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From gender gaps to gender-transformative climate-smart agriculture

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This review considers climate-related vulnerability and the key issues linking gender equality and social inclusion to scaling and mainstreaming climate-smart agriculture (CSA) toward achieving transformative, inclusive, and sustainable food systems, to reduce climate-related vulnerability. Recent literature continues to highlight structural barriers, biases, inequalities, and power relations impeding the contribution of CSA to reducing climate-related vulnerability. We review the role of CSA solutions toward achieving gender equality and transformation outcomes to enable food system transformation for climate change resilience. Effective food system transformation requires gender-responsive interventions, social and youth inclusion, intersectionality, and cognizance of how global social and environmental changes affect the transformation process. In the context of food system transformation, gender transformation requires scalable, enabling mechanisms.

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Introduction

To date, much of the research on the nexus between gender and climate has emphasized the negative impacts on women, in terms of their increased vulnerability to climate-related shocks. Women in developing countries rely predominantly on natural resources for their farming activities, household needs, and caregiving roles. For many women in these contexts, access to important resources such as credit, information, extension and agricultural services, as well as training in technology, is largely limited due to social norms and stakeholder biases. This affects their agency at home and within their communities [1••–4].

Agricultural intervention approaches have largely ignored women as agents of change [5••] as well as their capacity for — and learning in relation to — climate change adaptation, so that the root causes underpinning climate-related vulnerability persist [6–8••]. More effort is needed at the R&D-policy interface [9] to generate models that support and promote gender equity and equality in the context of the escalating climate crisis — especially when a global transformation is required to effectively strengthen food systems to respond to the impacts of climate change. If current gender and social inequality trends persist unchecked under climate change, gender gaps and existing inequalities will increase [5,10••], including those relating to agriculture and food security. This situation will curtail efforts in many regions to transform agriculture systems to deliver on Sustainable Development Goal targets [11,12].

We review the potential of climate-smart agriculture (CSA) to achieve gender equality and transformation outcomes that enable food system transformation for climate change resilience. This is done through an understanding of the linkages between climate-related vulnerabilities, gender equality, and social inclusion, and their interrelation with food system transformation [11,13••]. The section on *Gender-driven gaps, constraints, climate-related vulnerability, and climate-risk perceptions* presents the contribution of CSA toward gender equality, while also setting the background by examining the elements of gender, norms, productivity, and vulnerability that impede the application of CSA to reduce climate vulnerability. Section *From gender gaps to gender-inclusive resilience* highlights the contributions of CSA toward gender equality while also looking at R&D gaps that can provide further evidence for the potential of CSA to improve gender equality. Finally, Section *From gender gaps to gender-transformative climate-smart agriculture* discusses the approaches that can promote gender-transformative change at scale to build climate change resilience.

The review recognizes that, while several definitions of CSA[1] exist, the CSA concept evokes discussions that go far beyond a list of specific practices. The effective implementation of CSA practices is conceptually linked to social, economic, and political dimensions that create enabling environments in which institutions, policies, and finance are harnessed to transform agricultural systems [14,15]. These environments are affected by the differences in climate-linked vulnerabilities of women and men and their ability to derive benefits from CSA [13••]. For this reason, the review does not focus on specific CSA practices but rather on the CSA concept and how it can or cannot support gender equality and transformation outcomes to strengthen food system resilience.

Gender-driven gaps, constraints, climate-related vulnerability, and climate-risk perceptions

Differences in women's and men's agricultural productivity are caused primarily by gender-related barriers where women are excluded from benefiting equally from CSA adoption or encounter barriers affecting their crop production and incomes. These barriers include (i) gender norms and gender biases [16,17]; (ii) the gender division of labor and increases in women's workloads from climate impacts [18••,19]; (iii) access to land and livestock [20,21•]; (iv) ability to use inputs (e.g. adapted/improved seed and fertilizer[2]) [22–24]; (v) access to information and climate services[3] [25••–27•]; (vi) finance [28–30]; and (vii) influence in community and household decision-making [31–34]. As a result, women may become enmeshed in a nonvirtuous cycle, where low incomes from reduced productivity mean they may not be able to invest in CSA options, and in turn their crops may be even more affected by climate impacts [36,18••].

