnot et al., 2011; Guinin Asso et al., 2022; Liu et al., 2023; Sun et al., 2025). Conversely, strong community-based rights may foster social cohesion and intergenerational transfers even in the absence of formal documentation (Sun et al., 2025; Valkonen, 2021; Van Gelder, 2009). This is particularly relevant in Benin, where customary systems and local norms coexist with statutory land tenure laws. Future interventions should therefore aim to align these dimensions by strengthening both the legal recognition of rights and the institutions that underpin farmers' perceptions of security.

5.3 Influence of the strength of land rights on sustainable development dimensions

Although the primary analysis demonstrated the positive effects of land rights on economic, social, and environmental development, it is important to highlight that the strength and legal recognition of land tenure further amplify these effects.

Descriptive statistics show that only a small proportion of households possess formal land titles (3%) or ADC/CFR certificates (34%), while others rely on land use certificates (18%) or have no certificate (45%). In line with previous studies (e.g., Deininger and Jin, 2006; Ekpodessi and Nakamura, 2022; Place, 2009), and considering the legal framework of Benin, where ADC/CFR certificates (customary land rights) are formally recognized under the 2013 and 2017 Land and Domain Code, the testimonies collected during the survey indicate that households with stronger forms of land documentation (particularly land titles and ADC/CFR certificates) benefit more significantly from access to credit, investments in agricultural practices, improvements in social status, and sustainable land management initiatives compared to those with only land use certificates or no certificate. For example, households holding formal land titles or ADC/CFR certificates reported greater investments in

agroforestry practices, better access to formal credit for agricultural expansion, and increased participation in local governance structures, as evidenced by the testimonies of household heads.

This trend suggests that the stronger the legal security of land tenure — from no certificate to land use certificate, to ADC/CFR certificates, and ultimately to full land titles — the greater the positive impacts on economic growth, environmental conservation, and social stability. These findings provide supportive evidence for hypotheses H1.2, H2.2, and H3.2. Future research should formally test these differential effects through stratified or multi-group analysis comparing outcomes across types of land rights.

5.4 Toward a systemic understanding of land tenure and development

Unlike many previous studies that have examined land tenure effects in disciplinary silos—focusing separately on agriculture, gender, or conservation (Asaaga et al., 2020; Platteau, 1996)—this study offers a systemic assessment of how secure land rights simultaneously influence economic, social, and environmental outcomes. The use of structural equation modeling (SEM) enables us to capture both direct and indirect effects, revealing the interdependencies across dimensions.

For instance, increased agricultural income (economic) was found to support the adoption of conservation practices (environmental), while gender-inclusive access to land (social) contributed to improved food security and household resilience (economic) (Asaaga et al., 2020). These dynamic interactions reinforce Jabareen's call for integrated frameworks that reflect the complex, interlinked nature of sustainable development (Jabareen, 2008). This methodological integration offers a more complete understanding of the multifaceted role of land rights in promoting rural transformation.

5.5 Policy implications

Several actionable recommendations emerge from our findings for policy and practice:

- Formalize a diversity of land rights: While land titles offer the highest degree of legal protection, customary and use certificates also provide substantial benefits. Legal recognition of diverse tenure systems can improve tenure security without marginalizing traditional authorities or local practices (Byamugisha, 2021; Zevenbergen et al., 2013). For example, Rwanda's Land Tenure Regularization Program provides a successful model for integrating formal and customary systems. However, as highlighted by Asaaga et al. (2020), the effectiveness of such reforms in Benin or other sub-Saharan African contexts is not automatic but depends on complementary conditions such as affordable registration costs, institutional capacity to enforce rights, and accessible dispute resolution mechanisms.
- Promote gender-responsive land registration: To close the gender gap in land access, governments should implement joint titling programs, legal literacy campaigns, and institutional safeguards—such as quotas in local land administration bodies or support from paralegal networks—to ensure women's full participation in land governance (Doss et al., 2015; Goldman et al., 2016).

