Landesa

WOMEN'S LAND TENURE SECURITY AS A PATHWAY TO CLIMATE CHANGE MITIGATION AND ADAPTATION

EVIDENCE SCAN

Photo: Rehema Selemani looking over the land behind her house in Vilabwa village, Kisarawe district, Tanzania.

Report Author: Tatiana Gumucio

January 2024

Acknowledgements

We gratefully acknowledge the inputs and perspectives contributed by thematic experts who participated in informal interviews that helped form the conceptual framework used in the Evidence Scan and provided initial guidance on how to conceptualize and approach priority evidence and data gaps. The thematic experts include: Elizabeth Bryan, Ruth Meinzen-Dick, David Kaimowitz, Omaira Bolaños, Caleb Stevens, Johanna von Braun, Eva Hershaw, Nayna Jhaveri, Rodrigo Paz Ybarnegaray, Everlyne Nairesiae, Kame Westerman, and David Bledsoe.

The author thanks Landesa colleagues Krista Jacobs, Rachel McMonagle, Jolyne Sanjak, and Beth Roberts for their review and inputs on earlier versions of the report, including feedback on the conceptual framing. The author also gratefully acknowledges Nicole Tomita for her work developing the visual representations of the conceptual framework included in the report and Megha Panigrahi for her support to copy-editing and report formatting. The content of the paper reflects the author's views.

Landesa

Contents

Acronyms and Abbreviations

IPCC	Intergovernmental Panel on Climate Change
GHG	Greenhouse Gas
USAID	United States Agency for International Development
NTFP	Non-Timber Forest Product
CIFOR	Center for International Forestry Research

Landesa

Executive Summary

As research on the nexus of land tenure security and climate grows, a more fine-tuned focus on tenure security *for whom* is needed to assess emerging evidence that women's land tenure security can be an important lever for enhanced climate change mitigation and adaptation. To this end, we reviewed relevant empirical evidence to ascertain how women's land tenure security (WLTS) affects climate change mitigation and adaptation. Our review seeks to further clarify the significance of women's land tenure security to climate change mitigation and adaptation, inform Landesa and partners' climate advocacy, and provide guidance to partners in data generation.

Using examples from prior related reviews and inputs from experts, we developed a conceptual framework to guide our review. The framework identifies three main pathways from women's land tenure security to climate change mitigation and adaptation: sustainable management of forest resources, long-term land investments, and expanding response options. We limited the review to rural contexts in regions and countries of the Global South.

We find that a limited amount of research empirically analyzes the links between women's land tenure security and climate change mitigation or adaptation, although findings generally agree on a positive relationship along the three pathways. We highlight where the existing literature hints at evidence along the three main pathways.

- There is strong evidence that formalized or documented tenure can contribute to long-term land investments that promote carbon sequestration and enhanced adaptive capacities for female-headed households in Sub-Saharan Africa.
- Strong evidence indicates that elements of women's tenure security, such as land rights durability, robustness, and completeness, also contribute to enhanced response options available to women in Sub-Saharan Africa and South Asia.
- A moderate amount of evidence finds that women's participation in forest management groups can promote forest livelihood productivity and full income, important factors supporting resilience, in South Asia.
- Although particularly limited, the evidence also suggests that gender equity in forest decision-making bodies, where there may have been male biases in the past, can contribute to improved forest conditions in South Asia.

We also highlight how additional evidence generation will be key for strengthening our understanding of the significance of WLTS to climate change mitigation and adaptation. In general, there is a need for collection of data that more accurately represents women's tenure security in research assessing effects on mitigation and adaptation or resilience. Moreover, assessment of key elements of women's tenure security besides formalized tenure and voice in decision-making bodies can enhance our understanding of pathways to mitigation and adaptation. Assessment of the completeness of women's bundle of rights in collective tenure arrangements can be an important gap for studies concerning the sustainable forest resources management pathway to address. Additional research is also needed on the multiple links within each pathway leading to outcomes of mitigation and adaptation. More rigorously designed mixed methods and qualitative research can help articulate multiple links between women's land tenure security and climate change mitigation and adaptation. Collecting data on women's land tenure security and its relationships with climate change mitigation and adaptation in Latin America and in Southeast

Asia will be key for closing significant regional gaps in the evidence. Collecting data on women's land tenure security for non-agricultural livelihoods will also help close evidence gaps on how women's tenure security contributes to mitigation and adaptation in other livelihood contexts.

There is potential, although limited, to address knowledge gaps concerning the relationship between women's land tenure security and climate impacts by connecting existing data collected through the Living Standards Measurement Study – Integrated Survey on Agriculture (LSMS-ISA) with remotely sensed data and other available datasets that can show mitigation or resilience impacts. The LSMS-ISA survey module is helpful for its more nuanced consideration of the elements of women's tenure security in comparison to other available datasets; however, it only exists for Sub-Saharan African contexts to date. Concerted efforts and investments will be needed for more robust research design to assess the elements comprising women's tenure security and to articulate the role of women's tenure security along complex pathways to mitigation and adaptation.

Introduction

Governments, donors, and rural development organizations increasingly recognize the significance of rural land tenure security to address extreme weather events and slow onset hazards (i.e., precipitation pattern changes, sea-level rises, increasing temperatures, and desertification/drought) resulting from climate change and tenure security's importance for mitigating detrimental impacts to rural livelihoods and well-being. An IPCC special report highlights the significant link between land tenure and climate change (IPCC, 2019), and research suggests that land tenure insecurity can hamper behaviors that support sustainable rural development and resilience to shocks, including adoption of improved farming practices and long-term livelihood investments. Consequently, there is growing interest to robustly assess these and related links (Murken and Gornott, 2022; Stevens, 2020).

As research on the nexus of land tenure security and climate grows, a more fine-tuned focus on tenure security *for whom* is needed. Critical gender inequalities in land tenure security exist due to discriminatory laws and social norms limiting women's rights to access, manage, inherit, transfer, and benefit from land (UN Women, 2018). Correspondingly, women have limited authority in decision-making on adaptation and land investment. Lack of legal and socially legitimate land rights can also contribute to women's limited access to extension services and technical information to improve sustainable land use. These factors limit women's contributions to decision-making fora on land use and often prevent women from receiving compensation or other redress related to land.

There is emerging evidence that women's land tenure security can be an important lever to enhance climate change mitigation and adaptation and to build climate resilience. Addressing gendered inequalities in land tenure security can generate more robust household and community resilience to climate change and extreme climate events (Bryan, 2022). It can also enable long-term land investment in climate-smart agricultural practices and strategies to sequester carbon and help rural households and communities prepare for and adapt to climate change. Furthermore, insights from conservation initiatives suggest that women's participation and leadership in land and environmental governance institutions, along with recognition of their distinct knowledge and priorities, can contribute to effective implementation and sustainability of resilience interventions (Kratzer and Masson, 2016).

This paper articulates the pathways between women's land tenure security and climate change adaptation and mitigation, and the strength of evidence for each pathway, through review of relevant empirical evidence. We acknowledge the limitation that this review focuses on gender and does not deeply consider other important factors related to the question of tenure security *for whom* – including dimensions of belonging to Indigenous and different ethnic groups, age and lifecycle, partnership status, and other social and institutional factors – in part because of limited published analysis addressing these factors. We seek to articulate the pathways between women's land tenure security and climate change adaptation and mitigation and to identify gaps in the existing evidence and data concerning those pathways. The review will further clarify the significance of women's land tenure security to climate change adaptation and mitigation, inform Landesa and partners' climate advocacy, and provide guidance to partners in data and knowledge building.

Landesa

Conceptual framework

We organize the existing empirical evidence with a conceptual framework based on frameworks and thematic networks from Meinzen-Dick et al. (2017) and Murken and Gornott (2022) and draw on inputs from Landesa and partners. Meinzen-Dick et al. (2019) provide important gendered considerations on the links from women's land rights to livelihoods, full income, and empowerment. Although Murken and Gornott (2022) do not substantially incorporate a gender lens into their thematic network, it is helpful for highlighting the relationship between land tenure and range of response options in the context of climate stressors. Before presenting the main pathways in our conceptual framework, we outline elements of women's land tenure security, our conceptualization of climate change mitigation and adaptation, and trends in the knowledge base concerning tenure and climate change.

Elements of women's land tenure security

An important point of departure for our conceptual framework entails defining land tenure security and the elements that comprise women's land tenure security. We draw from Jhaveri's explanation of tenure security as "the degree of confidence a rights-holder has that the tenure is clear, durable, will be enforced, and broadly upheld by the community (2021: 2)." Critically, tenure security does not depend solely on formalization of land rights, which can be a positive (or negative) influencing factor. Socio-cultural norms and customary rules governing land rights also influence women's tenure security, often differently than men's. We also recognize that land rights are not limited to ownership, but rather consist of a bundle of rights that women might have or desire including women's right to participate in decision-making about land use and governance (UN Women, 2018). Jhaveri (2021) summarizes primary factors affecting women's and men's perceptions of land tenure security, drawing from the relevant literature across a range of individual and collective rights regimes, shown in Table 1.[1]

Table 1: Factors that contribute to women and men's perceptions of tenure security (Jhaveri, 2021)[2]

Legally and socially recognized legitimate rights for women and men
Robustness of gendered rights
Completeness of gendered rights
Durability for women and men
Enforceability of rights for women and men
Trust in authorities implementing gender equality principles
Gender-equal community norms for tenure rights
Exercising rights by women does not involve consultation or approval beyond what is asked of men
Quality of women's and men's social relationship in the community
Ability to withstand changes in families and communities
Awareness of gender-equal tenure rights
Gender-equal community or decision-making authority in governance bodies

[1] Although robustness, completeness, and durability of land rights may be closely related to other factors noted in the table, we include all of the items noted in the interest of conserving the comprehensiveness of the list.

