GENDER Platform

CGIAR GENDER Platform · Working Paper #005

MAY 2022

Effectively targeting climate investments: A methodology for mapping climate–agriculture–gender inequality hotspots

By Jawoo Koo, Carlo Azzarri, Avni Mishra, Els Lecoutere, Ranjitha Puskur, Nitya Chanana, Niyati Singaraju, Gianluigi Nico and Arun Khatri-Chhetri

ISBN: 92–9146–719–7

Citation: Koo, J., Azzarri, C., Mishra, A., Lecoutere, E., Puskur, R., Chanana, N., Singaraju, S., Nico, G. and Khatri-Chhetri, A. 2022. Effectively targeting climate investments: A methodology for mapping climate–agriculture–gender inequality hotspots. CGIAR GENDER Platform Working Paper #005. Nairobi, Kenya: CGIAR GENDER Platform.

ACKNOWLEDGMENTS
The CGIAR GENDER Platform is grateful for the support of CGIAR Trust Fund Contributors (www.cgiar.org/funders) and in particular wishes to thank the International Development Research Centre (IDRC) for supporting this work (https://www.idrc.ca/en).

COVER PHOTO CREDITS: ICRISAT

ABOUT CGIAR GENDER PLATFORM
Generating Evidence and New Directions for Equitable Results (GENDER) is CGIAR's 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

CONTACT
CGIAR GENDER Platform
at International Livestock Research Institute (ILRI)
PO Box 30709
Nairobi 00100, Kenya
Tel. +254-20 422 3000
GenderPlatform@cgiar.org

CGIAR GENDER Platform
Working Paper #005

MAY 2022

Effectively targeting climate investments: A methodology for mapping climate–agriculture–gender inequality hotspots

Jawoo Koo
Senior Research Fellow
International Food Policy
Research Institute (IFPRI)
j.koo@cgiar.org

Carlo Azzarri
Senior Research Fellow
International Food Policy
Research Institute (IFPRI)
c.azzarri@cgiar.org

Avni Mishra
Associate Scientist
CGIAR GENDER Platform
avni.mishra@irri.org

Els Lecoutere
Science Officer
CGIAR GENDER Platform
e.lecoutere@cgiar.org

Ranjitha Puskur
Evidence Module Leader
CGIAR GENDER Platform
r.puskur@irri.org

Nitya Chanana
Associate Scientist
Alliance of Bioversity
International and CIAT
n.chanana@cgiar.org

Niyati Singaraju
Associate Scientist
International Rice Research
Institute (IRRI)
n.singaraju@irri.org

Gianluigi Nico
Data Specialist and
Economist
FAO
Gianluigi.Nico@fao.org

Arun Khatri-Chhetri
Senior Advisor
Save the Children US
arunkhatri0913@gmail.com

TABLE OF CONTENTS

Abstract

Climate change is influencing the transformation of agriculture and food systems across the globe in unprecedented ways. A large number of smallholder farmers in low- and middle-income countries (LMICs) who depend on these systems for their food and nutrition security, and incomes are experiencing increasing vulnerability. Women are at a particular disadvantage, given their lower adaptive capacity due to unequal access to productive resources and services, driven by deeply entrenched social and gender norms and other structural barriers. However, addressing these gender gaps can enable women to use their knowledge and skill to contribute to climate-resilient agriculture.

This paper proposes a methodology to map climate–agriculture–gender inequality hotspots at national and subnational levels where climate hazards, women's exposure to climate hazards affecting food systems, and gender inequalities converge to impact women's vulnerability to climate change. These hotspots are geographical areas where extreme climate hazards intersect with large concentrations of women participating in food systems and in the agricultural labor force, and with high levels of gender inequalities—and as such, result in high risk and exposure, low adaptive capacities, and higher vulnerability of women to adverse effects of climate change. The hotspots are identified using a set of indicators based on available secondary data comparable across the countries, conforming to the framework developed for this assessment, and using the Principal Component Analysis methodology.

