



GENDER Impact
Platform



Food and Agriculture
Organization of the
United Nations

CGIAR GENDER Impact Platform · Working Paper #013

APRIL 2023

Addressing Gender Inequalities and Strengthening Women's Agency to Create More Climate-Resilient and Sustainable Food Systems

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ISBN: 92-9146-776-6

Citation: Bryan, E., Alvi, M., Huyer, S., and Ringler, C. 2023. *Addressing Gender Inequalities and Strengthening Women's Agency for Climate-Resilient and Sustainable Food Systems*. CGIAR GENDER Impact Platform Working Paper #013. Nairobi, Kenya: CGIAR GENDER Impact Platform. <https://hdl.handle.net/10568/129709>.

ACKNOWLEDGMENTS

This review relied on a recent systematic review of gender and climate-smart agriculture by Nitya Chanana. We greatly appreciate Nitya sharing the reference list from the review with us. We also thank Avni Misra for supporting this paper through an additional literature search and Linda Etale for co-organizing the review process. This paper also benefited from two external reviews by Joshua Eastin and Sarah Gammage and we thank the reviewers for their time and thoughtful comments. Thanks are also due to the team at the Inclusive Rural Transformation and Gender Equality Division at the FAO for guiding the development of this paper; thanks especially to Susan Kaaria (now with AWARD) for initiating this process, and Erdgin Mane, Lauren Phillips, Libor Stloukal, Vanya Slavchevska, Valentina Costa, Benjamin Davis, Nick Sitko, Omnia Rizk, Maurizio Furst and Ilaria Sisto for providing input at various stages of this paper's development. The CGIAR Generating Evidence and New Directions for Equitable Results (GENDER) Impact Platform is grateful for the support of CGIAR Trust Fund Contributors (www.cgiar.org/funders) and in particular wishes to thank the Food and Agriculture Organization of the United Nations for supporting this work (<https://www.fao.org/home/en>).

ABOUT THIS SERIES

The working paper, produced by the CGIAR GENDER Impact Platform, is one in [a series of analytical working papers](#) by our researchers. They were produced to inform the Food and Agriculture Organization of the United Nations to write the 2023 report on the *Status of Rural Women in Agri-food Systems*.*

These evidence-based papers address key themes important for gender and social equality, and women's empowerment in agriculture and food systems. They each discuss:

- current status and emerging thinking
- the theme's relevance for transformative change toward more inclusive food systems
- the evolution of equality in agriculture and food systems over the past 10 years in low- and middle-income countries
- what has proved effective to ease structural constraints, and promote equality and empowerment
- specific suggestions about interventions, programs and policies that can help make agriculture and food systems more inclusive.

COVER PHOTO CREDIT: Felix Clay/Duckrabbit/WorldFish. *Weeding maize, Mongu, Western Zambia.*

ABOUT CGIAR GENDER IMPACT PLATFORM

Generating Evidence and New Directions for Equitable Results (GENDER) is CGIAR's impact platform designed to put gender equality at the forefront of global agricultural research for development. The Platform is transforming the way gender research is done, both within and beyond CGIAR, to kick-start a process of genuine change toward greater gender equality and better lives for smallholder farmers everywhere. gender.cgiar.org.

* FAO. 2023. *The Status of Women in Agri-food Systems*. Rome.

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This working paper has gone through a process of nonblinded peer review by two reviewers external to the CGIAR GENDER Impact Platform, and has also been reviewed by the FAO team working on the 2023 FAO report on the *Status of Rural Women in Agri-food Systems*. The views expressed in this publication are those of the author(s) and do not necessarily reflect the views or policies of the Food and Agriculture Organization of the United Nations nor of the CGIAR GENDER Impact Platform.

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*Addressing Gender Inequalities
and Strengthening Women's
Agency for Climate-Resilient and
Sustainable Food Systems*

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Abstract

Climate change affects every aspect of the food system, including all nodes along agri-food value chains from production to consumption, the food environments in which people live, and outcomes, such as diets and livelihoods. Women and men often have specific roles and responsibilities within food systems, yet structural inequalities (formal and informal) limit women's access to resources, services and agency. These inequalities affect the ways in which women and men experience and are affected by climate change. In addition to gender, other social factors are at play, such as age, education, marital status, and health and economic conditions. To date, most climate change policies, investments, and interventions do not adequately integrate gender. If climate-smart and climate-resilient interventions do not adequately take gender differences into account, they might exacerbate gender inequalities in food systems by, for instance, increasing women's labor burden and time poverty, reducing their access to and control over income and assets, and reducing their decision-making power. At the same time, women's contributions are critical to make food systems more resilient to the negative impacts of climate change, given their specialized knowledge, skills and roles in agri-food systems, within the household, at work and at the community level. Increasing the resilience of food systems requires going beyond addressing gendered vulnerabilities to climate change to create an enabling environment that supports gender equality and women's empowerment, by removing structural barriers and rigid gender norms, and building equal power dynamics, as part of a process of gender-transformative change.

Keywords: gender equality, social equality, women's empowerment, food systems, climate change, resilience

1. Introduction: the case for gender equity in climate action

Climate change poses considerable risk to food systems in low- and middle-income countries (LMIC) and fragile contexts (IPCC 2022, p. 9–10). The negative impacts span beyond production to other aspects of the food system, including along agri-food value chains from production to consumption, the food environments in which people live, and outcomes such as diets and livelihoods (Fanzo et al. 2018). Climate change has already jeopardized progress made in reducing food and nutrition insecurity, compounding multiple threats already faced by marginalized communities in LMICs, including the COVID-19 pandemic, civil war and other conflict (FAO et al. 2021; Scheffran et al. 2012). Addressing climate change is, therefore, becoming increasingly urgent as multiple, interconnected stressors intensify.

Systemic inequalities at multiple scales exacerbate climate change challenges for the most vulnerable and marginalized countries, social groups and communities (Schipper et al. 2022). Threats are largest in climate-dependent economic sectors such as agriculture, and in LMICs with limited adaptive capacity. Within countries, climate change has differential impacts on people based on the local context in which they live, their level of exposure and sensitivity to climate shocks and stressors, their resilience capacities and the enabling environment (ibid.). Even within communities, there is considerable heterogeneity in vulnerability to shocks and stressors, and in preferences and needs when choosing how to respond. Social inequalities based on unjust social norms and unequal power dynamics within households, communities and food systems influence the distribution of the negative impacts of climate change, exacerbating vulnerability for the most marginalized and limiting options and scope for climate actions (ibid.). As a result, the outcomes of climate change differ by gender and other intersectional identities, such as ethnic group, age and wealth (Bryan et al. 2017; Djoudi et al. 2016; Huyer 2016; Jost et al. 2016; Kristjanson et al. 2017; Tandale 2019).

The literature documenting gender-related inequalities in exposure and sensitivity to climate disturbances, adaptive capacity, participation in climate responses at multiple scales and welfare outcomes has grown considerably in the last decade. These inequalities are driven by gender-differentiated roles and responsibilities, differential access to resources, technologies and services (e.g., financial and information), and are underpinned by patriarchal norms. Therefore, there is a high risk that women, youth and other socially marginalized groups will face disproportionate impacts, or that inequalities will be exacerbated if efforts to address climate change are not responsive to the needs of these groups (Huyer and Partey 2020; Eastin 2018).