[2] We refer to the following definitions of robustness, completeness, and durability: robustness is the legitimacy or recognition of rights in both formal and customary systems and the enforceability of rights against third parties; completeness is the scope of rights held, including the right to access, use, and derive benefits from lands and resources, as well as participation in their governance; durability is the length and certainty of rights (Salcedo La Viña and Giovarelli, 2021; Doss and Meinzen-Dick, 2020).

Although our conceptual framework does not distinguish among factors affecting perceived tenure security, we expect that studies assessing the relationship between women's land tenure security and climate change mitigation and adaptation would engage with one or more of them.

Defining climate change mitigation, adaptation, and resilience

For the purposes of this review, we conceptualize climate change mitigation as activities that lead to carbon sequestration. Mitigation can occur through soil conservation practices that enhance carbon sequestration (e.g., crop rotation, fallowing, terracing, agroforestry); increased tree planting (agroforestry, afforestation, re-forestation); and decreased rates of deforestation.

Concerning adaptation, we focus on increased individual, household, and communal capacities to adapt to climate change impacts. Capacities can be strengthened through increased investment in infrastructure (e.g., irrigation and other water harvesting systems, including pumps, farm ponds, percolation ponds, pitcher irrigation, boreholes; flood barriers; windbreaks), climate-smart agriculture (e.g., drought resistant crops; perennial crops; soil conservation techniques), and greater adoption of sustainable land use practices (e.g., fallowing, terracing, agroforestry). Having a greater range of available options to respond to climate shocks and stressors is another important aspect of adaptation (Theis et al., 2019). We consider resilience as the capacity to resist, cope with, or recover from shocks and stressors and arrive at a reduced state of vulnerability (Huyer et al., 2021).

Considering mitigation, adaptation, and tenure through a gender lens, social normative structures limiting women's roles and opportunities can inhibit women's participation in land use decision-making concerning mitigation and adaptation actions (Hurlbert et al., 2019). Furthermore, other gender biases in formal and informal tenure systems create inequalities in rights-based resource access that can disadvantage women and increase their vulnerability to climate change.

Relationships between land tenure and climate change mitigation and adaptation

Before focusing on the evidence for pathways from *women's* land tenure security to climate outcomes, we briefly outline evidence on the relationship between land tenure, in general, and climate change mitigation and adaptation. Although this gender-neutral literature does not differentiate women's and men's tenure, we consider that it provides valuable information on potential relationships that women's land tenure security can influence.

The discussion draws largely from Hurlbert et al. (2019) in the IPCC Special Report on climate change and land, including their presentation of findings according to natural resource systems (Table 2); however, the discussion also refers to other reviews and metanalyses. In general, the gender-neutral evidence base finds a clearer positive relationship between tenure security and mitigation, particularly as it concerns forest landscapes and collective tenure arrangements; however, less clear evidence exists for relationships between tenure security and adaptation.

Table 2: Relationships between tenure and mitigation and adaptation from gender-neutral research

Landscape or natural resource system	Implications of land tenure for mitigation of climate change	Implications of land tenure for adaptation to climate change
Forests	Land tenure insecurity has been identified as a key driver of deforestation and land degradation, leading to loss of sinks and creating sources of GHGs. While land tenure systems interact with land-based mitigation actions in complex ways, forest decentralization and community co-management has shown considerable success in slowing forest loss and contributing to carbon mitigation.	Land tenure security can lead to improved adaptation outcomes, but land tenure policy for forests that focuses narrowly on cultivation has limited ability to reduce ecological vulnerability or enhance adaptation. Secure rights to land and forest resources can facilitate efforts to stabilize shifting cultivation and promote more sustainable resource use if appropriate technical and market support are available.
Smallholder cropland	Secure land rights, including through customary systems, can incentivize farmers to adopt long-term climate-smart practices, e.g., planting trees in mixed cropland/forest systems.	Insecure land rights are one factor deterring adaptation and accentuating vulnerability. Specific dimensions of inequity in customary systems may act as constraints on adaptation in different contexts.
Landscape or natural resource system	Implications of land tenure for mitigation of climate change	Implications of land tenure for adaptation to climate change
Rangelands	Where pastoralists' traditional land use does not have legal recognition, or where pastoralists are unable to exclude others from land use, this presents significant challenges for carbon sequestration initiatives.	Many pastoralists in lands at risk from desertification do not have secure land tenure, and erosion of traditional communal rangeland tenure has been identified as a determinant of increasing vulnerability to drought and climate change and as a driver of dryland degradation.
Riverscapes and riparian fringes	Measures such as protection of riparian forests and grasslands can potentially play a major role in mitigation, provided rights to land and trees are sufficiently clear.	Unequal land rights and absence of land management arrangements in floodplains increases vulnerability and constrains adaptation. Marginalized or landless fisherfolk will be empowered by tenurial rights and associated identity to respond more effectively to ecological changes in riverscapes, including riparian zones.

Note: Adapted from Hurlbert et al. (2019).

Substantial research exists showing that devolving land and resource rights to Indigenous peoples and customary communities, can contribute to positive forest outcomes including reduced deforestation (FAO and FILAC, 2021; IPCC, 2019). For example, a report by FAO and FILAC (2021) drawing from over 300 studies from over the past twenty years highlights that forests managed by Indigenous and tribal peoples in Latin America are better conserved than others in the region. An evidence review by USAID (Stevens et al., 2020) on the links between land and resource governance and various development outcomes, drawing from systematic reviews and metanalyses across regions, finds that secure land rights for Indigenous communities tends to promote positive forest outcomes. Furthermore, Hurlbert et al. (2019) highlight that decentralization and co-management with communities can help slow forest loss, although interactions between land-based mitigation measures and tenure arrangements can be complicated.

Findings are more mixed concerning the links between land tenure security and adaptation outcomes in forested landscapes. Beyond land tenure security, technical and market support is needed to promote sustainable resource use and resilience to climate change. Furthermore, tenure policy that focuses on forest cultivation outcomes alone may be insufficient to promote ecological resilience and adaptation.

In comparison to forest landscapes, the relevant knowledge base is more limited for croplands, rangelands, and riverscapes, although it signals positive relationships between land tenure security and mitigation (Table 2). In smallholder cropland systems, there is evidence showing that land tenure security can contribute to uptake of long-term land investments, such as agroforestry, that promote carbon sequestration. Tenure insecurity, as it concerns exclusion rights or lack of rights formalization, can inhibit carbon sequestration initiatives in rangelands. Clear tenure and resource rights can be a factor promoting mitigation measures in riparian landscapes.

While limited research exists showing how land tenure security contributes concretely to adaptation, some studies illustrate how tenure insecurity can exacerbate vulnerability in croplands, rangelands, and riverscapes (Table 2). Erosion of traditional communal tenure arrangements can contribute to increased vulnerability to climate change for pastoralists. Furthermore, land rights could empower landless peoples in riparian zones to respond more effectively to climate change.

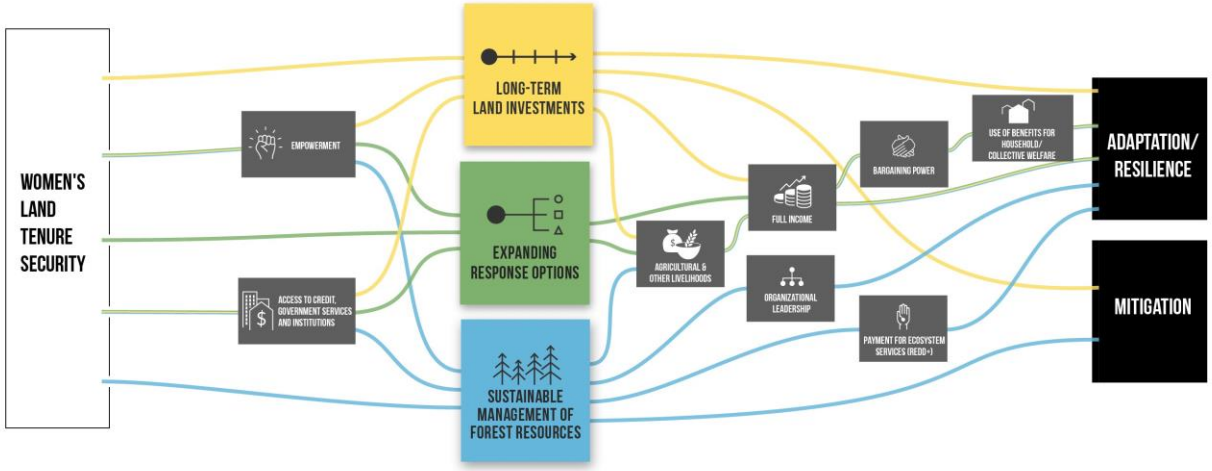
A body of research not specific to a landscape, but tending to focus on individually-held or household land rights, highlights that tenure security is one of several factors important for enabling sustainable land management practices, important for both climate change adaptation and mitigation. For example, a review by USAID (Stevens et al., 2020) highlights that governance support, land use planning, provision of public goods such as effective enforcement, and in some instances, subsidies are needed along with land tenure interventions to promote sustainable land management and positive environmental outcomes.

