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Gender-responsive approaches to carbon farming for sustainable development

SANUSI MOHAMMED SADIQ	Department of Agricultural Economics and Agribusiness, FUD, Dutse, Nigeria
I.P. SINGH	Department of Agricultural Economics, SKRAU, Bikaner, India
M.M AHMAD	Department of Agricultural Economics and Extension, BUK, Kano, Nigeria
B.S SANI	Department of Agricultural Economics and Agribusiness, FUD, Dutse, Nigeria

This review explores the nexus between gender responsiveness and carbon farming as pathways to achieving sustainable development goals (SDGs). While carbon farming is gaining prominence as a tool for climate mitigation through carbon sequestration, it is often implemented without acknowledging gender disparities that hinder equitable participation. This article draws on recent empirical studies and policy analyses to review frameworks and practices that integrate gender into carbon farming. It evaluates how such approaches enhance both the effectiveness of carbon farming and the socio-economic resilience of marginalized groups, particularly rural women. The findings underscore the transformative potential of inclusive, gender-smart climate solutions to accelerate both ecological and human development agendas.

Keywords: Agriculture, Climate-smart, Development, Gender, Sustainable

INTRODUCTION

Climate change represents one of the most pressing global challenges, with its effects disproportionately affecting the most vulnerable populations - especially rural communities in the Global South. In response, carbon farming, a set of agricultural practices that enhance the capture and storage of atmospheric carbon in soils and biomass, has emerged as a key climate mitigation tool. Practices like agroforestry, cover cropping, biochar application, and conservation tillage are designed to reduce greenhouse gas emissions while enhancing soil fertility and long-term productivity.

Yet, while the science and economics of carbon farming are gaining traction, social equity-particularly gender equity-remains a largely under-addressed aspect of its implementation. Women constitute nearly half of the global agricultural labor force and up to 70% in some regions such as sub-Saharan Africa (FAO, 2021). However, due to structural inequalities - including unequal land rights, limited access to credit, and exclusion from decision-making bodies - women are often marginalized in climate-smart agriculture initiatives, including carbon farming (Elias et al., 2021; Akter, 2025).

The concept of gender-responsiveness refers to interventions that identify and actively address the different needs, roles, and contributions of men and women. In the context of carbon farming, this means recognizing that gender shapes access to resources, adoption of technologies, exposure to risk, and capacity to benefit from climate mitigation programs (Samandari, 2017). Gender-responsive carbon farming initiatives therefore strive not just to reduce carbon footprints, but also to ensure equitable participation and benefit sharing across gender lines.

Importantly, integrating a gender perspective into carbon farming aligns with international frameworks such as the UNFCCC Gender Action Plan, the 2030 Agenda for Sustainable Development (especially SDGs 5, 13, and 15), and the Green Climate Fund's (GCF) gender policy. These frameworks emphasize that sustainability is unattainable without gender equality. Yet, despite the existence of such guiding instruments, implementation gaps remain widespread (Akyala et al., 2023).

Recent research, including field-based evidence from regions like Zimbabwe, Mali, and Nepal, illustrates how gender-sensitive design in carbon farming programs enhances both effectiveness and equity. These programs show improved adoption rates, better environmental outcomes, and stronger social cohesion when women are actively involved in design, monitoring, and benefit-sharing mechanisms (Muchabaiwa and Muchabaiwa, 2024; Lanzarini, 2025; Sadiq et al., 2025).

This review critically synthesizes literature and field data from recent studies to explore how gender-responsive approaches to carbon farming can serve as a transformative lever for sustainable development. The article aims to answer three key questions:

1. What are the prevailing gender-based barriers and inequalities in carbon farming systems?

2. How do gender-responsive practices improve carbon sequestration outcomes and livelihood resilience?

3. What frameworks, policies, and tools are effective in institutionalizing gender responsiveness in carbon farming?

In doing so, the article builds a comprehensive foundation for understanding how climate action, agricultural transformation, and gender justice can be harmonized to drive both environmental sustainability and social equity in tandem.