This review paper highlights key gender inequalities in experiences with, responses to and outcomes of climate change, and points to emerging evidence on promising approaches to reach, benefit and empower women through climate action. This presents a new thematic area that was not covered in the 2011 *State of Food and Agriculture* report, given the dearth of studies on the topic at that time (FAO 2011). For details on the search terms, criteria for inclusion and approach to the review see the [annex](#) in the overarching section (Lecoutere, Kosec, et al. 2023). The next section summarizes the now-extensive literature on gender inequalities related to climate change, focusing on key conceptual linkages. Section 3 describes some promising strategies to reduce gender inequality through climate action, and section 4 describes the benefits of doing so. The paper concludes with some observations on areas where more research and actions are needed.

2. Gender inequalities and climate change: defining the relationship

Recent conceptual frameworks of the linkages between gender and climate change highlight how climate change has differential impacts on men and women—some of which are the direct result of exposure and sensitivity to climate shocks and stressors, and others are indirect or filtered through the institutional environment and by actions taken to ameliorate negative impacts (Bryan et al. 2017; Kristjanson et al. 2017; Theis, Bryan, and Ringler 2019). Other frameworks focus on action areas for facilitating women’s empowerment and gender-transformative change through climate-smart agriculture (CSA) (Huyer et al. 2019; Huyer and Chanana 2021; Huyer, Gumucio, et al. 2021), and inclusive climate policy (Huyer et al. 2020). Several recent studies have emphasized the need to understand the gender dimensions of food system transformation with increasing women’s resilience to climate change being one key element (Njuki et al. 2022; Bryan, Ringler, and Meinzen-Dick 2022).

Drawing on these conceptual foundations, it is possible to identify several dimensions in which gender inequalities interact with climate risks and disturbances to produce gender-differentiated well-being outcomes. These elements include: (1) gender differences in exposure and sensitivity to shocks and stressors; (2) differential resilience and adaptive capacities of men and women; (3) gendered preferences for and uptake of climate change responses (broadly defined to include climate-smart practices, adaptation strategies, mitigation strategies and climate-resilient agriculture); (4) the level of gender integration in the design and implementation of policies, investments and interventions, and participation in decision-making and leadership; and (5) differential outcomes of climate change as a result of climate disturbances and the chosen responses at multiple scales (Dankelman 2010).

2.1 Gender differences in exposure, and sensitivity to climate shocks and stressors

Identifying areas where vulnerability to climate change is particularly high is important to target resources and design strategies to address the confluence of challenges for the most vulnerable (Chanana-Nag and Aggarwal 2020; Koo et al. 2022). Some studies have used mapping approaches to identify hotspots where women are particularly vulnerable to climate shocks and stressors (ibid.), while others use indices to compare the vulnerability of different populations along different dimension (Magassa et al. 2020).

Vulnerability assessments tend to find that women have higher vulnerability to climate shocks and stressors. However, narratives that describe women as particularly vulnerable to climate change perpetuate the perception of women as victims, while ignoring women’s agency in addressing climate change or dimensions of men’s vulnerability (Huyer, Gumucio, et al. 2021; Rao et al. 2019; Arora-Jonsson 2011). Moreover, such narratives miss important nuances about how vulnerability also varies by age, class, ethnicity and other intersectional identities (Djoudi et al. 2016).

Much of the literature focuses on vulnerability that is based on gender differences in adaptive or resilience capacities (e.g., Yadav and Lal 2018). Although this is a critical dimension of vulnerability and one where the largest gender gaps exist, it is also important to highlight how women and men are differently exposed to climate hazards and may experience the

same climate shocks and stressors differently due to their gendered livelihood roles and responsibilities. In some cases, women may be more exposed to the harmful impacts of climate change because of their livelihood activities. A case study from a peri-urban area in Magdalena, Mexico, shows that women were more affected by the negative impacts of climate change and associated water scarcity because they rely on fruit and vegetable processing for their livelihoods, for food security, and to maintain social ties (Buechler 2009). In other cases, women's roles may be less vulnerable to shocks and stressors. For instance, women are more likely to raise local livestock breeds and smaller animals, which tend to be more resilient to the negative impacts of climate change (Köhler-Rollefson 2012; Chanamoto and Hall 2015).

Because gender roles vary in different contexts (e.g., rural and urban food environments) the nature of gender differences in exposure will also vary. In rural settings, where women spend considerable time collecting water for domestic use, they may have a greater work burden in regions where climate change exacerbates water scarcity (Rao et al. 2019; Nkengla-asi et al. 2017). While droughts negatively affect the farming activities on which many rural households depend, vulnerable urban households may experience more harm from flooding and associated health-related risks, like cholera, due to poor water infrastructure and crowded conditions, with disproportionate impacts on urban women (Grasham, Korzenevica, and Charles 2019).

Differential exposure is also evidenced by gendered outcomes of climate disasters. Several global reviews have found that women tend to have higher morbidity and reduced life expectancy compared to men following droughts, storms, earthquakes and fires, especially where women have lower socioeconomic status, less access to information and limited agency to make strategic life choices (Neumayer and Plümper 2007; Doocy et al. 2013; Erman et al. 2021). Yet, women are not always more exposed to climate disasters. Some case studies found that men die at higher rates following climate disasters, for example Hurricane Mitch in 1998, because they are overrepresented in high-risk occupations such as construction (Delaney and Shrader 2000; Zagheni, Muttarak, and Striessnig 2015; Erman et al. 2021).

Men's and women's differential experience with climate shocks and stressors is reflected in the different ways in which they perceive and report the impacts of these disturbances, though patterns are not easily generalizable across contexts (Oloukoi et al. 2014; Twyman et al. 2014; Kristjanson et al. 2017; Rao et al. 2019) and sometimes there are few gender-differentiated perceptions of climate change (Assan et al. 2018; Nkengla-asi et al. 2017; Dah-gbeto and Villamor 2016; Partey et al. 2020). These experiences also have implications for how men and women respond to climate disturbances and how interventions may be designed to address gender-specific concerns.

Gender differences in food security, nutrition and health can influence men's and women's sensitivity to climate shocks and stressors. Where women and girls reduce consumption as a strategy to cope with climate shocks, this has negative implications for their physical capacity to withstand additional shocks and to engage in other coping and adaptive measures (Alston and Akhter 2016). Conversely, there is evidence that suggests women may be less sensitive in some ways to certain climate shocks. A study from Tanzania suggests that women are biologically less sensitive to heat stress than men, enabling them to maintain their labor in agriculture during heatwaves (Lee et al. 2021). Sensitivity to disturbances also varies across contexts. For instance, the negative effect of climate change on the nutritional content of staple crops such as wheat, rice, potatoes and soy are more likely to affect poor consumers in low-income countries given that these foods comprise a large share of their diets (Fanzo et al. 2018). Last—although it is not a direct impact of climate change—a common view in the development community is that climate change exacerbates other shocks such as conflict and the incidence of violence against women. One recent cross-country comparative study found mixed evidence on the impacts of climate shocks such as drought on intimate-partner violence (Cooper et al. 2021). However, other reviews suggest that climate change and disasters trigger multiple forms of violence against women and girls and that, in many cases, existing data underrepresent the extent of the problem, given that violence survivors are unlikely to report abuse or seek help when supporting services are inadequate (Masson 2022).