- Integrate land governance with climate and food security agendas: Since tenure security is a precondition for the agroecological transition, land policies must be aligned with broader national development goals. As suggested by Gignoux et al. (2012) and Guinin Asso et al. (2022), land governance should be integrated into National Adaptation Plans (NAPs), Nationally Determined Contributions (NDCs), and agricultural transformation strategies.

5 Conclusion

This study examined how land tenure security influences the sustainable development of rural households in Benin, focusing on economic, social, and environmental dimensions. Drawing on structural equation modeling and a rich dataset from smallholder communities, our analysis confirms that land tenure security is a critical enabler of rural transformation.

We found that household characteristics—particularly gender, education, and landholding size—significantly shape access to secure land rights. These findings highlight persistent inequalities and the need for targeted interventions that recognize the diversity of household profiles and tenure systems. Importantly, our results demonstrate that secure land rights are not only a legal asset but a catalyst for investment, empowerment, and environmental stewardship.

By taking a systemic approach, the study reveals how tenure security simultaneously supports income generation, strengthens social inclusion, and promotes sustainable land use. This underscores the interdependent nature of sustainable development and calls for integrated policies that bridge land governance, agricultural development, and climate resilience.

Our findings offer timely insights for policymakers, development practitioners, and researchers working to achieve the Sustainable Development Goals (SDGs). Formalizing a plurality of tenure systems, promoting gender equity in land governance, and linking land security to broader rural development strategies will be essential steps toward inclusive and resilient futures for farming communities.

Future research should explore the long-term effects of tenure reforms, consider intra-household dynamics more deeply, and assess how evolving climate risks may reshape land access and use patterns. Understanding these dynamics will be key to designing land governance systems that are both equitable and adaptive in the face of global change.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Vice Rectorat chargé de la Recherche Universitaire de l'Université de Parakou (VR-RU/UP). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the

publication of any potentially identifiable images or data included in this article.

Author contributions

SA: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Software, Writing – original draft. MB: Conceptualization, Supervision, Validation, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This work was supported by the German Academic Exchange Service (DAAD) and the Network of Excellence for Land Governance in Africa (NELGA) through the 2023 postdoctoral fellowship (Funding program no. 57706733).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