Pathways from women's land tenure security to adaptation and mitigation

We conceptualize three primary pathways from women's land tenure security to climate change mitigation and adaptation based on Meinzen-Dick et al.'s (2017) framework for links between women's land tenure security and poverty reduction and on Murken and Gornott's (2022) thematic network of climate change and land tenure interactions. We adapt the framework and thematic network to more

visibly consider women's collective land tenure contexts and note that the pathways from women's land tenure security to climate change mitigation and adaptation can occur at any of the individual level, household level, and community level (see Figure 1).

Figure 1: Conceptual framework: Pathways to climate change mitigation and adaptation from WLTS



Women's land tenure security can contribute to climate change mitigation and adaptation through three primary pathways: sustainable management of forest resources, long-term land investments, and increased range of response options not related to land investments. The broader gender-neutral knowledge base on land tenure and climate change mitigation and adaptation (Table 2) provides evidence of these three pathways; however, the findings do not consider the potential significance of women's land tenure security to mitigation and adaptation. For example, the gender-neutral knowledge base suggests that land tenure security can contribute to sustainable management of forest resources leading to enhanced carbon sequestration, especially as it concerns collective tenure arrangements. Land tenure security can also help contribute to enhanced capacities to adapt through sustainable management of forest resources, although other factors besides land tenure security may be important for increasing livelihood productivity, a key support for enhanced resiliency. Land tenure security can also promote long-term land investments that result in enhanced mitigation and adaptation, such as those concerning agroforestry; however, other factors related to local norms and institutions also critically influence pathways to adaptation. The evidence also suggests that tenure security leads to empowerment and an increased range of response options, contributing to enhanced adaptive capacities. There is potential to clarify pathways by illuminating relationships and multiple steps that lead to mitigation and adaptation, through critical consideration of gender and whose tenure security is at play.

Sustainable management of forest resources pathway: We hypothesize that women's land tenure security, particularly as it concerns gender-equal decision-making authority in communities or governance bodies, can positively affect sustainable management of forest resources, which can contribute critically to carbon sequestration **(mitigation)**. Women's livelihoods can often depend on

non-timber forest products and, in the case of coastal livelihoods, marine resources, differently than men's; consequently, women-inclusive or gender-balanced decision-making bodies over forest resources can more effectively represent women's priorities for sustainable management.

Women's meaningful participation in sustainable management of forest resources, through decision-making bodies, can contribute to enhanced **resilience**. Their participation in sustainable management of forest resources can promote women's enhanced collective agency and organizational leadership, providing them greater capacities to manage and cope with climate-related risks. Women's participation in forest resource decision-making bodies can also ensure their capacity to benefit from payments for ecosystem services, like REDD+; this can also have positive effects on income, making them better-resourced to respond effectively to climate change.

Long-term land investments pathway: Land tenure security can enhance incentive and ability to pursue long-term land investments (for example, in reforestation, afforestation, and in climate-smart agricultural (CSA) practices (such as agroforestry and soil conservation techniques) that contribute to **mitigation**. These investments also help build capacities for **adaptation** to climate change impacts, as do other investments in climate adaptation infrastructure, such as water harvesting systems, flood barriers, and wind breaks.

Expanding response options: A third pathway involves the potential for women's land tenure security to increase the range of available response options, besides those related to long-term land investments. Secure tenure can help shift socio-cultural norms and facilitate access to other assets and services consequential for women, who consistently contend with a more restrictive opportunity environment in comparison to men.

All three pathways can have positive effects on livelihood productivity and full income (including cash and in-kind income, as well as the value of time), which can support resilience and adaptation. For example, sustainable management of forest resources can promote productivity of NTFP, marine, and forest livelihoods and contribute to full income, which can help promote **resilience** to climate shocks and stressors. Land investments and other effective responses in the wake of climate shocks and stressors can promote agricultural and non-agricultural livelihoods and full income, and consequently, contribute to **resilience**. Income can be used for further long-term land investments and enable other additional response options, allowing for a cycling back and triggering of the prior links.

Women's empowerment and access to credit, government programs and services, and institutions – all of which women's land tenure security may enhance - can mediate the three pathways. Women's access to extension services or membership in cooperatives or other producer organizations can increase their access to information and resources needed to make long-term agricultural investments or apply climate smart agricultural practices. As an additional link, land tenure security can strengthen women's bargaining power over the use of full income. Women can use benefits (i.e., full income) from productive livelihoods differently than men, with a greater tendency towards household and collective welfare purposes. This can have important effects on household and community **resilience**.

Methods

We used a systematic search process to assess the available evidence on the effects of women's land tenure security on climate change mitigation and adaptation. For efficiency, we identified relevant prior

reviews of empirical evidence as a starting point for our findings. Using the online database Scopus, the following search terms were also used to identify additional articles, book chapters, conference papers, or working papers published between January 1, 2010, and August 25, 2022 that contained the specific phrase in its title, abstract, or keywords:

> (Women OR gender) AND ("land rights" OR "land ownership" OR "land tenure" OR "tenure security" or "secure tenure" or ("property rights" AND land)) AND ("crop rotation" OR "fallowing" OR terracing OR agroforestry OR "tree planting" OR deforestation OR afforestation or reforestation OR "sustainable land use") OR (Adaptation OR "adaptive capacity" OR "climate smart agriculture")

Additional titles were added via "snowballing" sources found in articles' reference lists, and through suggestions from resource experts interviewed. For each study, the methodology, definition of land rights, degree of sex-disaggregation in findings, and relevant link were recorded. The review included regions and countries of the Global South and did not systematically exclude livelihoods prevalent in these contexts; however, we did limit the review to rural contexts. Furthermore, our search was not exclusive to any specific type of land tenure arrangement (i.e., individual, collective, or customary rights regimes).

We also gathered insights on the pathways and evidence gaps concerning women's land tenure security and climate impacts through inputs from experts in climate change, natural resources, and land tenure at Landesa and ten other institutions.

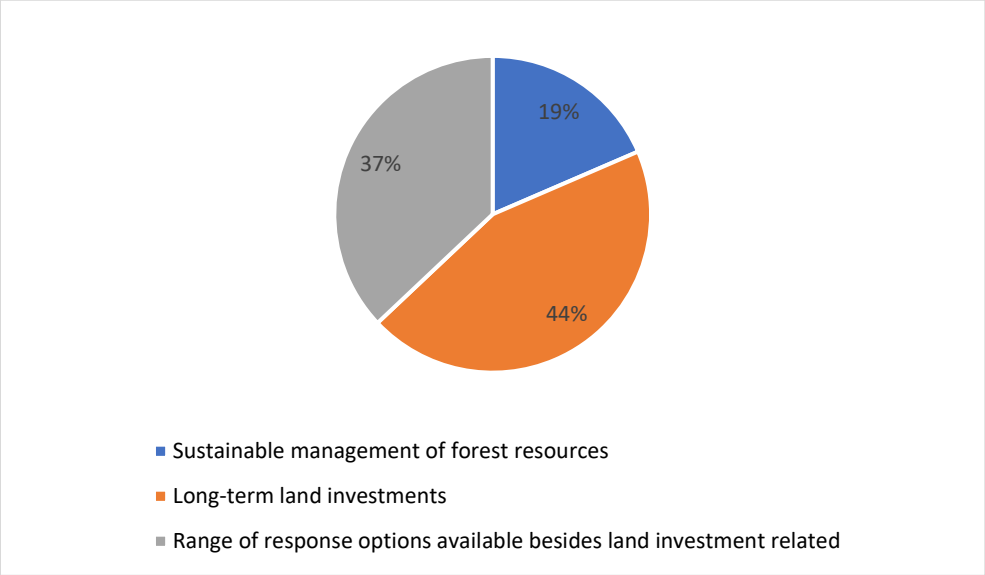
Because the evidence spans several categories of social and environmental outcomes and uses a range of methodologies, we present findings in narrative form.

Findings

We find that a limited amount of research empirically analyzes the links between women's land tenure security and climate change mitigation or adaptation; however, some links are studied more than others. Figure 2 shows the composition of evidence found per each of the three main pathways of interest. A total of twenty-seven publications were included in the review.[3] Forty-four percent and 37% of publications address the link between women's land tenure security and climate impacts via long-term land investments and range of response options available, respectively. Less of the evidence, 19%, addresses effects of women's land tenure security on mitigation and adaptation via sustainable management of forest resources.