Research is increasingly recognizing the gendered nature of climate-related vulnerability. Across semiarid regions, for instance, women-headed households and women with low incomes are the most vulnerable to climate change. Vulnerability is also created and maintained through informal and formal governance mechanisms such as those governing extension systems, adaptation planning, and intervention development; economic development and provision of social protection; and policy formulation processes. These shape daily life in places experiencing both extreme and slow-onset climate impacts, and often fail to take into account the need for gendered policies and interventions [7•,37••,38]. Women's and men's individual and culturally defined roles on the farm and in the household expose them to different climate impacts. Their ability to respond, adapt, and recover from these shocks is thus differential, as are their CSA needs and priorities [26,39••,40].

Women's and men's perception of climate risk also varies. Women and men tend to attribute different levels of importance when ranking risks such as drought or floods [40,41•] based on how exposed or dependent they are on the weather, natural resources, and environments.

Adaptation capacities and coping mechanisms in response to climate risks are conditioned by many factors, including gender, social status, poverty level or economic status/class, position, and power, as well as control over resources in the household and community. These can also determine the perception of risk [42,43]. Chanana-Nag and Aggarwal [44] note that CSA interventions can be better targeted if tailored to "the climatic risks experienced by women farmers, their social profile, and their needs, based on the role they play in agriculture".

From gender gaps to gender-inclusive resilience

Women's and men's adoption of adaptation practices differs, based on their household and farm labor roles, their understanding of climate impacts, and their access to information. Studies show that women may be "just as likely or more likely than men to adopt CSA practices" [45•], given adequate information, training, and resources with which to implement them [3••,46,47]. In Southeast Asia, women who received training on seed quality gained high knowledge scores, equal to those of trained men [26].

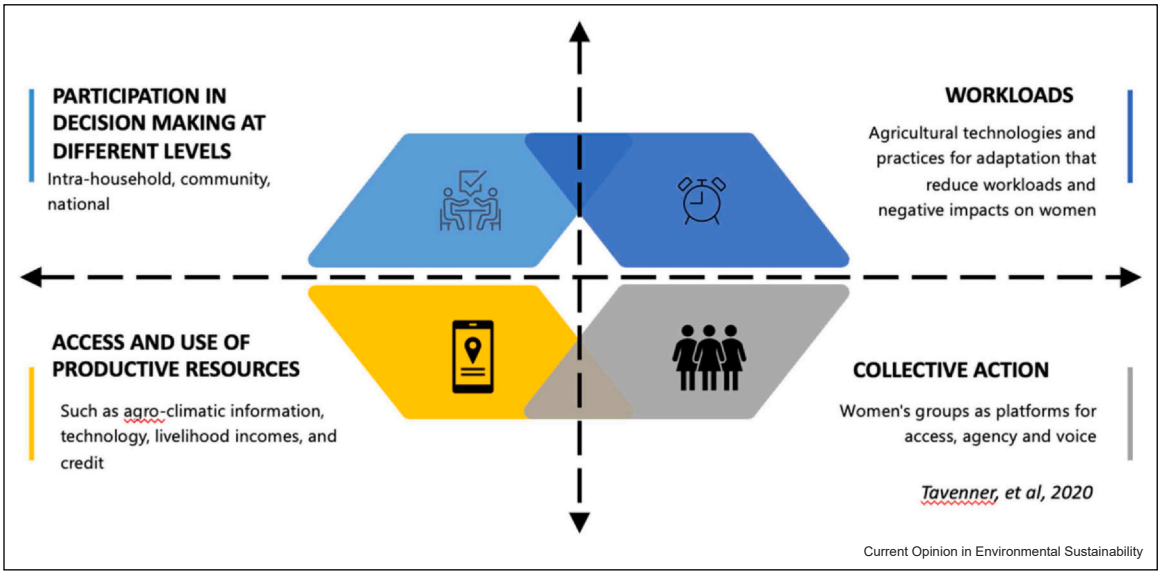
Concerns have been raised about the relevance of CSA for women, the dominance of technology, inequitable private sector-driven approaches (including women's

[1] One definition of CSA is an "approach for developing actions needed to transform and reorient agricultural systems to effectively support development and ensure food security under climate change. CSA aims to tackle three main objectives for a triple-win outcome: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible" [14]. However, setting in stone a defined list of CSA practices goes against the fundamental definition of location, time, and resilience specificity, which is at the core of CSA. CSA practices applied in a specific location in Kenya, may not be defined as such in Guatemala [15]. There are significant gender differences in CSA adoption and results. CSA has the potential to provide a range of benefits for women in adapting to climate change, but only if they are able to take advantage of it, through, for example, sufficient access to resources and information, and decision-making power to implement CSA practices. In Southern Africa, women chose to implement some CSA practices such as water-conserving planting techniques, drought-tolerant maize varieties, and legume intercropping. However, in contrast to men, they tended to use their own labor rather than mechanization to implement CSA practices, for reasons of cost [35•].