- Abdulai, A., Owusu, V., and Goetz, R. (2011). Land tenure differences and investment in land improvement measures: theoretical and empirical analyses. *J. Dev. Econ.* 96, 66–78. doi: 10.1016/j.jdeveco.2010.08.002
- Adéchian, S. A., Sossa-Vihotogbe, C. N. A., Djenontin, A. J., Akponikpe, P. B. I., and Baco, M. N. (2020). Déterminants socio-économiques et environnementaux du respect des recommandations en fertilisation minérale de quelques légumes feuilles traditionnels au Bénin. *Agron. Afr.* 32, 25–36. Available online at: <https://www.ajol.info/index.php/aga/article/view/196097>
- Adimassu, Z., Langan, S., and Johnston, R. (2016). Understanding determinants of farmers' investments in sustainable land management practices in Ethiopia: review and synthesis. *Environ. Dev. Sustain.* 18, 1005–1023. doi: 10.1007/s10668-015-9683-5
- Ajefu, J. B., and Abiona, O. (2020). The mitigating impact of land tenure security on drought-induced food insecurity: evidence from rural Malawi. *J. Dev. Stud.* 56, 2169–2193. doi: 10.1080/00220388.2020.1762862
- Akowedaho, B. D., Guinin Asso, I., O'Heix, B. C. P., Adéchian, S. A., and Baco, M. N. (2022). Access to land for agricultural entrepreneurial activities in the context of sustainable food production in Borgou, according to land law in Benin. *Land* 11:1381. doi: 10.3390/land11091381
- Arnot, C. D., Luckert, M. K., and Boxall, P. C. (2011). What is tenure security? Conceptual implications for empirical analysis. *Land Econ.* 87, 297–311. doi: 10.3368/le.87.2.297
- Asaaga, F. A., Hirons, M. A., and Malhi, Y. (2020). Questioning the link between tenure security and sustainable land management in cocoa landscapes in Ghana. *World Dev.* 130:104913. doi: 10.1016/j.worlddev.2020.104913
- Azadi, H., Movahhed Moghaddam, S., Mahmoudi, H., Burkart, S., Dadi Debelu, D., Teklemariam, D., et al. (2021). Impacts of the land tenure system on sustainable land use in Ethiopia. *Transitioning Sust. Life Land* 275:978.
- Aznar-Sanchez, J. A., Piquer-Rodriguez, M., Velasco-Munoz, J. F., and Manzano-Agugliaro, F. (2019). Worldwide research trends on sustainable land use in agriculture. *Land Use Policy* 87:104069. doi: 10.1016/j.landusepol.2019.104069
- Bambio, Y., and Agha, S. B. (2018). Land tenure security and investment: does strength of land right really matter in rural Burkina Faso? *World Dev.* 111, 130–147. doi: 10.1016/j.worlddev.2018.06.026
- Barrows, R., and Roth, M. (1990). Land tenure and investment in African agriculture: theory and evidence. *J. Mod. Afr. Stud.* 28, 265–297. doi: 10.1017/S0022278X00054458
- Bayisenge, J. (2015). Women's experiences of land conflicts in the context of the land tenure reform program in Rwanda. *Int. J. Gender Women Stu.* 3:a12. doi: 10.15640/ijgws.v3n1a12
- Byamugisha, F. F. K. (2013). Securing Africa's land for shared prosperity: a program to scale up reforms and investments (English). Africa development forum. Washington, DC: World Bank Group. Available online at: <http://documents.worldbank.org/curated/en/732661468191967924>
- Byamugisha, F. F. K. (2021). Experiences and development impacts of securing land rights at scale in developing countries: case studies of China and Vietnam. *Land* 10:176. doi: 10.3390/land10020176
- De Zeeuw, F. (1997). Borrowing of land, security of tenure and sustainable land use in Burkina Faso. *Dev. Change* 28, 583–595. doi: 10.1111/1467-7660.00055
- Deininger, K., and Jin, S. (2006). Tenure security and land-related investment: evidence from Ethiopia. *Eur. Econ. Rev.* 50, 1245–1277. doi: 10.1016/j.eurocorev.2005.02.001
- Deininger, K., Xia, F., Kilic, T., and Moylan, H. (2021). Investment impacts of gendered land rights in customary tenure systems: substantive and methodological insights from Malawi. *World Dev.* 147:105654. doi: 10.1016/j.worlddev.2021.105654
- Deng, X., Yan, Z., Xu, D., and Qi, Y. (2020). Land registration, adjustment experience, and agricultural machinery adoption: empirical analysis from rural China. *Land* 9:89. doi: 10.3390/land9030089
- DiStefano, C., and Morgan, G. B. (2014). A comparison of diagonal weighted least squares robust estimation techniques for ordinal data. *Struct. Equ. Model.* 21, 425–438. doi: 10.1080/10705511.2014.915373
- Doss, C., Kovarik, C., Peterman, A., Quisumbing, A., and Van Den Bold, M. (2015). Gender inequalities in ownership and control of land in Africa: myth and reality. *Agric. Econ.* 46, 403–434. doi: 10.1111/agec.12171
- Ekpodessi, S. G., and Nakamura, H. (2022). Impact of insecure land tenure on sustainable agricultural development: a case study of agricultural lands in the Republic of Benin, West Africa. *Sustainability* 14:14041. doi: 10.3390/su142114041
- Fenske, J. (2011). Land tenure and investment incentives: Evidence from West Africa. *Journal of Development Economics*. 95, 137–156. doi: 10.1016/j.jdeveco.2010.05.001
- Flintan, F., Nassef, M., Sawadogo, I., Sulieman, H. M., Otieno, K., Meinzen-Dick, R. S., et al. (2024). Collective Land Tenure and Gender Equity in Africa's Rangelands. Are We Really Leaving No One Behind? Cham: Springer.
- Gedefaw, A. A., Atzberger, C., Seher, W., Agegnehu, S. K., and Mansberger, R. (2020). Effects of land certification for rural farm households in Ethiopia: evidence from Gozamin district, Ethiopia. *Land* 9:421. doi: 10.3390/land9110421
- Gignoux, J., Macours, K., and Wren-Lewis, L. (2012). Impact of land administration programs on agricultural productivity and rural development: existing evidence,