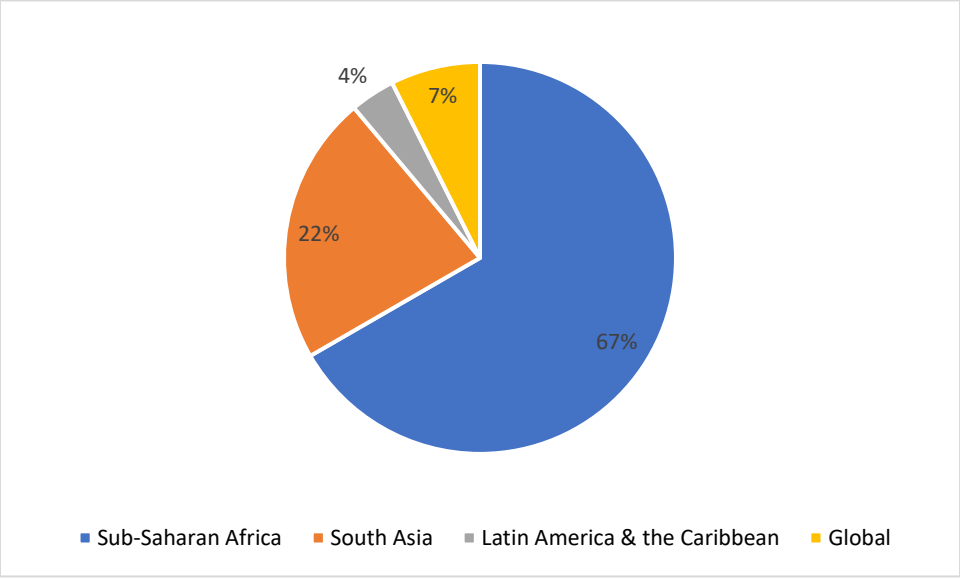
[3] Two of the publications included in the review are literature reviews themselves.

Figure 2: Breakdown of evidence per the three main pathways



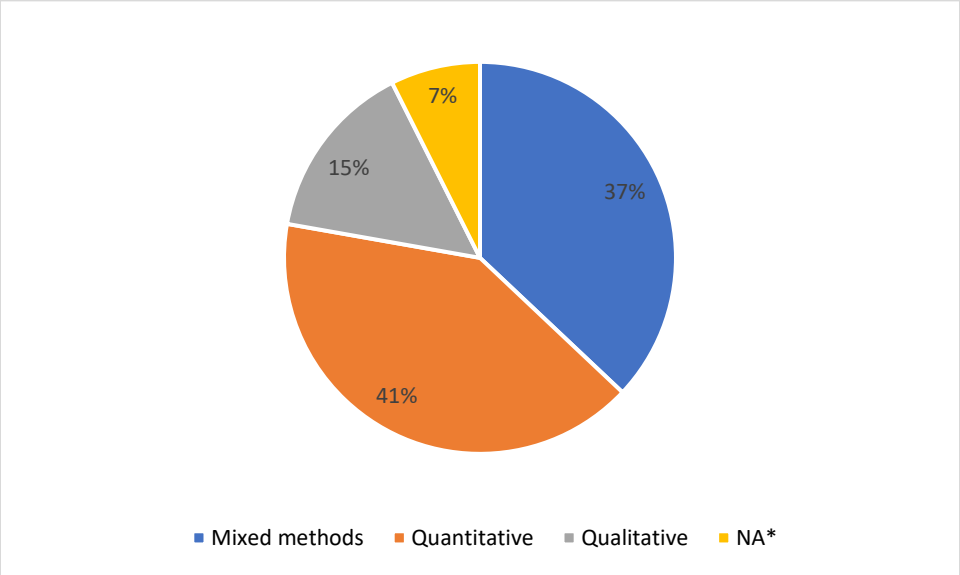
Concerning regional representation of the evidence, the majority (67%) of the research found targets Sub-Saharan African countries (Figure 3). Twenty-two percent of publications target South Asian countries. Seven percent of the publications have a global scope; these were the two literature reviews. A minimal amount of evidence concerns Latin America and the Caribbean (4%, 1 publication), and none address Southeast Asia.

Figure 3: Breakdown of evidence per region



Most of the publications use either quantitative (41%) or mixed methods (37%). Much less of the research (15%) uses qualitative methods alone (See Figure 4).

Figure 4: Breakdown of evidence per methods used



*Note: NA pertains to literature reviews included in our evidence review.

In general, existing research engages minimally with the factors affecting women's land tenure security. Despite the limited critical consideration of women's tenure security in the literature itself, studies tend to examine completeness, durability and robustness as primary elements.

Women's land tenure security and sustainable management of forest resources

Although there has been significant interest in formalizing community land rights, with the goal of promoting carbon sequestration from the vast forested areas held by Indigenous and customary communities, there has been limited attention to assessing the effects of women's land tenure security in collective rights regimes[4] governing forest landscapes on outcomes related to climate change mitigation; there has been even less consideration of the effects on adaptation. Nineteen percent of the publications found in our review addressed this pathway (See Figure 2). Of this evidence, the majority (80%) targets South Asian countries (Table 3). Table 4 shows that most of this research uses quantitative methods (60%) with some using mixed methods (20%).

[4] Salcedo-La Viña and Giovarelli (2019: 4) highlight important factors supporting women's tenure security in collectively held lands, including: "that collective land tenure is legally recognized and enforceable and women can claim and exercise rights equally with men, including the right to use and benefit from the lands and resources and participate in their governance"; and that, particularly in contexts where women had no rights or secondary rights to land, laws devolving control over common resources to local communities mandate gender inclusion.

Table 3: Regional breakdown of evidence per main pathways

	Sub-Saharan Africa	South Asia	Latin America & the Caribbean	Global
Sustainable management of forest resources	0%	80%	0%	20%
Long-term land investments	83%	0%	8%	8%
Range of response options available besides land investment related	80%	20%	0%	0%

Table 4: Methodological breakdown of evidence per main pathways

	Mixed	Quantitative	Qualitative	NA*
Sustainable management of forest resources	20%	60%	0%	20%
Long-term land investments	25%	67%	0%	8%
Range of response options available besides land investment related	60%	0%	40%	0%

*Note: NA pertains to literature reviews included in our evidence review.

One helpful line of research addresses women's participation in decision-making and governance over collectively held resources. Call and Sellers' (2019) global review of the social and environmental impacts of sustainable livelihood policies and interventions shows evidence from a body of studies on how women's participation in forest management can contribute to carbon sequestration (for example, through improved forest growth), drawing particularly from studies in India and Nepal on women's inclusion in Joint Forest Management Committees (JFMCs) and Executive Committees. CIFOR-led studies on gender composition of forest user groups in Kenya, Uganda, Bolivia and Mexico highlight the importance of gender equity in forest decision-making bodies for improved forest management, where there may have been male biases in the past. However, they note that all-female management groups may be less effective at monitoring forests and sanctioning rule-breakers, in comparison to those with more gender balance. The effectiveness of all-female management groups may be inhibited by other prevalent gender inequalities concerning time-labor burdens, capacities to adopt technologies, and access to extension services.

Other research on women's participation in forest management groups shows how it can contribute to community- and individual-level resilience through forest livelihood productivity and full income, with a particular focus on South Asian countries. This research tends to use quantitative and mixed methods. Ray et al.'s (2016) study in West Bengal, India, shows that when women were excluded from decision-making in Joint Forest Management Committees (JFMCs), local forest conditions (i.e., abundance of forest products, disappearance of tree species, changes in total forest area) and forest incomes did not improve. Their findings suggest that trends in forest conditions and incomes might be more positive where women have significant decision-making in the JFMCs but that socio-cultural norms mediate potential effects on livelihood outcomes, for example, which forest livelihood activities women engage in and the extent to which their opinions are actually considered in committee decisions. Adding to the evidence concerning JFMCs in West Bengal, Das's (2021) assessment finds an association between the formation of all-women JFMCs and increased village-level forest income and forest resources collected. Moreover, through adaptive collaborative management measures incorporated into Community Forest User Groups (CFUGs) in Nepal, meant to affect favorable distribution of benefits to women and the poor, women became more involved in CFUG-related income generation activities (McDougall et al., 2013). There was also an increase in the number of female recipients of loans through the CFUGs. An important mechanism of the adaptive collaborative management approach was decentralized decision-making arrangements allowing women and marginalized groups to influence CFUG decisions. Furthermore, St. Clair (2016) finds that increased involvement of women in forest user groups in Nepal contributed to women's fuelwood collection from local forests instead of from far-distanced areas, likely reducing women's time burden for fuelwood collection.

Another related line of research illustrates how women's limited inclusion in REDD+ forest governance processes and limited tenure security in general prevented them from benefitting from carbon sequestration (Call and Sellers, 2019; World Bank, 2021). Although not directly researched in existing studies, women's limited capture of monetary benefits made available through REDD+ and payments for ecosystems services made to communities can have critical effects on women's resilience capacities.

Within the literature on sustainable management of forest/collective resources, we found little research on the relationship between women's land tenure security and enhanced organizational leadership, as a pathway contributing to resilience. Only Das's (2012) study provides evidence of increased social capital, including indicators of political action, as a result of the formation of all-female JFMCs in villages in West Bengal. We would have expected women's participation in forest/collective decision-making bodies to have considerable effects on women's organizational leadership, but none of the research reviewed documented evidence related to this relationship.