[2] The benefits of using chemical or organic fertilizers and adapted seeds on productivity, adaptation, and mitigation are determined by context-specific circumstances. Organic fertilizer may be augmented by insect larvae or supplemented with chemical fertilizer, for example, depending on cost and accessibility.

[3] "Climate services involve the production, translation, transfer, and use of climate knowledge and information in climate-informed decision-making and climate-smart policy and planning." (https://climate-services.org/about-us/what-are-climate-services/)

Figure 1



The four dimensions supporting gender equality in CSA adoption. Source [13••].

exclusion from the technology development process), and entrenched power inequities [48–50]. Introducing tailored labor-saving technologies that reduce women's drudgery is likely to increase the adoption of adaptation practices and increase women's productivity, reducing the gender productivity gap [51]; while adoption may be reduced if women have concerns about increased workloads resulting from the introduction of labor-intensive activities [52•]. The Global Commission on Adaptation [8••] points to the impact of "power and gender inequalities" that "undermine climate change adaptation", exacerbating existing barriers. Power relationships are inherent in social, economic, political, and judicial structures. Rao and Kelleher [53] note that these imbalances are redressed by increasing equality in control over resources (physical, human, intellectual, and intangible), prevailing ideology (beliefs, values, and attitudes), and instigating changes in institutions and structures.

A gender-blind[4] application of CSA can exacerbate existing inequalities, thereby undermining the agenda for women's equality. In some cases, a gender-blind approach can entrench and solidify power relations governing women's opportunity and ability to benefit from CSA. For instance, introduction of laser land-levelling equipment in India ignored women's activities in dairy production. A limited number of women were able to benefit, but only if their male relatives rented the equipment for them [54]. In the livestock sector, climate-smart interventions have neglected the gendered power relations governing differential roles in livestock rearing [55,56], intensifying inequalities by overlooking women's roles or ignoring their activities in certain sectors [57]. Similarly, Perez et al. [7•] noted that, in nine countries in East and West Africa, public and private-registered organizations supporting livestock and agricultural production held strong antiwomen biases, directing their support primarily to men.

Recent analyses indicate the interactions of CSA adoption and training with gender equality [58,59]. Research in South Asia and Southern Africa found that CSA is more likely to be adopted in households where women are empowered to some degree [35,60]. A global comparative review of CGIAR research and case studies from South/Southeast Asia and West Africa assessed approaches to reduce vulnerability to climate risks while supporting their capacity for resilience. It found that four gender-equal dimensions dimensions are integral for CSA to be empowering for both women and men: (i) involvement in decision-making; (ii) access to resources and agroclimatic information; (iii) reduced workload/drudgery; and (iv) collective action for agency (Figure 1). It noted that CSA can

[4] Although the term 'gender-blind' is criticized as being 'ableist', as used here, it is based on extensive gender analysis and conceptual approaches in the global development community. As formulated by IDRC, it is defined as the situation where there is "no attention to gender or the varied needs of marginalized populations" [61] and by the United Nations as an approach that "ignores gender norms, discrimination and inequalities" [62]. In this discussion, it refers to CSA practices implemented without analysis of local social, cultural, and political roles, responsibilities, rights, power relations, and dynamics that would prevent gender-transformative outcomes.

contribute to gender equality by addressing these dimensions [13••].