2.2 Gender inequality in adaptive capacities

The body of literature on gendered adaptive or resilience capacities to respond to climate change has grown considerably over the past decade. This literature conforms with the wider body of literature on the factors shaping structural gender inequalities in agri-food systems, including differences in access to resources and technologies, access to information and financial services, and social norms (as described in companion working papers by Kosec et al. 2023 and Lecoutere, Achandi, et al. 2023). It further highlights how these factors limit the range of response options available to women, thereby reducing their ability to respond effectively to climate change. Therefore, building women's adaptive capacities is a key entry point for reducing their vulnerability and increasing their contribution to climate action.

2.2.1 Gender differences in access to and control over resources

Women tend to have more limited access to the resources and productive assets needed to respond to climate change, including natural resources, such as land and water, productive inputs, and technologies, assets and human capital. In particular, lack of access to and control over land prevents women from investing in longer-term climate-resilient agriculture practices (Jost et al. 2016; Perez et al. 2015) including soil and water conservation (Meinzen-Dick et al. 2019), agroforestry (Quisumbing and Kumar 2014) and small-scale irrigation (Theis et al. 2018; Bryan and Garner 2022).

Access to and control over other assets are also an important source of resilience because they act as a store of value that can be drawn upon to cope with climate (and other types of) shocks (Theis, Bryan, and Ringler 2019; Goh 2012). Yet women tend to own, and have control over, fewer high-value or productive assets, like livestock (Djouidi and Brockhaus 2011; Tavenner and Crane 2018). While gendered asset dynamics following climate shocks are not always straightforward and depend on the type of shock and local gender roles (Rakib and Matz 2016; Quisumbing, Kumar, and Behrman 2018), in some cases, women's assets, such as jewelry, may be drawn down in response to shocks if the asset is less important for generating household income, the owner has weaker bargaining power within the household or the asset is easier to sell (Quisumbing, Kumar, and Behrman 2018). Depletion of productive assets following climate shocks can be particularly detrimental to poor households that rely on these kinds of assets to maintain their livelihoods. However, sales of women's assets following shocks, while they may not be productive assets, further increase gender inequality in men's and women's resilience capacities over the longer term.

Women also lack access to productive inputs and technologies needed to adapt to climate change (and reduce gender gaps in agricultural productivity), which are covered in the companion working paper by Puskur et al. (2023). Laborsaving tools and inputs such as fertilizer are particularly important to increase the productivity and efficiency of plots managed by women and reduce women's labor burden, which is increasing with climate change (Jost et al. 2016; Murray et al. 2016; Perez et al. 2015). Reducing the gender gap in fertilizer use also has potential to contribute to reducing greenhouse gas (GHG) emissions from agriculture (Farnworth et al. 2017). However, often when technologies and inputs are adopted at the household level, and even when they are distributed to women directly, these tend to be controlled by men (Haapala 2019; Bryan and Garner 2022; Theis et al. 2018). Thus, women's use of climate-smart technologies, such as irrigation or conservation agriculture, do not always confer direct benefits to women, especially when underlying unequal power dynamics are not addressed (Tsige 2019).

2.2.2 Gender differences in human and social capital

Gender differences in human and social capital also contribute to gender differences in adaptive capacities. Social networks and groups are especially important to access information, resources and economic opportunities needed to respond to climate change and they provide an important platform for women's capacity development and agency

(Huyer, Gumucio, et al. 2021; Kumar et al. 2021; Falco and Bulte 2013). Women also have more limited voice and leadership opportunities in rural organizations: a case study from Kenya shows that men and women participate in different types of groups and that men tend to have a wider social network, leading to greater participation in community decision-making and in influencing adaptive behavior (Ngigi, Mueller, and Birner 2017).

Human capital is an important adaptive capacity: people with better education, knowledge and skills have more options to access services, adopt new technologies and diversify their livelihoods (Muttarak and Lutz 2014). However, the gender gap in educational attainment persists (Evans, Akmal, and Jakiela 2020), and there is growing evidence that climate change negatively affects girls' education more than boys', and that promoting girls' reproductive rights, education and life skills would lead to greater climate resilience (Sims 2021; Chigwanda 2016; Muttarak and Lutz 2014). Countries where girls have higher levels of schooling also have lower climate change vulnerability scores (Kwauk and Braga 2017).

2.2.3 Access to services

Access to services, especially climate information, extension and financial services, are essential for climate change adaptation. Research shows that climate information services are less likely to reach women (Bernier et al. 2015; Bryan, Kato, and Bernier 2021; Carr and Onzere 2018; Diouf et al. 2020; Gumucio et al. 2020b; Jost et al. 2016; Partey et al. 2020; Tall et al. 2014) and there is a long literature documenting gender differences in access to different sources and types of information; see the *Making Complementary Agricultural Resources, Technologies and Services More Gender Responsive* (Kosec et al. 2023) in this series of working papers. Moreover, women have different preferences for the services they receive—including different preferences for weather index insurance products (Akter et al. 2016) and climate information services (Henriksson et al. 2021; Twyman et al. 2014; Tall et al. 2014; Gumucio et al. 2020b). When services are not designed to take women's needs and preferences into consideration, they are less likely to increase women's knowledge or adoption of climate-smart practices such as agroforestry (Duffy et al. 2021).

Recent research explores the potential to reduce information asymmetry with digital devices and services. For example, a case study from India shows that climate and agricultural information provided via mobile phones reduced information gaps between men and women farmers and increased women's knowledge of climate-smart technologies (Mittal 2016). However, a large gender digital divide remains. For example, there is a gender gap in mobile phone ownership, estimated at 13 percent in sub-Saharan Africa (Rowntree et al. 2019), which can limit women's access to climate and weather information disseminated through ICT (Gumucio et al. 2020b). A case study from Ghana shows that women have less access to climate information via mobile phones compared to men, and that even when women do receive climate information, other resource constraints still limit their ability to apply climate information to farming practices (Partey et al. 2020).

Given both demand and supply constraints, women are less likely to be reached by and benefit from financial services (Adegbite and Machethe 2020; Jemimah Njuki et al. 2019; Timu and Kramer 2021) and this contributes to even greater income and wealth inequality (Fouejieu et al. 2020). There is also growing interest in the potential for agricultural insurance to provide financial protection to poor rural households who are particularly vulnerable to climate shocks (Janzen, Carter, and Ikegami 2021). Having insurance may enable them to make investments that increase agricultural productivity and incomes (Karlán et al. 2014; Jensen and Barrett 2017; Farrin and Miranda 2015). However, a review by Timu and Kramer (2021) finds strong evidence of gender gaps in access to, demand for and usage of agricultural insurance.