Women's land tenure security and long-term land investments

The literature on how women's land tenure security affects adoption of long-term investments, particularly natural resource management practices, suggests that lack of tenure security contributes to reluctance to make long-term investments in land, critically affecting sustainable land management and production (Meinzen-Dick et al., 2017; Hurlbert et al., 2019). Forty-two percent of the evidence found in our search addresses this pathway (see Figure 2). Similarly to a review by Meinzen-Dick et al. (2017) we find that little existing research considers "women's land rights" when addressing these questions. Of this research, most of it (83%) is almost entirely focused on Sub-Saharan Africa (Table 3). Sixty-seven percent and 25% of this evidence is quantitative or mixed methods, respectively (Table 4). It is also

limited to agricultural and agroforestry livelihoods. More of this research assesses effects on investments in sustainable land use practices (i.e., fallowing, agroforestry, terracing), with slightly fewer assessing effects on soil conservation techniques, and minimal research analyzing effects on investments in adaptation infrastructure. Furthermore, more of the research compares outcomes between female-headed and male-headed households and so neglects intrahousehold gender dynamics and the experiences of women living in dual- or male-headed households. The few studies that do assess effects on women in male-headed households also tend to include more nuanced analysis of the elements comprising women's land tenure security.

Several studies find positive impacts of formalized or documented tenure for female-headed households on sustainable land management practices. Ali et al.'s (2014) research in Rwanda shows that a land reform program contributed to participants' increased investments in soil conservation measures, such as bunds, terraces, and check dams. The most significant change in land investments was among female household heads, and the authors hypothesize that as a sub-group they had experienced higher levels of tenure insecurity before the land regularization program than men. An evaluation of tenure and agroforestry extension services interventions in Zambia similarly shows that tenure security had significant positive influence on agroforestry, measured in terms of extent of seedlings planted, percent of field planted, and seedling survival rates for women household heads and no influence for any other sub-groups, at least in the short-term (Huntington et al., 2018). An impact evaluation in Ethiopia also found that land certification (formal documentation of use rights) increased the probability that households invested in soil and water conservation practices, (such as building and maintaining bunds, hedges, canals, and wells; using water harvesting structures; or planting grasses, trees, or bushes) particularly for female-headed households (Alvarado et al., 2022); furthermore, second-level certification, which included parcel-level digital registration with the provincial government, increased the probability of soil or water conservation among households headed by widows. Goldstein et al.'s (2018) evaluation of a land demarcation program in Benin found that land tenure security (represented by land demarcation) is positively correlated with land fallowing in female-headed households in the treatment villages. The demarcation process led women to move their agricultural activities to plots outside the village that were not demarcated and were less secure, as a means to increase their tenure security on non-demarcated plots.

A related line of research highlights that land rights formalization alone may be insufficient to promote long-term land investments, especially for female-headed households; awareness and knowledge of land rights may be a critical factor. A study in Uganda finds that both legal status of land and knowledge of land rights are critical factors associated with tree planting and soil conservation measures, particularly for female-headed households (Deininger et al., 2008). In Ethiopia Quisumbing and Kumar (2014) find smaller impacts of land certification on female-headed households' incentive to plant trees compared with male-headed households and postulate that the difference arises from inequalities in training and knowledge in tenure security, land transferability, and gender rights.

Among women living in male-headed households, research shows the importance of the durability, robustness, and completeness of women's land rights to enable potential outcomes related to long-term land investments. For example, Dillon and Voena's (2018) research in Zambia shows less fallowing practices implemented by married-couple households in areas where widows do not inherit land. They attribute the households' reduced investment in land quality to wives' concern over prospective loss of

land after their husbands' death. Kelly et al.'s (2019) study in Haiti illustrates that women had lower perceived tenure security and a less complete bundle of rights (particularly concerning ownership and exclusion rights) on land they inherited in comparison to men; consequently, they were less inclined to make investments in tree planting, terracing, or fallowing on inherited land. Conversely, women and men had similar bundles of rights concerning lands they had purchased, and there were no significant differences between women's and men's tendencies to make land investments on purchased lands. Documentation of land, whether formal or informal, also contributed to land investments for women and men, notably on purchased land. Nchu et al. (2019) notes that women in male-headed households in the study site in Cameroon tend to not have rights to own or manage farmlands. Although most women can access farmland through their spouses, they often lose this right upon divorce or widowhood. Consequently, their perceived tenure insecurity was found to be a significant factor limiting women from adopting long-term land investments to enhance their agricultural productivity and reduce their vulnerability to climate change impacts.

Research assessing the influence of matrilocality in Malawi on women's and men's land tenure security and consequent investments in agroforestry and soil conservation finds mixed results. Toth et al. (2017) find that married men in matrilocal communities may be disinclined to adopt fodder tree technologies, due to the risk of losing land rights upon divorce. Lovo (2016) similarly finds that men in matrilineal-matrilocal communities had higher tenure insecurity in comparison to women and were also less likely to make soil conservation investments (i.e., planting of vetiver grass; construction of soil bunds, contour box ridges and terraces). In contrast, Benjamin et al.'s (2021) findings suggest the positive relationship of women's tenure insecurity with investments in agroforestry. They find that native women in matrilineal-matrilocal societies were less likely to invest in agroforestry, in contrast to non-native women in the communities, suggesting that the latter invest in agroforestry to secure their land rights. However, they recognize the possibilities of reverse causality in their study and highlight their findings as only suggestive.

None of the studies from our search results empirically address outcomes of livelihood productivity or full income, resulting from long-term land investments enabled by women's land tenure security.

Women's land tenure security and enhanced range of response options

The literature addresses how women's land tenure security can increase their range of response options available to improve their individual-level resilience. Responses are not limited to long-term land investments but also include shorter-term CSA practices and off-farm livelihood strategies. Studies related to enhanced range of response options nearly always incorporate a gender lens in their approach. Thirty-nine percent of the evidence found in our review addresses this pathway (Figure 2). Of this research, the majority (80%) targets Sub-Saharan Africa, with some (20%) focusing on South Asian countries (Table 3). Sixty percent and 40% of this evidence uses mixed or qualitative methods, respectively (Table 4), and it emphasizes agricultural livelihoods. In comparison to the other two pathways, studies more often fail to critically assess the relationship between women's land tenure security and resilience and fail to clearly define adaptation or resilience impacts.

A majority of these publications show that women do not have as complete a bundle of rights as men and their rights are not as durable as men's due to gender biases in customs surrounding land

inheritance; correspondingly, women are more constrained in adopting effective adaptation strategies.[5] For example, Nyahunda et al.'s study in South Africa (2021) finds that women's lack of land ownership rights left them with insecure means to support their agricultural livelihoods. In a study in India, Khandekar et al. (2019) find that socio-cultural norms undergirding gender biases in land inheritance laws limit women from owning farmland, leaving them with insufficient capacity to cope with climate change impacts. Similarly, Kumasi et al. (2019) note that lack of rights to farmlands, along with other factors such as lack of credit facilities and water access, inhibited female farmers in Ghana from adapting to climate change. Research in Malawi and Zambia (Khoza et al., 2019) highlights the importance of tenure insecurity in relation to other factors limiting women's capacity to adopt climate-smart agricultural practices (including conservation agriculture, improved seed varieties, energy-saving stoves, and others), making the distinction between women-household heads and women who live in male-headed households: even when women have opportunity to make decisions on CSA adoption, in the case of female household heads, their limited ownership, access, and control of land inhibits them from implementing the practices. In Antwi-Agyei et al.'s (2015) study in Ghana, gender biases in customary land tenure arrangements effectively discriminated against women in distribution and ownership of farmland. Consequently, women in communities vulnerable to climate change reported insecure land tenure to be a barrier inhibiting adaption strategies, including diversification of livelihoods to include off-farm income-generating activities, significantly more than men. Several of these studies used data collection methods that asked women and men to report on the main factors inhibiting them to adapt to climate change impacts but did not carry out robust analysis of the link between women's land tenure security and adaptation.