The paper also presents the results of the analysis emerging from the application of this methodology. This includes a global ranking of 87 LMICs in Latin America, Asia and Africa by a climate–agriculture–gender inequality hotspot index using representative national-level data. Identification of subnational climate–agriculture–gender inequality hotspot areas using representative subnational level data in four selected countries is also discussed. Hotspot mapping can support organizations aiming to effectively target investments to address climate-change mitigation and adaptation so that women are not left out, and the climate change–induced food-systems transformations help advance gender equality.

Keywords: climate, food systems, agriculture, gender, hotspots, women

1. Introduction

Global efforts to transform food systems[1] so that they enable the provision of affordable and nutritious food for all in an environmentally sustainable way are imperative. Rapid climate change, however, undermines the ongoing efforts to end hunger, food insecurity and malnutrition. The food systems—including cropping, livestock, forestry, fishery and aquaculture sectors—face direct stress from climate-induced changes such as increases in temperature, variation in precipitation patterns and weather anomalies, and the increased frequency of extreme weather events. All these trigger crop failure, pest and disease outbreak, and degradation of land and water resources—impeding the development of resilient food systems (Aggarwal et al. 2018; IPCC 2019; UNDP 2016). These changes are more pronounced and acute in Africa and Asia, continents that have been identified as "climate change hotspots" (De Souza et al. 2015), as they are particularly threatened by climatic variations and house a large population of smallholder farmers who are dependent on their immediate environment for food and income, and who are vulnerable to poverty and inequality (Amjath-Babu et al. 2019).

Gender relations and associated dynamics play a crucial role in food systems, from the farm to food consumption. Women comprise up to 48 percent of the rural agricultural labor force in low-income countries (FAO 2020) and over 55 percent in parts of South Asia and Africa (UN Women 2020). They are also identified as agents of food and nutritional security (Allen et al. 2018; Njuki et al. 2021). Women constitute an important proportion of smallholder farmers, and are often primary users and managers of natural resources. Agricultural households are negatively affected by droughts and floods, and depend highly on women's labor in subsistence or cash-crop production or other agricultural activities—as producers, wage workers and providers of (unpaid) family labor (Nelson et al. 2002; Eastin 2018). Studies in Kenya, Ghana and Bangladesh also highlight women's key role in contributing to climate change–adaptation practices such as crop diversification, water harvesting, small-scale irrigation, improved livestock feeding and improved grain storage (Kristjanson et al. 2017; Bryan et al. 2021).

The Intergovernmental Panel on Climate Change (IPCC) notes that poverty, along with socioeconomic, cultural and political marginalization, cumulatively put women in a disadvantaged position in coping with the adverse impacts of a changing climate (Chanana-Nag and Aggarwal 2018; Huyer 2016; IPCC 2019). Differences in gendered roles and responsibilities; lower access to productive resources, technology, markets, finance and information; as well as restrictive sociocultural norms are factors that can make women more vulnerable to climate-change adversities affecting food systems, compared to men. Evidence also suggests that climate change will exacerbate women's differential vulnerabilities (Nellemann et al. 2011). But it is also known that, despite these inequalities, empowering women through positive actions and interventions can improve household food security and promote sustainable land management (IPCC 2019).

Given the significant contribution that women can make to developing resilient food systems, understanding the locally specific interactions between multiple climate-change risks, and gendered exposure and vulnerabilities in food systems is essential. This understanding is

1 Food systems are defined by the Intergovernmental Panel on Climate Change (IPCC) as systems that encompass all activities and actors in the production, transport, manufacturing, retailing, consumption, and waste of food, and their impacts on nutrition, health, well-being, and the environment (IPCC, 2019). Food systems incorporate food supply chains, including production, food environments, and consumer behaviour related to food, and influence the foods people choose to consume (HLPE 2017).

key to informing effective actions and interventions to improve coping mechanisms and mitigate risks for women and men. These different risks and vulnerabilities do not exist

discretely, and often overlap with each other in complex ways specific to the local context and conditions. Geographical areas where significant physical and ecological effects of climate change coexist with the presence of “a large concentration of vulnerable, poor, or marginalized people” are identified as ‘hotspots’ (De Souza et al. 2015). The identification of hotspots will facilitate how future efforts are targeted to locations and populations that are most vulnerable to adverse effects of climate change, to make these more impactful.