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2025.1621537/full#supplementary-material>

- challenges and new approaches. *Rev. D'études Agric. Environ.* 96, 467–498. doi: 10.4074/s1966960715003045
- Goldman, M. J., Davis, A., and Little, J. (2016). Controlling land they call their own: access and women's empowerment in northern Tanzania. *J. Peasant Stud.* 43, 777–797. doi: 10.1080/03066150.2015.1130701
- Goldstein, M., Hounbedji, K., Kondylis, F., O'Sullivan, M., and Selod, H. (2018). Formalization without certification? Experimental evidence on property rights and investment. *J. Dev. Econ.* 132, 57–74. doi: 10.1016/j.jdeveco.2017.12.008
- Guinin Asso, I., Adéchian, S. A., Salifou, M., M'po Kouyinpou, B. P., O'heix, B. C. P., and Baco, M. N. (2022). Effects of the systematic cluster approach (SCA) and rural land plans (RLPs) on land tenure security for agricultural household: insight from Benin (West Africa). *Land* 11:1681. doi: 10.3390/land11101681
- Handoko, W. (2020). The impact of land conflict on Darmakradenan toward social, economic, and politic vulnerability in the life of farmers community. *SHS Web Conf.* 86:01039. doi: 10.1051/shsconf/20208601039
- Ho, H.-A. (2021). Land tenure and economic development: evidence from Vietnam. *World Dev.* 140:105275. doi: 10.1016/j.worlddev.2020.105275
- Holden, E., Linnerud, K., and Banister, D. (2017). The imperatives of sustainable development. *Sustain. Dev.* 25, 213–226. doi: 10.1002/sd.1647
- Iacobucci, D. (2010). Structural equations modeling: fit indices, sample size, and advanced topics. *J. Consum. Psychol.* 20, 90–98. doi: 10.1016/j.jcps.2009.09.003
- Jabareen, Y. (2008). A new conceptual framework for sustainable development. *Environ. Dev. Sustain.* 10, 179–192. doi: 10.1007/s10668-006-9058-z
- Joumard, R. (2019). "Que recouvre le concept de développement durable," in: *Fifth Int. Conf. on Energy, Materials, Applied Energetics and Pollution, ICEMAEP2019, Mentouri Brothers Constantine*, 2067–2077
- Kehinde, M. O., Shittu, A. M., Adewuyi, S. A., Osunsina, I. O. O., and Adeyonu, A. G. (2021). Land tenure and property rights, and household food security among rice farmers in northern Nigeria. *Heliyon* 7:e06110. doi: 10.1016/j.heliyon.2021.e06110
- Keudem, G. G. L., Savadogo, K., Keudem, G. G. L., and Savadogo, K. (2023). Land tenure security and agricultural production in the rural areas of Burkina Faso. *AJAR* 19, 1083–1099. doi: 10.5897/AJAR2023.16520
- Lawry, S., Samii, C., Hall, R., Leopold, A., Hornby, D., and Mtero, F. (2017). The impact of land property rights interventions on investment and agricultural productivity in developing countries: a systematic review. *J. Dev. Eff.* 9, 61–81. doi: 10.1080/19439342.2016.1160947
- Liu, X., Guo, X., Li, L., and Xie, F. (2023). Impacts of tenure security on rural households' forestland investment: evidence from Jiangxi, China. *Forests* 14:1806. doi: 10.3390/f14091806
- Long, G., Zhou, X., and Li, J. (2024). Land tenure, loans, and farmers' cropland conservation behavior: evidence from rural Northwest China. *Land* 13:413. doi: 10.3390/land13040413
- Manara, M. (2025). Institutional transition: social cohesion and demand for land titles in urban Tanzania. *World Dev.* 185:106799. doi: 10.1016/j.worlddev.2024.106799
- Muchomba, F. M. (2017). Women's land tenure security and household human capital: evidence from Ethiopia's land certification. *World Dev.* 98, 310–324. doi: 10.1016/j.worlddev.2017.04.034