Other studies address the significance of the completeness, durability, and robustness of women's land tenure security, providing evidence of how they can contribute to enhanced response options available to women. Ahmad et al.'s research (2021) in Pakistan shows how access to agricultural land was a positive significant factor for adoption of flood adaptation strategies (related to income stabilization, irrigation, livestock production), for women more than men. They also found that gender biases in socio-cultural norms concerning land inheritance limited women's access rights . While they limit their conceptualization of adaptation to "food security," Etale and Simatele's research (2021) in Western Kenya also highlights the importance of access rights to enable women's adaptation to climate change impacts. Furthermore, they highlight how the strictness of socio-cultural norms concerning gender roles critically limits women's land ownership rights in comparison to men, despite progressive laws in Kenya to promote gender equality in land rights (including inheritance and transfer rights). Women are reluctant to take actions for law enforcement, due to the strength of local socio-cultural norms and fear of community backlash. Tsige et al.'s study (2020) in Ethiopia illustrates how both land access and management rights enabled women to implement conservation agriculture and small-scale irrigation

[5] It should be noted that none of the studies identified by our search significantly addressed the theme of migration as climate change adaptation. One publication (Chandra et al., 2017) found through our snowball searching highlights how the land tenure insecurity of female household heads in a conflict-prone area in the Philippines, along with changing environmental conditions and other factors, contribute to their tendency to displacement and resettlement in comparison to other population groups. Customary land rights in the study site are not robust or enforceable. In this case, migration is not effective adaptation to climate shocks and stressors, but rather a last resort strategy to cope with conflict. The research suggests that if female household heads' land tenure was more secure, they would be less prone to displacement; however, there are several other factors with which to contend.

schemes, but also how land ownership facilitated their membership in water user associations and access to extension services. Tsige et al. is one of the only studies to address outcomes of women's land tenure security related to access to government services and institutions. The study also makes distinctions between female household heads, women living in male-headed households, and women living in female-headed households, and also compares women in monogamous and polygamous marriages, noting variations in land access and management rights per the particular axis of difference: women in monogamous marriages tend to have less access and management rights in comparison to first wives in polygamous marriages, who often have plots of land assigned to them by their husbands; women living in female-headed households tend to have greater access rights than those living in male-headed households. Although the study does not specify the adaptation measures taken, Aloukoutou et al. (2019) highlight that women's ownership of agricultural land in Benin is empowering in that it influences their voice in productive decision-making related to adaptation, for example, in identifying problems, formulating alternative planning activities, and allocating resources.

Friedman et al.'s (2019) qualitative study in Ghana is one of a small number of studies that provide evidence that articulates how women's land tenure security can contribute to longer term outcomes related to livelihood productivity and full income, through women's increased range of available response options. Women's land use and management rights contributed to their long-term planning and strategy making for their livelihoods; women with less complete bundles of land rights tended to have a shorter-term outlook on livelihood planning. Moreover, women's land use rights and management rights were associated with women's income generation from land use (in this case cocoa cultivation), capital generation, and livelihood portfolio diversification, enhancing their resilience to climate change. The study also illustrates how women's land tenure security was associated with women's self-efficacy, an important aspect of intrinsic agency (and empowerment).

Bargaining power and use of benefits

Our search found no studies assessing the relationship between women's land tenure security and bargaining power, use of benefits, or consequent effects on adaptation. However, Meinzen-Dick et al.'s (2017) review of the pathways between women's land tenure security and reduced poverty found a high amount of evidence in high agreement for the positive relationship between women's land tenure security and bargaining power and decision-making on human capital investment (i.e., children's health, children's health insurance coverage, allocation of household expenditures to food instead of alcohol and tobacco) which may support resilience and adaptation capacities.

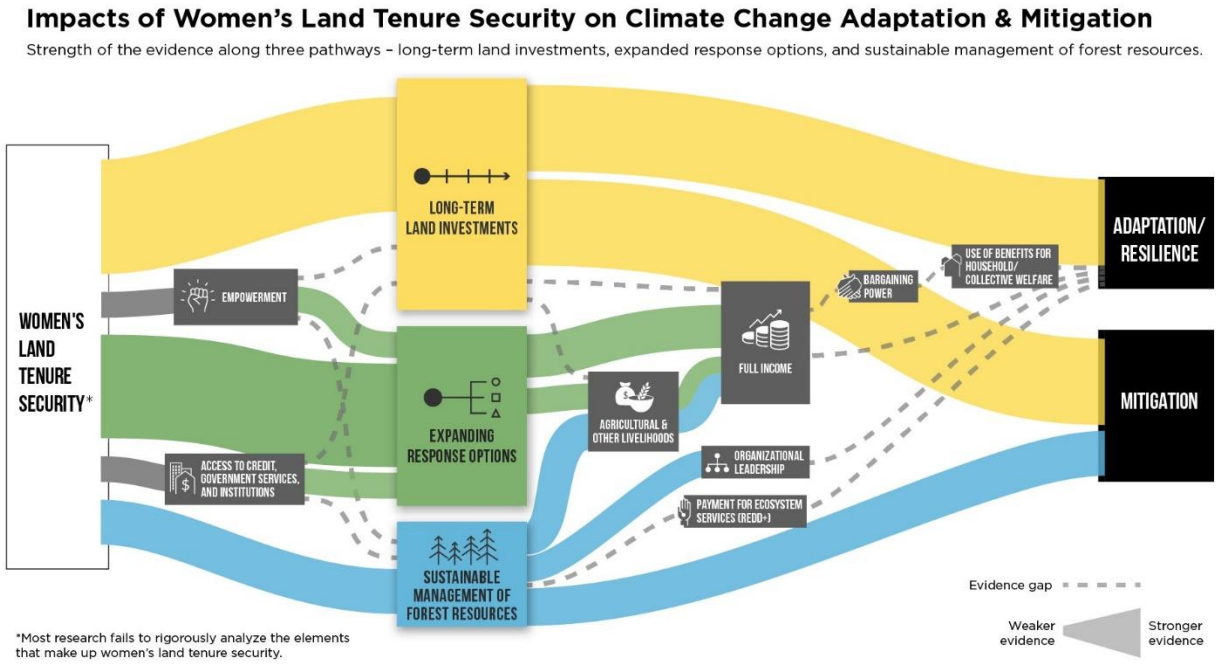
Discussion and conclusions

We conclude by highlighting the amount of evidence for and level of agreement within the key pathways, as well as opportunities for addressing knowledge and data gaps.

Summary of evidence along the pathways

Although the overall volume of available evidence is low, findings generally agree on a positive relationship between women's land tenure security and climate change mitigation and adaptation across the pathways. We highlight below where the existing evidence suggests relationships along the three main pathways (See Figure 5) and indicate how additional evidence generation will be key for strengthening our understanding of the significance of WLT to climate change mitigation and adaptation.

Figure 5: Evidence found along the three pathways



1. Findings show evidence of how formalized or documented tenure for female-headed households can contribute to long-term land investments in privately held arrangements in Sub-Saharan Africa. Formalized tenure was associated positively with various sustainable land use practices, soil and water conservation measures, and investments in adaptation infrastructure for female-headed households. **(Much evidence).**

While current evidence suggests the potential for land tenure security of female-headed households to promote climate change mitigation and adaptation through the long-term land investment pathway, it is important to design studies to assess how land tenure security for women in male-headed households contributes to long-term land investments. The majority of women are members of male-headed households. Furthermore, analysis of land tenure security that goes beyond documented tenure will help strengthen understanding of WLTS's relationship with long-term land investments. Other studies included in the review show the importance of specific elements of WLTS, including durability, robustness, completeness, and land rights awareness, to long-term land investments, and they call into question the significance of documented tenure alone.

2. There is evidence that durability, robustness, and completeness of women's land rights contribute to larger range of response options available to women in Sub-Saharan Africa and South Asia. Results from our review show how these elements of women's tenure security can contribute to conservation agriculture, irrigation schemes, livelihood diversification, and other livelihood management strategies that help build adaptive capacity. **(Much evidence).**

While current evidence illustrates the potential of the pathway of women's land tenure security to expand climate response options, studies often neglect to clearly frame and define the expected outcomes in relation to adaptation and resilience. The vague framing might also align with weaknesses in the broader gender-neutral knowledge base concerning linkages between tenure security and adaptation: it contains suggestive evidence, but it fails to present clear relationships between the two. Research addressing this pathway can benefit from defining the expected enhancement in range of response options and how the enhanced range affects resilience and adaptive capacities. Friedman et al. (2019) provide a helpful example of how to identify and assess changes in response options by analyzing the response options available to those women with stronger land tenure security in comparison to those with weaker tenure security. They also assess response options according to a conceptual framework for vulnerability to determine how the differing responses reduce vulnerability to climate change. Use of conceptual frameworks related to resilience will help more clearly define expected outcomes, strengthen this line of evidence, and articulate the pathway moving forward.

3. Findings from the review also suggest that women's inclusion in forest management groups in South Asia contributes to sustainable management of forest resources that results in forest livelihood productivity and full income, important factors supporting resilience. For example, studies show how women's inclusion in forest management groups has positive effects on forest income, forest resources collected, and reduced time labor burdens for women. **(Moderate evidence.)**

While providing suggestive evidence of how WLTS can contribute to enhanced adaptation and resilience impacts through forest resources management, studies that assess women's bundle of rights in relation to men's in collective rights arrangements would more effectively address knowledge gaps along this pathway. Research on the sustainable forest management pathway that assesses women's complete bundle of rights, including voice in forest governance bodies but also for example, benefit rights, can clarify relationships between WLTS and climate change adaptation. There exist case studies assessing the barriers and factors promoting women's land tenure security in collective tenure arrangements, including analysis of elements such as completeness, durability and robustness (Salcedo-LaViña and Giovarelli, 2021; World Bank, 2021); however, these do not assess the links with climate change adaptation. The limited amount of studies addressing the sustainable forest management pathway in comparison to the other two (Figure 2) highlights the opportunity for more research to clarify relationships between WLTS and climate along this pathway.

4. Although evidence is particularly limited, women's inclusion in forest management bodies, in contexts where membership was predominantly male, can lead to enhanced carbon sequestration through sustainable management of forest resources that results in improved forest conditions in South Asia. This line of evidence would also benefit from assessing elements of WLTS beyond voice in decision-making on land use, such as completeness of the bundle of rights. **(Limited evidence).**

General evidence gaps and opportunities

It is also important to note other knowledge gaps that represent opportunities for strengthening the knowledge base.