The aim of this paper is to develop and pilot applying a methodology to identify ‘climate–agriculture–gender inequality hotspots’, which are defined as geographical areas where extreme climate hazards intersect with large concentrations of women participating in food systems and in the agricultural labor force; and with high levels of gender inequalities—and as such, result in high risk, high exposure, low adaptive capacities, and more vulnerability of women to adverse effects of climate change. Climate–agriculture–gender inequality hotspots, therefore, are areas marked by food systems which are transforming under climate stress, where gender inequalities are persistent and vulnerabilities are likely to be exacerbated under a changing climate.

Identifying climate–agriculture–gender inequality hotspots fits within the broader goal of identifying pathways through which gender equality can benefit from changing food systems, and through which food systems can benefit from greater gender equality. It is imperative to ensure that women are not left behind and can seize adaptation and mitigation opportunities that emerge as food systems transform against the background of climate change—not only for the intrinsic value of gender equality, but also because this can enable improved food production and accessibility, incomes, and food and nutritional security.

2. Context

2.1. Climate change and the vulnerabilities of food systems

Globally, over one billion people rely on food systems that not only feed them but also sustain their livelihoods. It is anticipated that the instability of food systems will likely increase with climate change, particularly with a two degree increase in temperature (IPCC 2019). Climate change–related challenges to agriculture and food systems are projected to have a substantial and widespread impact on food production, food security, and livelihoods of many—particularly smallholder producers in the global South (Bryan et al. 2017).

Climate change can be understood from two perspectives: long-term (decadal) climate trends and short-term weather variability. Most immediately, climate change is experienced as increasing temporal and spatial variability in temperature, precipitation and winds, manifesting in higher incidence and magnitude of extreme events. The types of extreme events that are projected to increase include the frequency and intensity of heatwaves, frequency of heavy precipitation events and associated floods, intensity of tropical cyclone events, and incidence of extremely high sea levels owing to storm surges. Extended dry spells and the area affected by drought annually are projected to increase as well (Vermeulen et al. 2012). Figure 1 illustrates the predominant climate hazard types across the globe.