2.2.4 Patriarchal norms underpin gender inequalities in adaptive capacities

Patriarchal norms underpin all the above barriers to women's ability to respond to climate change. For example, a case study from Cameroon highlights how patriarchal norms limit women's access to land, because insecure tenure arrangements prevent them from adopting practices to respond to climate change or investing in plots (Nchu, Kimengsi, and Kapp 2019). Sociocultural barriers also limit women's ability to adopt certain technologies such as agroforestry (Kiptot and Franzel 2012) and treadle pumps (Njuki et al. 2014), and limit women's mobility, income-earning opportunities and ability to participate in groups (Djoudi and Brockhaus 2011; Jost et al. 2016; Rao et al. 2019). Perceptions of appropriate gender roles in some contexts, for example in Cambodia, where women's role in farming is overlooked and undervalued, can often exclude women from decision-making spaces and spheres within the rural farming households. This includes excluding them from the adoption of climate-smart practices such as conservation agriculture (Sumner, Christie, and Boulakia 2017).

2.3 Gender differences in climate change response preferences and choices

Harmful social norms and resulting gender inequalities in access to resources and services also limit women's bargaining power and agency at multiple scales and in different domains, including in agricultural production decisions, livelihood choices, income-earning opportunities, and in market transactions (e.g., trade). For more on this, see the working paper by Quisumbing et al. (2023). Unequal power dynamics limit women's ability to negotiate for their preferred responses to climate disturbances within households, communities, groups and organizations, and in policy spheres (Steinfeld and Holt 2020), despite having different needs, preferences and priorities for how to respond to the negative impacts of climate change (Bryan et al. 2017; Ngigi, Mueller, and Birner 2017; Kristjanson et al. 2017).

The process of negotiation can lead to a set of observed response choices that can be characterized in different ways. First, given generally lower resilience capacities, women often have fewer options to respond to climate disturbances and are more likely to adopt short-term coping measures than medium- to longer-term adaptive strategies, which further exacerbates their vulnerability to future shocks (Ahmad, Afzal, and Rauf 2021; Anugwa et al. 2020; Jost et al. 2016; Mersha and Van Laerhoven 2016; Bastakoti and Doney 2020). For example, a comparative analysis of women's agency and adaptive capacity across Asia and Africa found that women often resort to coping strategies that reduce their well-being and future resilience (Rao et al. 2019). A study of adoption patterns of climate-smart push-pull technology in East Africa further demonstrates that, even when women show interest and willingness to adopt new technologies, they still face considerable resource constraints that limit their use of these technologies (Murage et al. 2015). Women also are less able to participate in mitigation activities. Early evidence from agricultural carbon-market projects suggests that women are less likely to participate in sustainable land management activities that lead to soil-carbon sequestration, have little input in the design of such activities, and, when involved, they see a large increase in their labor burden (Lee et al. 2015).

Second, intersectional identities also influence response choices. For example, a study from three climate-smart villages in Latin America, where multiple climate-smart interventions were implemented, found that gendered patterns of adoption and the use of climate forecast information also depend on women's level of education and age (Acosta et al. 2021). In another example, widows and divorced women in Tanzania face greater agricultural production constraints and are more likely to seek off-farm opportunities for earning income (Van Aelst and Holvoet 2016). A study from Uganda found that, in addition to gender; age, wealth and marital status influenced the adoption of drought-tolerant maize (Fisher and Carr 2015). In South Asia, socioeconomic status also influences migration decisions following adverse climate events: resource-rich households choose to migrate as an adaptive response

while resource-poor households tend to migrate to cope with climate shocks. Women and children of all income levels are less able to migrate at all (Bhatta et al. 2015).

Third, when women are involved in decisions about climate change adaptation, evidence suggests that they tend to make different choices. For example, evidence from Tanzania shows that women's agency in intrahousehold bargaining is associated with greater engagement in nonfarm income-earning activities, and different crop choices on the farm (Van Aelst and Holvoet 2016; 2020). Case study evidence suggests that these choices are often reflective of gendered livelihood roles and responsibilities (Bernier et al. 2015; Bryan, Kato, and Bernier 2021; Ngigi, Mueller, and Birner 2017; Twyman et al. 2014). In Bangladesh, women were found to be more likely than men to adopt practices that relate to their existing livelihood roles such as improved livestock feeding and grain storage practices, when they are aware of these practices (Bryan, Kato, and Bernier 2021). Women also tend to prefer practices that reduce their workloads (Arora et al. 2017; Farnworth et al. 2017; Murray et al. 2016; Mutenje et al. 2019; Khatri-Chhetri et al. 2017), although women sometimes adopt low-risk, labor-intensive practices due to the high cost of some laborsaving technologies (Mutenje et al. 2019).

2.4 Lack of gender integration in policies, investments and interventions

Another important gender gap relates the lack of gender-responsive policies, investments and interventions, and the lack of women's leadership in policy spheres. A growing literature provides strong evidence that climate policies and programs at multiple scales do not adequately integrate gender (and intersectional social identities) or budget for stated outcomes (Acosta et al. 2019; 2020; Ampaire et al. 2016; Ampaire et al. 2020; Huyer et al. 2020; Mersha and van Laerhoven 2019). In comparison to other environment-related processes, the integration of gender equality into climate policy has been slow at both global and national levels (Huyer et al. 2020). When gender is mentioned in policy, women tend to be framed as victims of climate change rather than as agents of change (Huyer and Partey 2020; Garcia, Tschakert, and Karikari 2020). A policy analysis of the extent to which gender is integrated into agricultural and climate change policies in Nepal found that, although gender is acknowledged in most policies, the scope for intervention is mostly restricted to increasing reach and participation of women farmers in policy implementation, and there is less focus on benefits for women (Paudyal et al. 2019).

Governments, parliamentarians, policymakers and implementing agencies often lack the capacity to integrate gender in climate adaptation efforts (Ampaire et al. 2020; Bryan et al. 2018; Ragasa et al. 2013) and to understand the interests of different stakeholders based on intersectional identities such as ethnicity, class and caste (Resurreccion et al. 2019). This is also the case with climate mitigation interventions, as even less attention is paid to the gender equity implications (Lee et al. 2015). Integrating gender into climate change policies also must consider how local gender norms limit women's ability to participate in and benefit from the implementation of climate interventions, and take steps to enhance the transformative potential of policy action (Acosta et al. 2019). This is not always easy as demonstrated by a case study from Uganda, which showed that although local policymakers often adhere to global discourses about gender inequality, there is limited interest in adopting local solutions that actually challenge the underlying social norms that drive gender inequalities (Acosta et al. 2021). Ampaire et al. (2020) also found that implementation and monitoring instruments were missing from policy in East Africa and that policies tended not to address structural inequalities.