More research is needed on the multiple links within each pathway leading from women's land tenure security to climate change mitigation and adaptation. Our review found few studies that assessed subsequent links and outcomes of women's tenure security concerning organizational leadership or access to credit, government services, and institutions. Furthermore, no studies assessed outcomes related to women's bargaining power and use of benefits for collective welfare. Friedman et al.'s (2019) study is one of few examples that attempt to follow a path from tenure security through changing options to changing behaviors, resources, and outcomes.

More rigorously designed mixed methods and qualitative research can help articulate multiple links between women's land tenure security and outcomes leading to mitigation and adaptation. A majority of the evidence addressing the long-term land investment pathway was produced through quantitative studies; all of the evidence addressing this pathway also tended to analyze one link (i.e., investment in sustainable land use practices, soil conservation techniques, etc.), although the evidence produced was often of better quality. Qualitative and mixed methods research can help articulate multiple links, while quantitative and mixed methods impact evaluations can help assess the strength of links.

Collecting data on women's land tenure security and its relationships with climate change mitigation and adaptation in Latin America and in Southeast Asia will be key for closing significant regional gaps in the evidence. Most research focuses on Sub-Saharan African countries, with a limited number of studies targeting South Asia. The Latin American regional gap is particularly concerning, considering the significant presence of Indigenous communities in the region. There is untapped regional potential for understanding how women's land tenure security can be a factor influencing sustainable forest management and mitigation and adaptation impacts.

Collecting data on women's land tenure security for non-agricultural livelihoods will help close evidence gaps on how women's tenure security contributes to mitigation and adaptation in pastoral, aquacultural, and other livelihood contexts. Most studies focus on agriculture or agroforestry and some on forestry.

It may be possible to address the general knowledge gap concerning the relationship between women's land tenure security and mitigation and adaptation through connecting existing data related to women's land tenure with remotely sensed data, forest inventories, and other available datasets that can show mitigation (i.e., forest cover or tree density) or resilience impacts (as in Cooper (2018)). The Living Standards Measurement Study – Integrated Survey on Agriculture (LSMS-ISA) has recently incorporated a module to measure women's and men's land rights, developed by the 50x2030 Initiative seeking to address sustainable development goals related to land rights (SDGs 5.a.1. and 1.4.2.) The module is particularly helpful in comparison to other surveys because it collects data on women's and men's bundles of rights and on their perceptions of tenure security (Brunelli and Gourlay, 2022). It has been implemented as part of national surveys in over ten country contexts in Sub-Saharan Africa to date.[6]

[6] For additional information and open access data from the LSMS-ISA see Data Catalog (worldbank.org)

Demographic and Health Surveys (DHS) include data on women's and men's agricultural land ownership; however, they do not consider de facto rights over land nor the bundle of rights besides ownership, as the LSMS-ISA survey module does. The LSMS-ISA is also applicable to other land uses and livelihoods besides agriculture, although the DHS datasets include national-level data for other regions besides Sub-Saharan Africa.

There exist potential opportunities to address weaknesses in the knowledge base through analysis of existing data concerning links between women's empowerment, particularly bargaining power, and resilience. Although tending to focus on agricultural livelihoods, data concerning various domains of women's empowerment exist for USAID Feed the Future countries (two countries in South Asia and eight countries in Sub-Saharan Africa). Although collected for sub-regions of the countries and at specific points in time as part of repeated household surveys, data collection methods drew from the Women's Empowerment in Agriculture Index, which includes an indicator for women's voice in decision-making over use of income. Using the data to analyze the relationship between women's bargaining power (using input on use of income as a proxy) and measurements of resilience can help close evidence gaps.[7] The Feed the Future datasets also include measurements of women's membership in influential groups in the community. Similarly to the data on bargaining power, it can be possible to assess the relationship between women's organizational leadership (using membership in influential groups as a proxy) and resilience, although limited to Sub-Saharan African and South Asian country contexts.[8]

It may be possible to take advantage of remotely sensed data to more robustly assess the relationships between women's land tenure security and resilience to climate shocks and stressors. Although it did not analyze women's land tenure security, a study by Cooper (2018) defines an indicator of resilience in terms of how an extreme event such as drought affects household malnutrition and food security. The study sourced i) data on rainfall using remotely sensed satellite data and ii) data on nutrition and food security from the World Health Organization and the United States Feed the Future Initiative. Concretely defining and measuring resilience in this and similar ways can help to more critically assess the effects of women's land tenure security pathways on climate resilience.

Conclusions

The majority of our recommendations concern the need for data collection to address conspicuous evidence gaps concerning the relationships between women's land tenure security and climate outcomes; more particularly, though, there is a need for collection of data that more accurately represents women's tenure security in research assessing effects on mitigation and adaptation or resilience. Although important evidence exists where data on i) documented land rights and ii) participation in land governance bodies were used to assess women's tenure security, it often does not

[7] Data from Demographic and Health Surveys (DHS) related to women's bargaining power are also available, for more countries and spanning a greater number of regions than the Feed the Future datasets; however, the DHS data measures women's final say in three main decisions concerning i) their own healthcare, ii) making large purchases, and iii) visits to family, friends and relatives. Only the second main category of decisions may be relevant to bargaining power, detracting from the data's strength as a proxy for bargaining power. Use of income for purposes related to household or community welfare might not necessarily fall under the category of large purchases either.

[8] Datasets for two Latin American countries, Guatemala and Honduras, also exist, although they are not publicly available.

account for key elements of women's tenure security. Data collection should also go beyond female household heads and include females in male-headed households. While survey modules like the LSMS-ISA collect data related to important elements of women's tenure security, the data exists only for Sub-Saharan African contexts presently. Promoting data collection on these elements in other geographies will be important for closing knowledge gaps. Women's tenure and resource rights vary across regions and livelihoods; better understanding of this variance is important for designing and implementing large-scale landscape-based mitigation measures and adaptation plans that do not create or exacerbate inequalities in land rights or adaptive capacities, but rather reduce or transform them.

Additional recommendations concern designing research to more clearly articulate pathways between women's land tenure security and mitigation, adaptation, and resilience. Examining multiple linkages between women's land tenure security and climate outcomes will help more robustly assess contributing factors and articulate complexities of pathways. Within the Expanding Response Options pathway, applying conceptual frameworks related to resilience to more clearly define expected outcomes can help researchers and evaluators to deepen and communicate the evidence base for this pathway. In light of findings from the broader knowledge base that tenure security (not specifically women's) can be one of several factors contributing to enhanced adaptation and resilience, research designs would ideally account for these other factors as part of the overall context in quantitative and qualitative analyses.

More, gendered data on the relationship between women's land tenure security and climate outcomes is needed for answering questions concerning whose land rights, whose contributions to and control over mitigation effects (and benefits), and whose resiliency, for more effective advocacy and policy making on gender equality and climate change. Concerted efforts and investments will be needed for more robust research design to assess the elements comprising women's tenure security and to articulate the role of women's tenure security along complex pathways to mitigation and adaptation. Next steps require identifying stakeholders, roles, and responsibilities for moving the agenda forward.

References

Ahmad, D., Afzal, M., & Rauf, A. (2021). Flood hazards adaptation strategies: a gender-based disaggregated analysis of farm-dependent Bait community in Punjab, Pakistan. *Environment, Development and Sustainability*, *23*(1), 865. https://doi-org.goddard40.clarku.edu/10.1007/s10668-020-00612-5

Ali, D. A., K. Deininger, and M. Goldstein. (2014). Environmental and Gender Impacts of Land Tenure Regularization in Africa: Pilot Evidence from Rwanda. *Journal of Development Economics* 110: 262–275. http://doi.org/10.1016/j.jdeveco.2013.12.009.

Aloukoutou, A. M., Yegbemey, R. N., & Aïhounton, G. D. B. (2019). Towards inclusive decision-making for climate change adaptation: a household-level analysis in North Benin (West Africa). *Advancing climate change research in west africa: Trends, impacts, vulnerability, resilience, adaptation and sustainability issues* (pp. 229) Retrieved from www.scopus.com

Alvarado, G., Kieran, C., Jacobs K., Beduhn, J., Heidenrich, T. and Linkow, B. (2022). *Ethiopia Strengthening Land Tenure and Administration Program Follow-on Report: An Impact Evaluation of Second-level Land Certification*.

Antwi-Agyei, P., A. J. Dougill, and L. C. Stringer. (2015). Impacts of Land Tenure Arrangements on the Adaptive Capacity of Marginalized Groups: The Case of Ghana's Ejura Sekyedumase and Bongo Districts. *Land Use Policy* 49: 203–212. http://doi.org/10.1016/j.landusepol.2015.08.007.

Benjamin, E. O., Ola, O., Sauer, J., & Buchenrieder, G. (2021). Interaction between agroforestry and women's land tenure security in sub-Saharan Africa: A matrilocal perspective. *Forest Policy and Economics*, *133*. https://doi-org.goddard40.clarku.edu/10.1016/j.forpol.2021.102617

Brunelli, C., & Gourlay, S. (2022). Individual Land Rights: Filling Data Gaps with the 50x2030 Initiative. *Statistical Journal of the IAOS*, *38*(1), 111–124.