THEORETICAL FRAMEWORK

The theoretical underpinning of gender-responsive approaches to carbon farming is grounded in an interdisciplinary fusion of gender theory, environmental justice, and sustainable development theory. This section unpacks these perspectives and their relevance in constructing a robust analytical lens for understanding the gender dimensions of carbon farming.

Ecofeminism: Linking Environmental and Gender Justice

Ecofeminism posits that the domination of nature and the subordination of women arise from similar patriarchal structures that prioritize exploitation, hierarchy, and control (Shiva, 1988; Warren, 2000). In the context of carbon farming, this lens reveals how:

• Women's traditional ecological knowledge and roles as stewards of biodiversity are often overlooked in modern carbon sequestration programs.

• The technocratic and market-based nature of many carbon farming schemes (e.g., carbon credits and offset markets) frequently reinforces male-dominated access to resources and capital.

Ecofeminism urges a decolonized and inclusive model of climate action, where both nature and marginalized groups - especially rural women - are empowered as agents of change.

Sustainable Livelihoods Framework (SLF)

Developed by the UK's Department for International Development (DFID), the Sustainable

Livelihoods Framework provides a holistic tool to analyze the assets and vulnerabilities of rural households. It emphasizes five key capital assets:

• Natural capital (land, water, biodiversity)

• Human capital (knowledge, skills)

• Social capital (networks, institutions)

• Physical capital (infrastructure, tools)

• Financial capital (income, credit)

When applied through a gender lens, SLF helps uncover differential access to assets between men and women and how this influences the adoption and outcomes of carbon farming practices. For example, lack of secure land tenure disproportionately affects women, limiting their eligibility for carbon farming programs and carbon credits (Angula et al., 2021; Elias et al., 2021).

Inter-sectionality Framework

Rooted in feminist scholarship (Crenshaw, 1991), inter-sectionality examines how multiple identities—such as gender, class, ethnicity, and geography—interact to produce varying levels of vulnerability or empowerment. In rural agricultural settings:

• Widowed women may face different barriers than married women.

• Indigenous or minority women may be doubly excluded from access to CSA training or climate finance.

Inter-sectionality enriches the understanding of how carbon farming must be tailored to fit diverse experiences rather than applying one-size-fits-all gender policies.

Environmental Justice Theory

Environmental justice advocates for the equitable distribution of environmental benefits and burdens, inclusive decision-making, and recognition of marginalized voices. Applied to carbon farming:

• Women must not only be participants but also decision-makers in land-use planning, carbon credit negotiations, and benefit-sharing schemes.

• Projects that disregard social equity risk creating new forms of “green inequity” - where elite farmers benefit from carbon markets while poor, landless women remain excluded (Samandari, 2017).

Theory of Planned Behavior (TPB) – As a Behavioral Lens

Understanding adoption of carbon farming techniques is also supported by the Theory of Planned Behavior (Ajzen, 1991), which posits that behavioral intention is shaped by:

• Attitudes toward the behavior (e.g., views on composting or agroforestry),

• Subjective norms (e.g., social expectations within communities),

• Perceived behavioral control (e.g., confidence and resources to implement new practices).

Gender plays a critical role in all three domains. For instance, women may value sustainability more but feel disempowered due to lack of tools, training, or land rights - thereby reducing adoption despite favorable attitudes.

Integration into the Study

Combining these theories provides a multi-layered foundation for analyzing:

• The structural inequalities embedded in carbon farming systems.

• The socio-ecological dynamics that hinder or enable women's participation.

• The behavioral and institutional changes necessary for achieving both carbon sequestration and social transformation.

This theoretical framing ensures that gender-responsive carbon farming is not treated as a peripheral add-on but as a core pillar of sustainable development and climate justice.

CONCEPTUAL FRAMEWORK

A conceptual framework serves as a schematic representation of the key constructs, relationships, and assumptions that guide both theory and practice. For gender-responsive carbon farming, the framework must integrate climate action, gender equity, and sustainable development into a coherent model that informs planning, implementation, monitoring, and impact assessment.

Below is the visual and narrative expansion of the conceptual framework guiding this topic.