There is also considerable gender inequality in climate investments (Faucherre 2016; Schalatek 2022). First, the amount of official development assistance dedicated to gender and climate change (adaptation and/or mitigation) is inadequate, being only 8.6 percent of all official development assistance (Schalatek 2021). Second, global financing mechanisms that fund adaptation and mitigation policies and programs, particularly the private sector

mechanisms such as carbon and biodiversity offsets, often pay less attention to gender and equity concerns (ibid). These highlight the need for greater scrutiny of how financial mechanisms are deployed and what their distributional impacts are (Glemarec, Qayum and Olshanskaya 2016). For example, a review as well as several case studies from the literature on gender and REDD+ (Reducing Emissions from Deforestation and Forest Degradation plus conservation, sustainable management of forests and enhancement of forest carbon stocks) found the subordination of women (particularly indigenous women) in decision-making in the forestry sector and, hence, in national REDD+ regimes (Pham et al. 2016), as well as marginalization in the design and implementation of REDD+ policies (Arwida et al. 2017), hindering effective forest protection, fair resource allocation, gender equality and social justice (Löw 2020). The effectiveness of expanding access to climate finance to reduce gender inequalities depends also on building capacities and institutions to challenge social structural constraints that limit women's ability to engage in CSA, forest sequestration and disaster management (Wong 2016).

2.5 Gender inequality in outcomes of climate change responses

Climate change and the choice of climate-smart practices, technologies or adaptation strategies have important implications for women's empowerment and gender equality outcomes through changes in labor allocation, control over income and assets, and livelihood choices, among other pathways (Bryan et al. 2017). Every response option carries some degree of trade-off among people and across outcomes and spatial and temporal scales (ibid.). Thus, interventions aimed at increasing resilience to climate change are not gender neutral. Most climate interventions have been implemented without an explicit focus on women's empowerment or the use of gender-transformative approaches (GTAs). Given this shortcoming, such interventions may not address—and may, in fact, perpetuate—structural inequalities that limit women's contribution to addressing the harmful impacts of climate change (Huyer and Parthey 2020).

In particular, short-term coping strategies, such as drawing down assets, keeping girls home from school or reducing consumption have short- and long-term negative welfare implications for all family members but may be especially detrimental to women and girls. For example, although women are generally in charge of food preparation and cooking, in some cases they eat last (Hathi et al. 2021) and may be more likely to reduce how much they eat in response to shocks (Algur, Patel, and Chauhan 2021). Reducing consumption in the short-term can have long-term, even intergenerational, implications. For example short maternal stature, a consequence of poor nutrition in childhood, is associated with low birth weight and child stunting, which in turn has implications for adolescent nutritional status, thus perpetuating the cycle of undernutrition (Martorell and Zongrone 2012).

Climate shocks can also shift household expenditure away from investments in girls, toward immediate household needs, causing deficits in girls' long-term health and human capital outcomes (Feeny et al. 2021; Staffieri, Sitko, and Maluccio 2022). Evidence from several contexts suggests that older girls are especially likely to be pulled from school following climate shocks, when the demand for family labor increases (Staffieri, Sitko, and Maluccio 2022; Agamile and Lawson 2021; Björkman-Nyqvist 2013). A study in Vietnam showed long-term effects of rainfall shocks on gender gaps in employment and suggested that these operate through differential effects on education attainment (Feeny et al. 2021).

The outcomes of response choices are often nuanced, as demonstrated by several case studies on the gendered impacts of climate-induced migration. In some contexts, male outmigration increases women's decision-making authority at home (Rajkarnikar 2020; Simelton, Duong, and Houzer 2021). In other cases, women left behind due to men's outmigration face additional hardship, including increased work burden (Lei and Desai 2021), loss of identity, marital separation, increased health burden (Sznajder et al. 2022) and mortality risk (Agadjanian, Hayford, and Jansen 2021). Often, women migrants face sexual

exploitation and human trafficking (ElDidi et al. 2022), in addition to social costs and stigma (Evertsen and van der Geest 2020). Some evidence suggests that climate shocks in conflict-prone areas exacerbate negative impacts on women: Chandra et al. (2017) found that extreme climate events in conflict-prone agrarian communities in the Philippines subject women to numerous adverse outcomes including forced migration, increased discrimination, loss of customary rights to land, resource poverty and food insecurity.

There are also often trade-offs and nuances in welfare outcomes following the adoption of new climate-smart practices or technologies. For example, in the case of conservation agriculture (CA), a systematic review in sub-Saharan Africa showed that CA is associated with women's greater participation in agricultural decisions, increased income and better household food security. However, it is also associated with increased workloads and health risks (Wekesah, Mutua, and Izugbara 2019). Other studies have similarly documented the negative implications of CA for women's time burden (Beuchelt and Badstue 2013; Farnworth et al. 2016), which has resulted in many women abandoning the practice (Hove and Gweme 2018).

Another review found that women's participation in sustainable livelihood interventions leads to increased income, better food security and improvement in short-term environmental outcomes (Call and Sellers 2019). However, these benefits may come at a cost to women—these initiatives were found to increase women's labor burden without corresponding gains in women's income (Beuchelt and Badstue 2013; Call and Sellers 2019). Similarly, in Ethiopia, adoption of multiple climate-smart practices was associated with higher dietary diversity and greater calorie and micronutrient intake (Teklewold, Gebrehiwot, and Bezabih 2019). In this case, female-headed households received the largest boost in food and nutrition security following the adoption of climate-smart practices compared to male-headed households, suggesting that facilitating women's adoption of CSA would also improve nutritional outcomes for this subset of women (ibid.).

Some climate-smart technologies have the potential to reduce women's labor burden, while also contributing to higher productivity, incomes and, in some cases, positive environmental outcomes (Khatri-Chhetri et al. 2017). For example, the rice drum seeder was found to reduce women's time burden while mitigating GHG in India (Gartaula et al. 2020; Joshi, Khan, and Kishore 2019), although in other cases it was found to reduce employment for women (Paris and Chi 2005). However, the introduction of laborsaving technologies, like pumps for small-scale irrigation, may not reduce women's overall work burden but may rather enable them to allocate time to more-preferred livelihood activities (Bryan and Garner 2022).

A growing number of studies examine how labor patterns shift following climate shocks and the adoption of specific farming practices in response to climate change. Recent evidence suggests that households reallocate labor in response to climate shocks and stressors in ways that have different impacts on women and men. A study on the impacts of climate extreme events (e.g., heatwaves and droughts) on labor force participation in agriculture, drawing on individual-level labor data from 30 countries in Africa, found that while heatwaves and droughts reduce individual effort intensity in agriculture considerably, the work intensity of women farmers was much less affected by heatwave shocks than that of men farmers (Nico and Azzarri 2022). A case study from Tanzania supports these overall findings: heat stress was shown to reduce total male family labor in agricultural production, while female family labor remained unchanged, or even increased in the case of female-headed households (Lee et al. 2021). These results highlight the importance of women farmers' contributions to agricultural production under a changing climate; however, they also raise concerns regarding the working conditions of women under a more hazardous production environment.

Some have argued that CSA interventions in practice focus largely on technical solutions, are driven by entrenched global interests and emphasize market-oriented approaches that address the productivity and profitability objectives (Clay and Zimmerer 2020; Collins 2018; Haapala 2019; Karlsson et al. 2018). Shifting smallholder production toward a more commercial orientation has considerable equity implications (Karlsson et al. 2018). The literature suggests that women and other disadvantaged groups often face constraints to participating in value chains, markets and business activities (Farnworth 2011; Fischer and

Qaim 2012; Waithanji, Njuki, and Nabintu 2013; Dalaa et al. 2021) and that these constraints vary for different groups of women (Andersson Djurfeldt 2018) and depend on the value chain in question (Rubin, Boonabaana, and Manfre 2019). Thus, while commercial-oriented CSA may provide benefits in terms of productivity and profitability, it may come at the expense of a loss of women's agency—including their control over income, assets and decision-making authority (Tavenner et al. 2019).