Bryan, E. (2022). State of knowledge on gender and resilience. Gender, Climate Change and Nutrition Integration Initiative (GCAN) Evidence Brief. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.135005

Call, M. & Sellers, S. (2019). How does gendered vulnerability shape the adoption and impact of sustainable livelihood interventions in an era of global climate change? *Environmental Research Letters*, *14*(8), 1. https://doi.org/10.1088/1748-9326/ab2f57

Chandra, A., McNamara, K.E., Dargusch, P., Caspe, A.M., and Dalabajan, D. (2017). "Gendered Vulnerabilities of Smallholder Farmers to Climate Change in Conflict-Prone Areas: A Case Study from Mindanao, Philippines." *Journal of Rural Studies* 50: 45–59. https://doi.org/10.1016/j.jrurstud.2016.12.011.

Cooper, M. (2018). Using natural areas and empowering women to buffer food security and nutrition from climate shocks: Evidence from Ghana, Zambia, and Bangladesh. *IFPRI Discussion Paper* 01717. Washington, DC: International Food Policy Research Institute (IFPRI). http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/132366

Das, N. (2012). Impact of participatory forestry program on sustainable rural livelihoods: lessons from an Indian province. *Appl. Econ. Perspect. Policy* 34 428–53

Deininger, K., D. A. Ali, and T. Yamano. (2008). "Legal Knowledge and Economic Development: The Case of Land Rights in Uganda." *Land Economics* 84 (4): 593–619.

Dillon, B., & Voena, A. (2018). Widows' land rights and agricultural investment. *Journal of Development Economics*, *135*, 449–460. https://doi-org.goddard40.clarku.edu/10.1016/j.jdeveco.2018.08.006

Doss, C., & Meinzen-Dick, R. (2020). Land tenure security for women: A conceptual framework. *Land Use Policy* 99 (105080) https://doi.org/10.1016/j.landusepol.2020.105080

Etale, L., & Simatele, M. D. (2021). Climate Change Adaptation for Food Security and Gendered-Land Rights in Western Kenya. *Journal of Asian & African Studies (Sage Publications, Ltd.)*, 1. https://doi-org.goddard40.clarku.edu/10.1177/0021909620988302

FAO and FILAC. (2021). *Forest governance by indigenous and tribal peoples. An opportunity for climate action in Latin America and the Caribbean*. Santiago. FAO. https://doi.org/10.4060/cb2953en

Friedman, R., Hirons, M.A., Boyd, E., 2019. Vulnerability of Ghanaian women cocoa farmers to climate change: a typology. *Climate Develop*. 11 (5), 446–458. https:// doi.org/10.1080/17565529.2018.1442806.

Goldstein, M., Houngbedji, K., Kondylis, F., O'Sullivan, M., & Selod, H. (2018). Formalization without certification? Experimental evidence on property rights and investment. *Journal of Development Economics*, *132*, 57–74. https://doi-org.goddard40.clarku.edu/10.1016/j.jdeveco.2017.12.008

Huntington, H., Haflett, A., & Ewing, B. (2018). The impact of interventions to promote climate change adaptation: does stronger tenure security increase farmer investment in sustainable agroforestry? Presented at *2018 World Bank Conference on Land and Poverty*, Washington, D.C.

Hurlbert, M., J. Krishnaswamy, E. Davin, F.X. Johnson, C.F. Mena, J. Morton, S. Myeong, D. Viner, K. Warner, A. Wreford, S. Zakieldeen, Z. Zommers, (2019). Risk Management and Decision making in Relation to Sustainable Development. In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D.C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)].

IPCC. (2019). *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* (J. M. P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. P¨ortner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M (ed.)).

Jhaveri, N. (2021). Gender, tenure security, and landscape governance. PIM Flagship Brief November 2021. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.134790

Kelly, L.D., Deaton, B.J., and Amegashie, J.A. (2019). The nature of property rights in Haiti: Mode of land acquisition, gender, and investment. Journal of Economic Issues LIII(3): 726-747. DOI 10.1080/00213624.2019.1644922

Khandekar, N., Gorti, G., Bhadwal, S., & Rijhwani, V. (2019). Perceptions of climate shocks and gender vulnerabilities in the Upper Ganga Basin. *Environmental Development*, *31*, 97–109. https://doi-org.goddard40.clarku.edu/10.1016/j.envdev.2019.02.001

Khoza, S., Van Niekerk, D., & Nemakonde, L. D. (2019). Understanding gender dimensions of climate-smart agriculture adoption in disaster-prone smallholder farming communities in Malawi and Zambia. *Disaster Prevention & Management*, *28*(5), 530–547. https://doi.org/10.1108/DPM-10-2018-0347

Kratzer, S., and Masson, V.L. (2016). *10 Things to Know: Gender Equality and Achieving Climate Goals*.

Kumasi, T.C., Antwi-Agyei, P., & Obiri-Danso, K. (2019). Small-holder farmers' climate change adaptation practices in the Upper East Region of Ghana. *Environ Dev Sustain* 21: 745-762. https://doi.org/10.1007/s10668-017-0062-2

Lovo, S. 2016. "Tenure Insecurity and Investment in Soil Conservation. Evidence from Malawi." *World Development* 78: 219–229. http://doi.org/10.1016/j.worlddev.2015.10.023.

McDougall, C., Jiggins, J., Pandit, B.H., Thapa Magar Rana, S.K., and Leeuwis, C. (2013). Does adaptive collaborative forest governance affect poverty? Participatory action research in Nepal's community forests. *Soc. Nat. Resour.* 26 1235–51

Meinzen-Dick, Ruth Suseela; Quisumbing, Agnes R.; Doss, Cheryl R.; and Theis, Sophie. 2017. Women's land rights as a pathway to poverty reduction: A framework and review of available evidence. IFPRI Discussion Paper 1663. Washington, D.C. http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/131359

Murken, L., & Gornott, C. (2022). The importance of different land tenure systems for farmers' response to climate change: A systematic review. *Climate Risk Management*, *35*. https://doi-org.goddard40.clarku.edu/10.1016/j.crm.2022.100419

Nchu, I.N., Kimengsi, J.N., & Kapp, G. (2019). Diagnosing Climate Adaptation Constraints in Rural Subsistence Farming Systems in Cameroon: Gender and Institutional Perspectives. *Sustainability*, *11*(14), 3767. https://doi.org/10.3390/su11143767

Nyahunda, L., Makhubele, J.C., Mabvurira, V., Matlakala, F.K., (2021). Vulnerabilities and inequalities experienced by women in the climate change Discourse in South Africa's Rural Communities: Implications for Social Work. Br. J. Social Work 51 (7), 2536–2553. https://doi.org/10.1093/bjsw/bcaa118

Quisumbing, A. R., and N. Kumar. (2014). *Land Rights Knowledge and Conservation in Rural Ethiopia: Mind the Gender Gap.* IFPRI Discussion Paper. Washington, DC: International Food Policy Research Institute.

Ray, B., Mukherjee, P., and Bhattacharya, R.N. (2017). Attitudes and cooperation: does gender matter in community-based forest management? *Environ. Dev. Econ.* 22 594–623

Salcedo-La Viña, S., and R. Giovarelli. (2021). *On Equal Ground; Promising Practices for Realizing Women's Rights in Collectively Held Lands*. Washington, DC: World Resources Institute.

St. Clair, P.C. (2016). Community forest management, gender and fuelwood collection in rural Nepal. *J. Forest Econ.* 24 52–71

Stevens, C., Panfil, Y., Linkow, B., Hagopian, A., Mellon, C., Heidenrich, T., Kulkarni, N., Bouvier, I., Brooks, S., Lowery, S., and Green, J. (2020), *Land and Development: A Research Agenda for Land and Resource Governance at USAID*.

Theis, Sophie; Bryan, Elizabeth; and Ringler, Claudia. (2019). Addressing gender and social dynamics to strengthen resilience for all. In 2019 Annual trends and outlook report: Gender equality in rural Africa: From commitments to outcomes, eds. Quisumbing, Agnes R.; Meinzen-Dick, Ruth Suseela; and Njuki,

Jemimah. Chapter 9, Pp. 126-139. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/9780896293649_09

Toth, G. G., Nair, P. K. R., Duffy, C. P., & Franzel, S. C. (2017). Constraints to the adoption of fodder tree technology in Malawi. *Sustainability Science*, *12*(5), 641. https://doi-org.goddard40.clarku.edu/10.1007/s11625-017-0460-2

Tsige, M., Synnevåg, G., Aune, J.B., (2020). Gendered constraints for adopting climate-smart agriculture amongst smallholder Ethiopian women farmers. *Scientific African* 7, e00250. https://doi.org/10.1016/j.sciaf.2019.e00250.

UN Women. (2018). Towards a gender-responsive implementation of the United Nations Convention to Combat Desertification. New York: UN Women.

World Bank. (2021). *Gender Equity in Land and Forest Tenure in REDD+ Programming: Synthesis Report.*