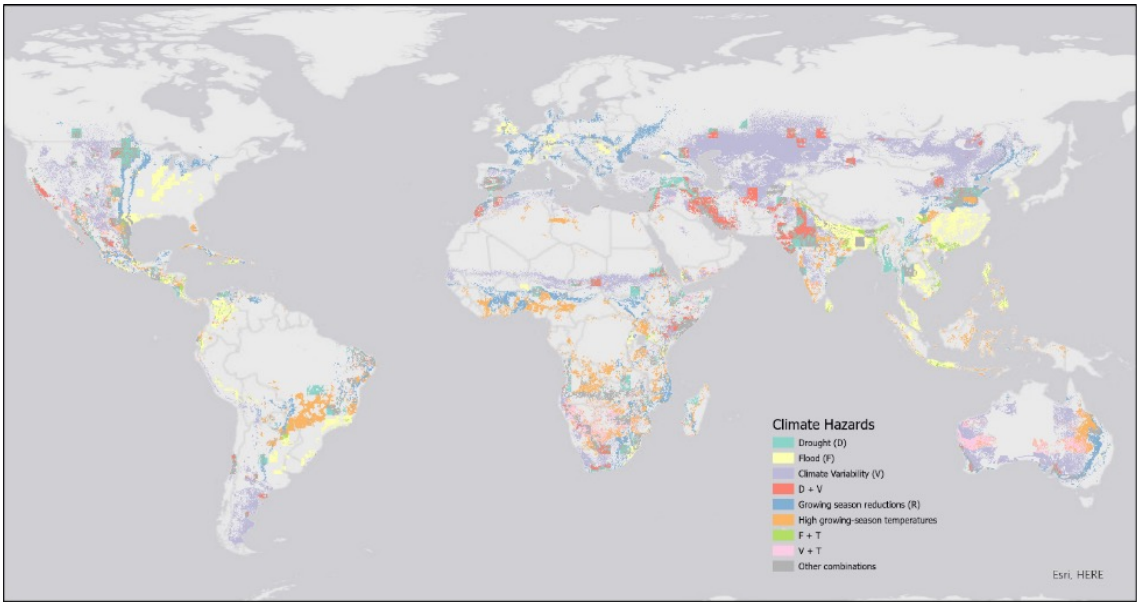


Figure 1. Predominant climate hazard types (source: P. Thornton/ CCAFS)

Agricultural production is projected to experience declines in yield and reduced crop suitability under high temperatures. This is especially the case in tropical and subtropical regions—including in South Asia and sub-Saharan Africa where, agriculture accounts for an average of 18.2 percent and 15.5 percent of national gross domestic product, respectively (The World Bank 2020). In low-latitude regions (tropical and subtropical), evidence suggests that warming has negatively affected the yield of some crops including maize and wheat. Pastoralism, which is practiced by close to 200–500 million people and in more than 75 percent of countries, is projected to become more vulnerable to climate change (McGahey et al. 2014). Coupled with non-climate-related stressors, climate change is projected to affect pastoralism by lowering pasture and animal productivity, damaging reproductive function, and leading to biodiversity loss (IPCC 2019).

2.2 Gendered effects of climate change in food systems

The effects and impact of climate change and related weather anomalies are locally specific and are experienced differently by different social groups defined by gender, age, race, disability, sexual orientation, wealth and/or class (Nelson et al. 2002; Vincent and Cull 2014). In many contexts, gender is an important determinant of vulnerability and adaptive capacity to climate-change adversities affecting food systems.

Women and men are vulnerable to climate risks because of multiple factors including their involvement in an exposed agricultural sector (or a stage of value chain), their sensitivity to the risk (e.g., their level of dependency on an exposed agricultural sector), and their capacity (or capability) to deal with the risks (Perez et al. 2015). However, it has been observed that women tend to be more vulnerable to climate-related shocks. For instance, women are more likely to be killed by natural disasters, and specifically in societies where the socioeconomic status of the women is low (Neumayer and Plümper 2007). Women and girls are also more likely than men to go hungry following natural disasters linked to climate change (FAO 2017; Oxfam 2019). In Andhra Pradesh in India, for instance, twice the number of women as men reported eating less in response to a drought (Lambrou and Nelson 2010). At the same time, men can be more vulnerable than women in cases, for instance, of them being over-represented in high-risk occupations such as construction activities (Delaney and Shrader 2000; Erman et al. 2021).

Women have limited options for livelihood diversification and are proportionately more dependent on natural resources (Terry 2009; Osman-Elasha 2012). Climate-related changes in cropping patterns and livestock production have been observed—with effects on gendered division of labor, increasing the farm and household workload of women, and direct health impacts for women (Nelson et al. 2002; Rao et al. 2019; Eastin 2018). In some cases, migration is adopted as an adaptation strategy by individuals experiencing climate-change impacts—especially men. Male outmigration, in many cases, is associated with increased labor responsibilities for women but not necessarily with improved access to finance, social networks or knowledge (Rao et al. 2020). Poor women, and women belonging to the lower castes or ethnic minorities are confronted with increasing work burdens; loss of support; and, in the face of limited resources, increased vulnerability (Rao and Mitra 2013). In South Africa, with increasing male outmigration, poor women take on extra workloads in their efforts to cope; and adopt diverse diversification strategies, including trade, to provide food for the household (Babugura 2020).