3. Reducing gender inequality through climate action: what strategies are effective?

Although much of the research on gender and climate change has focused on identifying differences in the ways in which men and women perceive climate shocks and changes, differential capacity needs and response-choice preferences, recent research has focused on applying this understanding to the development of gender-smart climate investments and interventions that reach, benefit and empower women for climate action and that transform the structures and barriers that drive gender inequality (Huyer and Chanana 2021). A set of promising approaches to gender-inclusive climate action at multiple scales is beginning to emerge. It centers around policies, investments and programs aimed at increasing women's access to productive resources (including laborsaving technologies), providing inclusive climate finance, expanding access to climate information services and promoting group-based approaches (Huyer et al. 2021). The extent to which any climate-smart interventions can reach, benefit and empower women depends on the design and implementation approach (Johnson et al. 2018). Most efforts concentrate on increasing women's access to and control over resources needed for responding to climate change, while less effort has been made to address structural inequalities and institutional barriers through GTAs at multiple scales. There is, however, growing acknowledgment that climate interventions should be accompanied by specific activities aimed at facilitating women's empowerment and gender-transformative change (Huyer and Partey 2020). In general, more research is needed to understand what climate interventions have proven effective at reducing gender inequalities, as well as what have not.

3.1 Gender- and environment-sensitive social protection

Several studies have demonstrated that social protection programs provide a buffer against climate shocks by facilitating adaptation, speeding recovery from shocks and improving welfare outcomes in risk-prone contexts (Premand and Stoeffler 2020; Knippenberg and Hodinott 2017; Macours, Premand, and Vakis 2012; Tenzing 2020). There is also evidence that social protection must go beyond targeting women in their capacity as mothers in order to promote women's empowerment and gender equality (Molyneux and Thomson 2011; Holmes and Jones 2013; Jones et al. 2017). However, few "shock-sensitive" social protection programs are gender responsive, and there is little research at the intersection of social protection, gender and climate change to shed light on the extent to which gender-responsive approaches reduce gender inequality in climate change impacts (Holmes 2019). Despite the dearth of literature on gender-responsive, shock-sensitive social protection, this is viewed as a promising area deserving of further study (Tschakert and Machado 2012)

and some case studies are emerging. For instance, a school feeding program in Malawi was shown to increase school enrolment for older girls, who are more likely to be withdrawn from school following climate shocks (Staffieri, Sitko, and Maluccio 2022).

Going beyond just increasing resilience to shocks, social protection programs are also being linked with payment for ecosystem services (PES) schemes to support broader environmental conservation and natural climate solutions through the protection, management and restoration of ecosystems. Evidence suggests that such programs are synergistic, contributing to sustainable development and climate change adaptation and mitigation (Griscom et al. 2020). PES schemes that include gender and social equality objectives have the potential to contribute to both gender equality and climate resilience, particularly where these schemes are used to diversify rural incomes or foster a shift to more regenerative and sustainable practices in food systems (Schwarzer, Van Panhuys, and Diekmann 2016). Some social protection programs—for example, Bolsa Verde, a cash transfer program with environment conditions in Brazil—are beginning to integrate gender and social equality and environmental objectives with promising outcomes in both areas (de Brauw et al. 2014; Schwarzer, Van Panhuys, and Diekmann 2016). Gender- and climate-responsive social protection programs will require greater use of sex-disaggregated data to assess poverty and vulnerability to shocks and stressors in the design and implementation of these programs (Holmes 2019). Key design features include proper targeting to women, identification of appropriate communication channels, selection of gender-appropriate work opportunities, and overcoming gender-specific constraints through, for example, activities to increase women’s financial inclusion (Holmes 2019).

3.2 Collective climate action through group-based approaches

There is strong evidence that group-based, collective approaches support women’s climate actions by increasing their access to information, shared resources, finance and collective agency (Cabot Venton, Prillaman, and Kim 2021; Huyer et al. 2021). For example, two studies from India found that using women’s groups and networks as communication delivery channels for climate change and weather information can increase women’s access to these critical services (Rengalakshmi, Manjula, and Devaraj 2018), leading to increased knowledge of climate-resilient practices (Dey, Singh, and Gupta 2018). A case study in Vietnam found that women’s groups enabled women to gain access to information leading to adoption of alternative wetting and drying practices in rice production, a GHG mitigation strategy (Farnworth et al. 2017). Groups such as village savings and loan associations have proved to be promising options for increased productivity and income in Southeast Asia (Huyer et al. 2021; Simelton et al. 2021). The use of groups in Kenya were shown to enhance women’s adaptive capacity through training and the provision of microcredit (Caretta 2014). Another study from Kenya also found groups to be an important determinant of adopting CSA practices—although the ways in which women and men participate in groups, and the types of groups they join differ, suggesting that gender-sensitive strategies are needed to utilize groups as a way to promote uptake of CSA practices (Ngigi, Mueller, and Birner 2017).

Beyond increasing access to information and resources leading to the adoption of climate-smart practices, groups also provide a vehicle to increase women’s agency. Women members of self-help groups in India were more politically engaged, more aware of public entitlements, and more likely to benefit from public entitlement schemes than nonmembers (Kumar et al. 2021). In Senegal, a women’s committee participated in local environmental management while also developing an income stream from baobab fruit powder (Huyer et al. 2021). A women’s group in Nepal increased their status in the community, reduced workloads and increased production through the management of solar irrigation pumps (ibid.). These examples indicate that group membership and collective action can engender capacity building tailored to women’s needs and constraints.

3.3 Gender-sensitive design and dissemination of climate information services

There is considerable evidence that well-designed climate information services that reach women increase adoption of CSA in ways that benefit women and their communities. For example, women's access to climate information was found to be a key determinant of awareness and adoption of climate-smart practices in Kenya (Bernier et al. 2015) and Bangladesh (Bryan, Kato, and Bernier 2021), reducing gender gaps in the adoption of key practices. Furthermore, a study using panel data from the Living Standards and Measurement Study in four countries in sub-Saharan Africa found that, when extension and information services reach women farmers, agricultural performance improves and the negative impacts of weather variability and climate shocks on agricultural income are reduced (Azzarri and Nico 2022). An evaluation of climate information service interventions in Rwanda suggests that interventions targeted to women fill a critical information gap leading to improved agricultural management decisions that increase resilience to climate change: women participants were found to apply the climate knowledge received through these interventions to their agricultural decisions, while there were no differences in decision-making behavior of men in the intervention and control groups (Gumucio et al. 2020a).