- Mwangi, D. K. (2024). Land-tenure shifts in the maa landscapes, Kenya, and the impacts on social-cultural relations, structural power and social economic differentiation. *Nature Anthropology* 2:10016. doi: 10.35534/natanthropol.2024.10016
- Naude, W. (2021). *Entrepreneurship and economic development: Theory, evidence and policy*. Rochester, NY: SSRN.
- Nguyen, M., and Le, K. (2023). The impacts of women's land ownership: evidence from Vietnam. *Rev. Dev. Econ.* 27, 158–177. doi: 10.1111/rode.12941
- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge: Cambridge University Press.
- Pellissery, S., and Lødemel, I. (2020). Property and social citizenship: social policy beyond the north. *Soc. Policy Soc.* 19, 275–292. doi: 10.1017/s1474746419000575
- Pezzagno, M., Richiedei, A., and Tira, M. (2020). Spatial planning policy for sustainability: analysis connecting land use and GHG emission in rural areas. *Sustainability* 12:947. doi: 10.3390/su12030947
- Pierr, F. M., Anseeuw, W., and Campolina, A. (2025). Land tenure for resilient and inclusive rural transformation. *Glob. Food Secur.* 44:100835. doi: 10.1016/j.gfs.2025.100835
- Place, F. (2009). Land tenure and agricultural productivity in Africa: a comparative analysis of the economics literature and recent policy strategies and reforms. *World Dev.* 37, 1326–1336. doi: 10.1016/j.worlddev.2008.08.020
- Platteau, J.-P. (1996). The evolutionary theory of land rights as applied to sub-Saharan Africa: a critical assessment. *Dev. Change* 27, 29–86. doi: 10.1111/j.1467-7660.1996.tb00578.x
- RNA (2022). *Résultats du Recensement National de l'Agriculture (RNA)*. Institut National de la Statistique et de la Démographie (INStad). accessible at Résultats du Recensement National de l'Agriculture (RNA)
- Savalei, V. (2021). Improving fit indices in structural equation Modeling with categorical data. *Multivar. Behav. Res.* 56, 390–407. doi: 10.1080/00273171.2020.1717922
- Slavchevska, V., Doss, C. R., De La O Campos, A. P., and Brunelli, C. (2021). Beyond ownership: women's and men's land rights in sub-Saharan Africa. *Oxf. Dev. Stud.* 49, 2–22. doi: 10.1080/13600818.2020.1818714
- Sun, X., Wang, J., and Rao, F. (2025). Land tenure security and sustainable land investment: evidence from national plot-level data in rural China. *Land* 14:191. doi: 10.3390/land14010191
- Tomislav, K. (2018). The concept of sustainable development: from its beginning to the contemporary issues. *Zagreb. Int. Rev. Econ. Bus.* 21, 67–94. doi: 10.2478/zireb-2018-0005
- Valkonen, A. (2021). Examining sources of land tenure (in) security. A focus on authority relations, state politics, social dynamics and belonging. *Land Use Policy* 101:105191. doi: 10.1016/j.landusepol.2020.105191
- Van Gelder, J.-L. (2009). Legal tenure security, perceived tenure security and housing improvement in Buenos Aires: an attempt towards integration. *Int. J. Urban Reg. Res.* 33, 126–146. doi: 10.1111/j.1468-2427.2009.00833.x
- Venkatesh, B., and Velkenedy, R. (2024). Spatial assessment on influence of land use and population density in the achievement score of sustainable development target 11.1. *Sustain. Dev.* 32, 381–391. doi: 10.1002/sd.2665
- Zevenbergen, J., Augustinus, C., Antonio, D., and Bennett, R. (2013). Pro-poor land administration: principles for recording the land rights of the underrepresented. *Land Use Policy* 31, 595–604. doi: 10.1016/j.landusepol.2012.09.005
- Zhao, M., and Guo, W. (2022). Does land certification stimulate farmers' entrepreneurial enthusiasm? Evidence from rural China. *Sustainability* 14:11453. doi: 10.3390/su141811453