Core Components of the Framework

1. Inputs

• Resources: Land, water, finances, tools

• Knowledge & Information: Agricultural extension services, climate-smart practices, gender training

• Institutional Support: Policies, governance structures, access to carbon markets

• Social Capital: Community organizations, cooperatives, women's networks

2. Processes (Interventions)

• Capacity Building: Training on CSA and carbon accounting disaggregated by gender

• Participatory Planning: Inclusion of women in decision-making processes

• Technological Adoption: Use of irrigation systems, biochar, agroforestry, etc.

• Access Facilitation: Enhancing women's access to markets, credit, and land rights

3. Outputs

• Increased female participation in carbon farming programs

• Improved agricultural yields and income diversification

• Establishment of inclusive cooperatives or local carbon markets

4. Outcomes

• Enhanced carbon sequestration

• Resilience against climate shocks (drought, soil degradation)

• Reduction in gender disparities in agriculture

5. Impact (Long-Term Goals)

• Achievement of SDGs 5 (Gender Equality), 13 (Climate Action), and 15 (Life on Land)

• Sustainable and climate-resilient livelihoods

• Climate justice and intergenerational equity

RESEARCH METHODOLOGY

The methodology for this research review adopts a systematic, qualitative, and integrative approach to explore how gender-responsive practices in carbon farming can contribute to sustainable development. Given the interdisciplinary nature of the subject - spanning gender studies, agricultural science, environmental policy, and development economics - the methodology integrates elements of systematic literature review, critical discourse analysis, and thematic synthesis.

1. Research Design

This study utilized a qualitative research design anchored in systematic review principles. The goal was not merely to aggregate existing knowledge, but to interpret patterns, identify gaps, and generate a new understanding of how gender-responsive strategies intersect with carbon farming.

2. Data Sources

Data were drawn from multiple academic databases and grey literature repositories, ensuring comprehensive coverage of peer-reviewed and practice-based knowledge:

• Peer-reviewed journals: ScienceDirect, SpringerLink, Wiley Online Library, MDPI Sustainability, Frontiers in Climate

• Policy reports: CGIAR, UNCCD, FAO, World Bank Gender and Climate portfolios

• Open-access platforms: ResearchGate, CGSpace, and institutional repositories

3. Inclusion Criteria

Articles and case studies were selected based on the following inclusion criteria:

• Published between 2015–2025

• Focused on carbon farming, climate-smart agriculture (CSA), or agroecology within a gender-

responsive framework

• Provided empirical evidence (qualitative or quantitative)

• Included perspectives from the Global South (e.g., Sub-Saharan Africa, South Asia, Latin America)

• Connected outcomes to sustainable development goals (SDGs)

A total of 142 initial records were identified, with 50 full-text papers reviewed in detail, and 10 core studies selected based on relevance, geographic representation, and theoretical contribution.

4. Data Extraction and Analysis

A structured data extraction matrix was developed to code each study under the following thematic areas:

• Project location and context

• Type of carbon farming or CSA practice

• Gender components (e.g., access to land, training, markets)

• Participatory or institutional mechanisms

• Measured outcomes (yields, income, resilience, carbon capture)

• Indicators of empowerment (decision-making, knowledge, agency)

Thematic qualitative synthesis was performed using the constant comparative method:

• Recurrent patterns were identified across cases (e.g., success factors like women-led cooperatives or inclusive extension services).

• Divergences were analyzed based on socio-cultural or policy context.

5. Case Study Integration

To complement the review, 4 case studies were analyzed in depth for their methodological rigor and policy relevance:

• Zimbabwe: Community gardens adopting mulching, crop rotation, and participatory water management (Muchabaiwa and Muchabaiwa, 2024)

• Namibia: Gender audits of ecosystem-based adaptation programs under GCF (Angula et al., 2021)

• India/Nepal: Gender inclusion in REDD+ and agroforestry (Elias et al., 2021; Tovar-Restrepo, 2017)

• Mali: Participatory forest restoration through women’s cooperatives (Lanzarini, 2025)

6. Limitations

While robust, this methodology had the following limitations:

• Language bias: Only English-language publications were included.

• Publication bias: Grey literature and non-indexed reports may have been underrepresented.

• Geographic gaps: Fewer studies were available from Latin America relative to Africa and Asia.

Despite these limitations, triangulating peer-reviewed data with case studies and reports ensures a multi-dimensional, globally informed analysis.