Nonetheless, while there is growing evidence on how CSA can contribute to building gender equality and climate resilience, more needs to be done. A preliminary overview[5] in 2021 [63] of journal articles and gray literature on gender, climate, and agriculture identified 288 publications. It found three main topics were covered: (i) adaptation using CSA practices; (ii) other adaptation actions or coping strategies (e.g. income diversification, seasonal migration, and off-farm labor); and (iii) vulnerability to, or the impact of, climate change . Forty-three percent of the articles reviewed were based in the African context, 27% focused on Asia, 6% on Latin America, and 20% on the global level. This review, while preliminary, highlighted research gaps in (i) geographical coverage, with low representation of research from Southeast Asian contexts; (ii) sectoral coverage, with few studies in livestock and fisheries; and (iii) methodologies, with few examples of mixed research combining quantitative and qualitative methods. The analysis also found low representation of research on certain important aspects of CSA such as value chains, scaling of adaptation practices, and water management. The review highlights a need to transition from a diagnostic to a more solution-oriented participatory research approach that explores how gender-responsive and gender-transformative strategies can contribute to building resilience [13••,37••]

From gender gaps to gender-transformative climate-smart agriculture

Experience demonstrates that the focus on closing the gender gap in agriculture has yet to achieve either gender equality or sustainable food security in the context of climate change. Addressing the root causes of vulnerability and inequality requires transformative approaches for more climate-resilient and equitable futures [64•,65]. Such approaches should be combined with gender-transformative climate adaptation strategies that take into account the roots of economic, political, ecological, and cultural vulnerability for different groups. CSA has the potential to contribute to this agenda if the approach incorporates power, equity, and access issues that go beyond focusing on the men–women divide [66••–68].

A global effort is needed to effectively strengthen and transform global food and nutrition security, boost smallholder yields and incomes, reduce poverty, increase gender and social inclusion, improve biodiversity conservation and ecosystem protection, and address shifting power dynamics. Transformative adaptation can effectively address vulnerability and its underlying causes, including inequitably distributed power, by reforming networks that control and influence these mechanisms [65,67]. Gender-transformative approaches — rooted in collective action, challenge to social and gender norms, negotiation, and advocacy for women's full socioeconomic and political participation — need to extend beyond the personal to social, structural, and institutional levels if gender roles and power structures are to be challenged (Figure 2). This includes through farmers', women's, and youth movements for sustainable food systems[6] [69–73•]. It is argued that the pathway from equality to transformation (Figure 2) is not direct and straightforward, with complex interconnections across stages.

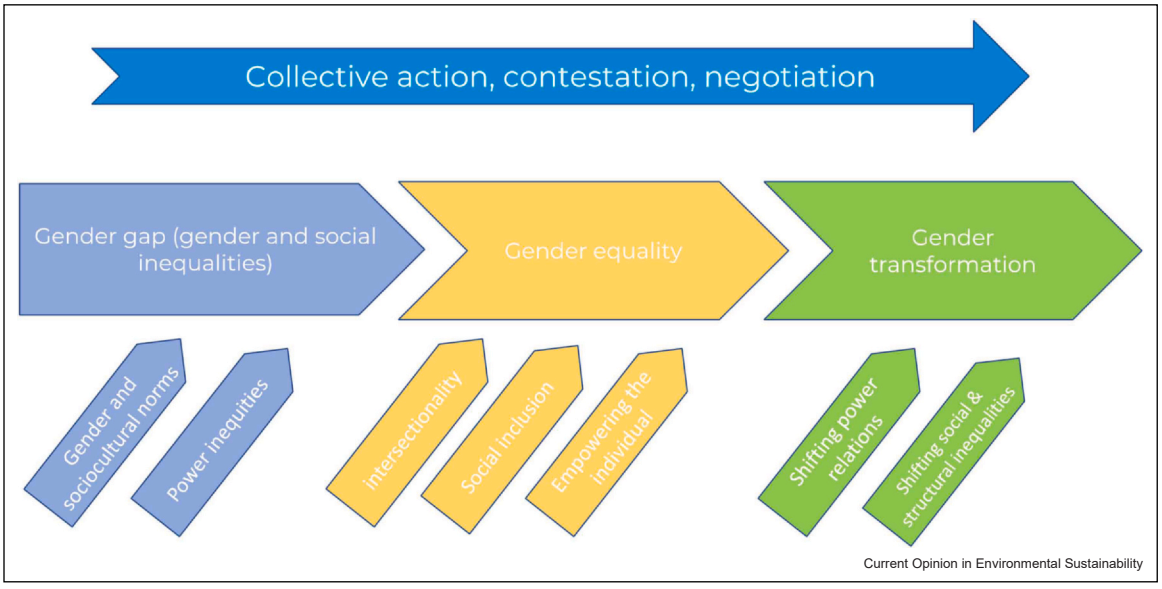
Intersectional approaches are needed that recognize the interconnected nature of social categories such as race, gender, class, sexual orientation, and other aspects of identity, and understand how they overlap and intersect to create oppression or privilege [74,75]. Arguably, gender research in CSA predominantly focuses on women and men, overlooking social, institutional, and political power relations that stem from gender, class, race, ethnicity, religion, and age [66••,76]. Individual roles and responsibilities influence the ability to cope with and adapt to climate-induced stresses. They can be especially evident across diverse or intersecting identities. Studies have shown how multiple identity categories of caste, economic class, and gender shape vulnerability to climate-related risks and disasters in India and Nepal [43,77]. Intersectionality assessments in Ghana informed capacity-building and delivery of climate information that was effective for CSA adoption, looking at age, gender, and socioeconomic status [78].