Well-designed and targeted gender training was also shown to increase women's adoption of resilient seeds in India (Dar et al. 2020). Addressing the gendered information gap in knowledge of climate-smart practices was also shown to increase adoption of climate-smart practices in India, leading to further benefits in terms of reduced male outmigration and better food and nutrition security (Agarwal et al. 2022). A recent study in India and Nepal found that women were more reliant on social networks and groups as sources of agricultural information, suggesting the need to expand women's access to formal extension while also leveraging social networks and farmer peers to improve information access (Alvi et al. 2021). Ways forward point to the inclusion of women's groups and networks in communication channels and the development of ICT and content that respond to women's preferences (Gumucio et al. 2020b).

There is some limited evidence that reducing information gaps may also increase women's agency. For example, a study from India found that women with access to agricultural information were more involved in decision-making around agricultural production (Mittal 2016). Another study found that mobile phone usage among women in Uganda was associated with women's empowerment as well as increased income, food security and better diets (Sekabira and Qaim 2017). More research is needed on the benefits of closing the gender information and digital divide and the potential for such interventions to contribute to women's empowerment and gender equality.

3.4 Design and dissemination of inclusive financial products

Financial inclusion supports women's climate action by enhancing women's productive capacity within agriculture and small-businesses along agricultural value chains (Fletschner and Kenney 2014; Njuki et al. 2019), potentially lead to improving women's intrahousehold bargaining power leading to more equitable and efficient allocation of resources (Fletschner and Kenney 2014). However, financial services, like insurance products, must be designed in a gender-sensitive way to reach, benefit, and empower women. Evidence suggests that financial products such as crop insurance programs can be successfully tailored to support gender equality, provide welfare benefits to both men and women, and increase opportunities for women's empowerment (Timu and Kramer 2021). In particular, bundled weather index insurance products seem particularly effective at reaching women and other marginalized farmers (Timu and Kramer 2021; Aheeyar, Samarakoon, and de Silva 2021). In the case of South Africa, the lack of access women have to land, resources, and extension services may affect their interest in this form of insurance (Born, Spillane, and Murray 2019). Thus, efforts to reach and benefit women with index insurance products should also include

disseminating information and technology, building trust in financial institutions, and linking to existing institutions.

3.5 Gender-responsive climate policies and investments at multiple scales

Policies, interventions, investments, infrastructure and institutions all play a role in creating an enabling environment for resilience and reducing gender inequalities in the food system. A number of instruments are used to structure national planning and commitments relating to climate adaptation and mitigation, including national adaptation plans, (NAPs), nationally appropriate mitigation actions (NAMA), REDD+ and nationally determined contributions (NDCs). There is significantly poor integration of gender dimensions into these mechanisms. Global climate financing mechanisms only recently began to integrate a gender lens, and then only the more prominent public multilateral mechanisms seem to have consistent frameworks, approaches and safeguards to ensure that gender and equity considerations are incorporated into their design, operation and evaluation (Schalatek 2021).

However, some progress is evident. While climate financing mechanisms such as the Global Environment Facility (GEF), the Adaptation Fund, and the Climate Investment Funds started out as largely gender-blind, there has been substantial effort to retroactively incorporate gender considerations into funding programs and structures (Schalatek 2022). At the national level, a review of NDCs found a significant increase in the content and number of references to gender since 2019: 68 percent of 193 NDCs submitted before September 30, 2021 made a reference to gender (Huyer 2022). To be effective, NDCs, NAPs and sectoral policies should include specific and concrete actions in climate-related sectors that target gender equality, articulate gender-specific target outcomes and develop gender-responsive monitoring and indicators specific to the agricultural sectors or natural resources. Gender budgeting and other strategies are needed to ensure the integration of women and youth into climate action, and consultative multistakeholder approaches need to be central to climate policy processes.

Improving the representation of women's voices and women's leadership, as well as the collaboration of women's ministries with other climate-related ministries in policy processes, can support the design of policies and programs that support women's meaningful engagement in climate action (UNDP 2016). Moreover, truly gender-responsive global climate funds would have to go beyond retrofitting gender to fundamentally alter the focus of funding operations to be more inclusive, including by prioritizing climate investments that disproportionately benefit women, bringing in more gender experts and leaders from women's organizations to the design of interventions, and monitoring and evaluating gender equality results (Schalatek 2022).

3.6 Large integrated programs

While the literature is still scant, there is emerging evidence that large integrated, community-based and participatory programs that integrate gender have the potential to improve outcomes for women beyond reaching and benefiting them. For example, a community-based adaptation program by CARE International that aimed to achieve social inclusion through focusing on building agency, changing relations and transforming structures, found positive shifts in women's empowerment (i.e., in terms of self-esteem and confidence to participate) and some initial signs of transformative social change, including shifting community attitudes regarding women's role in adaptation (Clarke et al. 2019).

Similarly, the multisectoral, climate-smart village approach, which uses participatory methods to test and apply a set of technological and institutional climate-smart practices in local contexts, was shown to increase gender equality across two dimensions, namely increasing women's access to and control over resources and women's collective action. In some regions, gender parity in the household increased as a result of participation in climate-smart villages, but impacts on women's workloads are less clear (Beal et al. 2021; Hariharan et al. 2020; Tesfaye et

al. 2022). Thus, reaching, benefiting and empowering women (and other marginalized groups such as youth) through large, integrative programs requires careful planning and project design before scaling context-appropriate climate solutions (Huyer et al. 2021).

3.7 Integrating activities aimed at women's empowerment and gender equality

More recent studies have emphasized the importance of going beyond climate interventions that reach and benefit women to ones that facilitate women's empowerment and address the root causes of gender inequality through GTAs. Gender-responsive, CSA has the potential to contribute to increasing women's agency (i.e., decision-making, reduced work burden, control over resources and income, and collective action) (Huyer et al. 2021), but more research is needed on different approaches in different socioeconomic, cultural, geographic and environmental contexts.

There is growing recognition that even efforts to increase women's agency are not enough to reduce gender inequalities in climate change outcomes and actions, and that GTAs are required to remove structural barriers by raising critical consciousness, shifting toxic cultural beliefs and attitudes, altering gendered power relations, and engaging men and boys as partners for gender equality (FAO, IFAD, and WFP 2020; Badstue et al. 2020). Specifically, GTAs may promote the agency of individuals and collective groups, increase access and promote rights to resources, address imbalances in care and productive work, redress practices that constrain women's autonomy, voice and bodies (Resurreccion et al. 2019), and increase knowledge and skills (Badstue et al. 2020; IFAD 2018).

Gender-transformative change goes beyond the individual, household levels to involve changes in norms, institutions and governing structures in the community and in broader society (Moser 2017). There is limited experience in applying GTAs in climate interventions and limited interest and action among local policymakers in tackling normative constraints (Acosta et al. 2021; Ampaire et al. 2020). However, some efforts are being made to tackle harmful norms, attitudes and behaviors through facilitated household and community dialogues as part of climate change interventions, including the International Fund for Agricultural Development's (IFAD) use of the Gender Action Learning System (GALS) in their climate change programming and FAO's community discussion clubs. Further efforts to increase the voice and influence of feminist movements in local development discourses may accelerate critical consciousness raising and normative change (ibid.). More testing and evaluation of the effectiveness of GTAs in addressing the root causes of gender inequality in climate change responses is needed.