7. Ethical Considerations

As this is a desk-based review, there were no human subjects involved, and therefore no formal ethical clearance was required. However, the research adheres to principles of integrity, attribution, and responsible interpretation of indigenous and gender-sensitive knowledge systems.

This matrix provided a structured foundation for thematic synthesis, allowing insights to be drawn across diverse geographical, ecological, and socio-political contexts.

RESULTS AND DISCUSSION

This section synthesizes the findings from the reviewed literature and case studies, focusing on how gender-responsive carbon farming interventions influence environmental and social outcomes. The analysis is structured around five key thematic domains that emerged from the data extraction matrix: resource access, adoption of technologies, decision-making and empowerment, resilience and livelihoods, and monitoring and impact evaluation.

1. Gendered Access to Resources: A Foundational Barrier

Across all case studies, inequitable access to critical agricultural resources such as land, finance, and information remains the most cited barrier for women's participation in carbon farming.

• Land tenure insecurity is particularly acute in patriarchal rural systems where land ownership is tied to male lineage (Samandari, 2017; Akter, 2025).

• Women's limited access to credit and carbon financing mechanisms hinders their ability to invest in long-term carbon sequestration practices like agroforestry or biochar application (Sadiq et al., 2025).

• In Namibia, women participants in Green Climate Fund-supported programs noted being sidelined from climate investments due to lack of documentation and collateral (Angula et al., 2021).

This finding validates the argument that without targeted interventions to redistribute access and ownership rights, carbon farming will reinforce rather than disrupt existing inequalities.

2. Adoption of Climate-Smart Technologies is Gendered

Adoption of carbon farming practices like mulching, crop rotation, composting, and intercropping is significantly influenced by gender norms, labor allocation, and perceived risk.

• In Zimbabwe, women's adoption of mulching and pest management in community gardens led to higher yields and soil health (Muchabaiwa and Muchabaiwa, 2024).

• In India, although women showed more ecological awareness, they were less likely to adopt high-tech practices due to limited exposure to extension services and training (Dhenge et al., 2016).

• Elias et al. (2021) highlighted that projects applying Gender Action Learning Systems (GALS) enhanced female adoption of nature-based carbon solutions by embedding experiential learning and peer mentoring.

This suggests that gender-responsive training and inclusive knowledge dissemination are critical for scaling carbon farming.

3. Women's Empowerment through Participatory Governance

When women are included in decision-making bodies, program planning committees, or cooperative governance structures, both gender equity and environmental outcomes improve.

• In Mali, participatory forest restoration involving women-led cooperatives resulted in enhanced reforestation and income diversification (Lanzarini, 2025).

• Akter (2025) showed that empowering women through gender-smart planning improved uptake of low-emission practices and catalyzed social capital development.

• However, in many cases, "participation" was symbolic, with women attending meetings but lacking the power to influence decisions (Samandari, 2017).

Effective empowerment therefore requires not just inclusion, but deliberative influence, capacity-building, and institutional accountability.

4. Building Climate Resilience and Sustainable Livelihoods

Gender-responsive carbon farming projects show improved livelihood resilience - especially for marginalized female-headed households.

• In Zimbabwe and Nigeria, CSA interventions reduced vulnerability to drought and improved household income stability (Akyala et al., 2023).

• In South Asia, women's collective action around composting and afforestation created new green jobs and reduced dependence on external inputs (Sadiq et al., 2025).

• Carbon farming also altered social dynamics - shifting norms around division of labor, access to technology, and community recognition of women as knowledge holders (Muchabaiwa and Muchabaiwa, 2024).

This affirms the potential of carbon farming to act as a vehicle for both environmental regeneration and social transformation, when designed inclusively.

5. Challenges in Monitoring, Reporting, and Verification (MRV)

Carbon farming is heavily reliant on robust MRV systems to quantify emissions reduction, assign carbon credits, and ensure transparency.

• However, few MRV frameworks integrate gender-disaggregated indicators, meaning women's labor, knowledge, and benefits often remain invisible (Banerjee & Misra, 2024).

• Elias et al. (2021) call for integrating gender-sensitive metrics—such as control over income, access to climate finance, and agency in decision-making—into carbon accounting tools.