Social inclusion, defined as "the process of improving the terms on which individuals and groups take part in society — improving the ability, opportunity, and dignity of those disadvantaged on the basis of their identity", can be seen

[5] The review, based on PRISMA guidelines, identified English language peer-reviewed and gray literature articles published between January 2010 and June 2021 using a keyword search in Web of Science (journal database), Google Scholar, as well as CGSpace, CARE, FAO, IDRC, and Prevention Web websites. Articles were screened to identify duplicates and non-English language articles. Exclusion criteria included lack of focus on gender and climate change-related issues in agriculture, and unavailability of full text. The full text of the remaining 288 articles was analyzed for the review, of which 172 were journal articles and 116 were gray literature publications.

[6] "Food systems are the sum of actors and interactions along the food value chain — from input supply and production of crops, livestock, fish, and other agricultural commodities to transportation, processing, retailing, wholesaling, and preparation of foods to consumption and disposal. Food systems also include the enabling policy environments and cultural norms around food. Ideal food systems would be nutrition-, health-, and safety-driven, productive, and efficient (and thus able to deliver affordable food), environmentally sustainable and climate-smart, and inclusive." Food Systems | IFPRI: International Food Policy Research Institute https://www.ifpri.org/topic/food-systems.

Figure 2



Pathway from gender gaps to gender transformation.

as one approach to intersectionality. While recognizing the intersectionality of different identities, it is also about increasing opportunities, voice, and decision-making power, including access to assets, finance, and services [79]. One example, Youth4Climate,[7] is a collaborative project of YOUNGOs, CliMates, and the International Institute for Sustainable Development to provide a platform for 400 youth climate leaders from 186 countries to influence international climate negotiations and action plans. Another, Act4Food Act4Change, is a global youth movement of more than 200 advocates who have pledged to create systemic change and highlight young people's priorities for sustainable global food systems [70].

Conclusions

Our literature review presents growing evidence that gender-responsive CSA approaches have the potential to encourage gender equality and transformation for climate resilience. There is consensus that climate vulnerability is gendered, and that gender-responsive CSA has the potential to close the gender gap in agriculture. Research also suggests that CSA can become a supporting condition for gender equality when equality and power issues are explicitly explored. From a research-to-action perspective, CSA researchers and practitioners should strengthen efforts to work with research communities to integrate the power shifts, inequality, and access required to foster sustainable transformation, while supporting strategies that directly address gender inequalities, norms, and power imbalances. CSA programs should no longer consider women as a uniformly vulnerable group. Research and innovation efforts need to develop a better understanding of the interlinkages between gender equality and transformation and the social, cultural, economic, and political dimensions that create an enabling environment for CSA implementation and adoption.

Gender-transformative CSA approaches must also focus on what constitutes effective and inclusive scaling and for whom. To truly transform food systems at scale, governing institutions and CSA policies need to go beyond recognizing gender gaps; they should integrate knowledge from different actors, be grounded in gender equality, social and youth inclusion mechanisms, and explore scaling strategies that expand opportunities for all groups in society [80,81]. Last, and importantly, CSA policies and practices need to incorporate and promote a deeper understanding of how intersecting inequalities are replicated and/or can be resolved through the implementation of CSA practices. Engaging with women, youth, and men in marginalized social groups [82], through collective organizations or individually, at every stage — from design to implementation — is key to achieving gender-transformative outcomes in a changing climate.

Data Availability

No data were used for the research described in the article.

[7] https://youth4climate.live/

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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