4. Projected benefits of closing gender gaps in climate action

As agriculture and food systems have a major impact on GHG emissions, climate adaptation and mitigation efforts are critical for creating just and sustainable food systems. Gender inequalities that limit women's contribution to addressing climate change can, therefore, hinder efforts to build sustainable food systems. The relationship between women's empowerment and climate resilience goes both ways: there is emerging evidence that ensuring greater gender equity in climate action not only benefits women, but also facilitates scaling of climate responses (including adaptation, mitigation, CSA and resilience-building

measures) and that women's empowerment may also contribute to reduce the negative effects of climate change on outcomes such as hunger and food security. One study from Kenya found that a set of interventions aimed at increasing women's empowerment, including civic education leadership training and the establishment of community development councils, increased women's decision-making authority and household adoption of drought-preparedness measures (Grillos 2018). A comparative study in Bangladesh, Ghana and Zambia shows that, in certain contexts, empowering women can mitigate the effects of precipitation extremes, and that there may be an interactive effect between ecosystem service availability and women's empowerment (Cooper 2018).

Women have important contributions to make agriculture more climate smart and resilient given their livelihood roles and responsibilities (Huyer et al. 2021). For example, women often manage certain livelihood activities, such as rearing local or smaller livestock breeds or species that are more resilient to the negative impacts of climate change, and will, thus, be fundamental to maintaining food and nutrition security (Kristjanson et al. 2014; Chanamuto and Hall 2015). Evidence shows that women can leverage their social networks for greater climate resilience (Tadesse et al. 2017; Violon, Thomas, and Garine 2016). Women farmers across contexts may also be more reliant on farmer-to-farmer networks than men, due to their relative isolation from formal seed and information sources (Otieno et al. 2021; Marimo et al. 2021). A study in Tanzania highlights how women's social networks increase their ability to negotiate for access to resources and formal institutions, allowing them to circumvent exclusionary social norms and adopt climate-smart strategies such as improved seeds and irrigation (Smucker and Wangui 2016).

Women's climate response choices also reflect their specialized knowledge, such as regarding diverse seed varieties and storage practices (Otieno et al. 2018). In the Himalayas, women lead crop and seed management decisions and tasks, and in times of crisis maintain informal institutional arrangements for agrobiodiversity conservation such as seed exchanges, an important risk-reducing measure that contributes to high levels of agrobiodiversity (Ravera et al. 2019). Following climate shocks that lead to male outmigration, women also demonstrate ingenuity through the adoption of new climate-smart agricultural practices and livelihood innovations, as demonstrated by case studies of rice farmers in Vietnam (Nhat Lam Duyen et al. 2021) and women in coastal areas of Bangladesh (Khalil et al. 2020). Some case study evidence suggests that women may be more likely to adopt crop and livelihood diversification strategies, which are important for reducing climate risks, and, in the case of crop diversification, improving household diets (De Pinto et al. 2020; Gumucio, Twyman, and Clavijo 2017; Mersha and Van Laerhoven 2016).

Thus, there are important potential synergies between empowering women/reducing gender inequalities and increasing food system resilience to climate change. This provides further motivation for policies and interventions to be designed in ways that maximize the contributions of men and women to address climate challenges. However, more evidence is needed to strengthen the case that increasing women's agency and removing barriers to their participation in climate-smart food systems strengthens climate resilience for all, and to identify the pathways through which this plays out.

5. Conclusions

This review found very strong evidence of gender inequalities in climate change vulnerabilities, climate actions at multiple scales, and the impacts of climate change. There is also strong evidence that climate change interventions have differential impacts on men and women, and that these outcomes vary across contexts and by other social characteristics. The literature also demonstrates that the lack of gender responsiveness of interventions can exacerbate gender inequalities (Eriksen et al. 2021). Although some promising approaches emerged from this review, the evidence on effective approaches to reducing gender inequality through climate action remains limited (see also Call and Sellers 2019).

In general, this review found little evidence of gendered outcomes in climate change interventions. The literature that does exist is patchy, for example focused only on a small set of climate-resilient practices and approaches (e.g., conservation agriculture) or contexts. Thus, there is a need for more research on the effectiveness of the promising approaches identified here to go beyond reaching and benefiting women to contributing to women's empowerment and reducing gender inequalities. There is also the need for more evidence on the extent to which reducing gender inequality in climate action leads to greater climate change and food system resilience. Moreover, most case studies come from sub-Saharan Africa or South Asia, with fewer studies from Southeast Asia, Latin America, North Africa and the Middle East.

This research would benefit from application of standardized tools, indicators and approaches to measuring these outcomes, in order to build evidence on which approaches work, under which conditions, and in which contexts. There are some available gender indicators for measuring the effect of CSA practices, services and technologies, including indicators on equity in decision-making, women's empowerment, intrahousehold food security and equity in the ownership of productive resources (Gutierrez-Montes et al. 2020). Various versions of the Women's Empowerment in Agriculture Index may be used to evaluate changes in women's agency as a result of climate change interventions (Alkire et al. 2013; Malapit et al. 2019). Another tool measures perceived empowerment outcomes (for women and men) of climate-smart interventions across political, social, economic and agricultural domains (Hariharan et al. 2020). New methods are being developed and tested to more easily collect data from rural women explore their experiences with CSA; including data collection through mobile phones (Eitzinger et al. 2022). Furthermore, Duffy et al. (2017) propose a set of national-level indicators for measuring gender, poverty, food security, nutrition and health status connected to CSA objectives.

While new tools are emerging to explore the gendered outcomes of climate interventions, few use intersectional approaches or include indicators of transformative change such as changing gender attitudes (e.g., masculinities). Beyond measuring outcomes, policymakers, project implementers and other stakeholders need capacity building to implement climate actions in a gender-responsive way. A review of knowledge, attitudes and practices of climate change adaptation programming implemented in Bangladesh, Ethiopia, Kenya and Mali noted that measurable targets and monitoring of implementation as well as *ex post* evaluation of program outcomes were lacking, and called for more capacity in these areas (Ragasa et al. 2013).

Despite more recent emphasis on the importance of transforming food systems under climate change (Steiner et al. 2020), understanding how gender inequalities drive food system outcomes (Njuki et al. 2022) and examining climate change impacts along agricultural value chains (Fanzo et al. 2018), this review found almost no literature on the intersection of gender, food systems and climate change. Most of the evidence on gender, climate change and food security in low-income countries is focused on agricultural production.

More evidence is needed to document gender differences in exposure to climate shocks and stressors along agricultural value chains and in different food environments, and how these overlap with existing inequalities such as women's more limited opportunities to engage in higher-value production or high-value nodes of agricultural value chains (Coles and Mitchell 2010; Masamha, Thebea, and Uzokwe 2018). Better understanding of how climate change will affect men's and women's livelihood strategies and opportunities along agricultural value chains would help devise gender-responsive strategies and interventions to increase men's and women's resilience, including through greater livelihood diversification and entrepreneurship.

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ANNEX AND GLOSSARY

Available at: <https://cgspace.cgiar.org/handle/10568/129709>.



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