• Tools like the Gender Climate Tracker and GALS are emerging as valuable frameworks to bridge this gap.

A gender-responsive MRV system ensures not only transparency and equity but also improves the accuracy of impact assessments.

CONCLUSION

This review demonstrates that gender-responsive carbon farming is not only a moral imperative rooted in human rights but also a strategic innovation critical to enhancing the effectiveness, equity, and sustainability of climate action.

While carbon farming promises ecological benefits such as carbon sequestration and improved soil fertility, its potential will remain underutilized unless it accounts for the social structures that determine who participates, who benefits, and who is excluded. Evidence from Zimbabwe, Namibia, Mali, South Asia, and elsewhere confirms that women - despite being vital actors in agriculture - are often left behind in carbon-based interventions due to structural constraints like insecure land tenure, lack of capital, limited extension services, and weak policy enforcement.

At the same time, gender-responsive practices such as inclusive land governance, participatory planning, tailored training, and equitable access to carbon markets have shown to improve both carbon and livelihood outcomes. These practices not only empower women and build resilience in rural communities but also improve the adoption and effectiveness of carbon sequestration practices.

Thus, integrating gender into carbon farming is not just an “add-on,” but a transformative strategy that can unlock co-benefits across the SDGs—particularly SDG 5 (Gender Equality), SDG 13 (Climate Action), and SDG 15 (Life on Land).

RECOMMENDATIONS

Based on the evidence synthesized in this review, the following policy, programmatic, and institutional recommendations are proposed:

1. Secure Land Tenure for Women

• Reform customary and statutory land laws to ensure legal recognition of women’s land rights.

• Include women in land certification and carbon asset registration programs.

2. Gender-Responsive Capacity Building

• Design CSA training programs to accommodate women’s schedules, literacy levels, and culturally appropriate communication.

• Encourage the use of peer-to-peer platforms such as Gender Action Learning Systems (GALS).

3. Inclusive Governance Structures

• Establish mandatory quotas or representation for women in decision-making committees overseeing carbon farming initiatives.

• Facilitate the formation of women-led cooperatives and producer groups involved in carbon credit schemes.

4. Equitable Access to Climate Finance

• Allocate gender-targeted subsidies and grants for climate-smart inputs, especially for smallholder women farmers.

• Develop inclusive carbon credit platforms where women can directly benefit from ecosystem services they help restore.

5. Integrate Gender Metrics in MRV Systems

• Design monitoring frameworks that include both quantitative (GHG emissions, crop yields) and qualitative (agency, empowerment) indicators.

• Require all carbon offset projects to report gender-disaggregated data.

6. Foster Cross-sectoral Collaboration

• Integrate gender-responsive carbon farming into national climate strategies (NAPs, NDCs).

• Encourage partnerships between ministries of agriculture, environment, gender, and finance for harmonized policy delivery.

7. Support Knowledge Sharing and Research

• Fund participatory action research focused on contextual gender dynamics in carbon farming.

• Create regional knowledge hubs where local women's innovations and voices are documented and disseminated.

POLICY IMPLICATIONS

Translating research findings into actionable policy reforms is essential to ensure gender equity is mainstreamed into carbon farming and broader climate resilience strategies. Below are the core policy implications derived from the review:

1. Mainstream Gender in Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs)

• Most NDCs under the Paris Agreement still treat gender as peripheral. Governments must ensure that gender indicators and actions are explicitly integrated into NDCs and NAPs.

• For example, adaptation sectors like agriculture, forestry, and land-use should incorporate gender equity targets, not just emissions reductions.

2. Reform Land Tenure and Resource Rights Frameworks

• Governments should adopt gender-sensitive land reform laws, ensuring that women - individually or collectively - can register and own land that qualifies for carbon credits or sustainable land-use initiatives.

• Land registration systems must be updated to recognize co-ownership models, especially for married or widowed women.

3. Institutionalize Gender Audits in Climate Finance

• All climate finance mechanisms - domestic or international - should mandate gender audits during

proposal appraisal, implementation, and post-project evaluation stages.

• The Green Climate Fund (GCF) and Adaptation Fund should require grantees to submit gender-disaggregated impact assessments.

4. Develop Gender-Responsive MRV Guidelines

• Ministries of Environment and Agriculture should work with research institutions to develop national guidelines for MRV (Monitoring, Reporting, and Verification) that track both carbon and social outcomes (e.g., changes in gendered access to income, training, and decision-making).

5. Integrate Carbon Farming into Gender Equality Strategies

• Ministries of Gender or Social Development must treat carbon farming as a strategic pathway for women's economic empowerment and ecological leadership.

• National gender action plans should include specific targets for women's participation in agroecology, reforestation, and CSA programs.

6. Create Gender-Inclusive Carbon Credit Platforms

• Public-private partnerships can support women-only carbon cooperatives, enabling them to access and trade carbon credits directly.

• Platforms should be built using open-source and mobile-first tools to ensure accessibility for rural women.

7. Build Cross-Ministerial Coordination Mechanisms

• Establish cross-sectoral task forces or committees that include representatives from agriculture, climate, finance, and gender ministries to oversee gender-responsive CSA programs.

• Encourage policy harmonization so that gender equality frameworks and climate strategies reinforce each other.

By embedding these changes into national policy and institutional frameworks, states can align their climate goals with the global gender justice agenda—ensuring that the transition to carbon-neutral development is also a transition to socially inclusive and equitable systems.

REFERENCES

Adhikari A., Ghimire S. (2025). Gendered dimensions of climate change impacts: challenges and adaptive strategies. Turkish Journal of Agriculture-Food Science and Technology, 13: 1354-1367.

Ajzen I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50: 179–211.

Akter S. (2025). Climate resilient development for agriculture and pathways for gender inclusivity. Agricultural Economics, 56: 446-456.

Akyala A., Ayanlade A., Adeyeye O., Oluwatimilehin I.A. (2023). Gender-responsive approaches to rapid climate warming among smallholder farmers. Current Research in Environmental Sustainability, 5: 100219.

Angula M.N., Mogotsi I., Lendelvo S., Aribeb K.M., Iteta A.M., Thorn, J.P. (2021). Strengthening gender responsiveness of the Green Climate Fund ecosystem-based adaptation programme in Namibia. Sustainability, 13: 10162.

Awiti A.O. (2022). Climate change and gender in Africa: a review of impact and gender-responsive solutions. Frontiers in Climate. 4: 895950.

Banerjee N., Misra V. (2024). Role of gender in sustainable mitigation for climate change in agriculture. In the climate-health-sustainability nexus: understanding the interconnected impact on populations and the environment (pp. 51-69). Cham: Springer Nature Switzerland.

Crenshaw K. (1991). Mapping the margins: Intersectionality, identity politics, and violence against women of color. Stanford Law Review, 43: 1241–1299.

Dhenge S.A., Shirke G.A.R.G.I., Sarap N.S. (2016). Gender responsive approach to climate smart agriculture. Advances in Life Sciences, 5: 23.

Elias M., Ihalainen M., Monterroso I., Gallant B., Paez Valencia A.M. (2021). Enhancing synergies between gender equality and biodiversity, climate, and land degradation neutrality goals: Lessons from gender-responsive nature-based approaches. CGIAR.

FAO (2021). The State of Food and Agriculture. Food and Agriculture Organization.

Lanzarini S. (2025). Women as stewards of forests: tropical forest issues. Tropical Forest Issues, 63: 198 pages. Tropenbos International.

Muchabaiwa I.R., Muchabaiwa T. (2024). A gender-responsive approach to climate-smart agriculture. A case study of community garden support. Asian Journal of Qualitative Research, 1: 40-57.

Sadiq M.S., Singh I.P., Ahmad M.M. (2025). Gender perspectives in the adoption of carbon farming technologies. MRS Journal of Multidisciplinary Research and Studies, 1: 40-45.

Samandari A.M. (2017). Gender-responsive land degradation neutrality. Global Land Outlook working paper. UNCCD.

Shiva V. (1988). Staying Alive: Women, Ecology and Development. Zed Books.

Warren K. (2000). Ecofeminist Philosophy: A Western Perspective on What It Is and Why It Matters. Rowman and Littlefield.

References