The weather shocks also have implications for women's assets which are critical for their resilience, but this is dependent on the level of their involvement in agriculture and asset ownership. For instance, drought impacts on women's assets in Bangladesh were observed to be low, given their lower direct involvement in agriculture, effective availability of emergency assistance, and low level of ownership and control of agricultural assets. On the other hand, drought in Uganda had a negative and significant impact on women's non-land assets, given their higher involvement in agriculture (Quisumbing et al. 2018).

2.3. Gendered capabilities to deal with climate change in food systems

Women are disproportionately affected by climate change because various socioeconomic and cultural factors limit their ability to respond to or cope with the impacts (Chanana-Nag and Aggarwal 2018; Huyer 2016). Restrictive social barriers and norms, limited access to and control over productive resources, high levels of poverty, lower likelihood of formal education, limited access to agricultural extension and inputs, and limited access to financial services affect women's adaptive capacities, and make women more vulnerable and less resilient to climate change in food systems (Anugwa et al. 2020, Diouf et al. 2020; Evertsen and van der Geest 2020, Nhat Lam Duyen et al. 2021; Acosta et al. 2019; Tsige et al. 2020; Yadav and Lal 2018).

Access, ownership and control of productive and financial resources are important aspects that build capabilities of women farmers to cope with the challenge of climate change in food systems. However, ample evidence exists to suggest that women tend to have fewer and lower value assets, less access to capital and labor, limited land ownership and fewer agricultural inputs (Anugwa et al. 2020; Diouf et al. 2020; Nchu et al. 2019). Even where women have access, they may not have the agency to use and control the resources as they need to adapt to climate-change impacts (Acosta et al. 2019; Akter et al. 2016; Duffy et al. 2021). Social norms and gender roles limit women's ability to make decisions or participate in different food-system activities—both at household and community levels (Evertsen and van der Geest 2020; Yadav and Lal 2018).

Similarly, limited access to information results in lower awareness and knowledge of climate risk, making them less prepared than men (Gumucio et al. 2020; Partey et al. 2018), and less able to adopt strategies to mitigate or adapt to climate risks (Bernier et al. 2015; Bryan et al. 2021). Rabbani et al. (2015) observed that women were less likely to diversify into viable livelihood options in the face of a climate shock in different ecological zones of Bangladesh due to restrictive social norms, lack of education, and limited access to productive resources. Iradukunda et al. (2019) highlighted gender differences in the uptake of disease management practices for banana crops in Burundi, where men adopted technical innovations faster than women because of more access to information and more participation in farmer learning groups. Jost et al. (2016)—in their study of Uganda, Ghana and Bangladesh—found that women used fewer climate sustainable agricultural practices because of resource constraints, lack of access to information and extension services, and sociocultural norms and practices that restricted women's participation in training programs.

Social norms pose barriers to access supportive institutional mechanisms, including extension services and collective action. For instance, despite their membership in community groups, women in Africa are unable to benefit from them due to sociocultural factors including who owns land, who is head of a household, who has domestic responsibilities and the 'status' of women in society that limit their gains compared to men (Acosta et al. 2019; Ngigi et al. 2017; Tsige et al. 2020). Similarly, social norms limit women's ability to participate in group activities, move freely, and use specific technologies or practices—reducing their capacity to respond to climate-related stresses (Bryan et al. 2017).

However, using climate-change interventions to address these gender gaps and challenges, and women's needs and priorities, can significantly contribute towards developing climate-resilient food systems. Identifying hotspots, therefore, can act as the first step in initiating this process.

3.Methodology

This paper aims to develop a methodology to identify climate–agriculture–gender inequality hotspots in LMICs, building upon the work by Khatri-Chhetri et al. (2017), the methodology of which is described in more detail in Chanana-Nag and Aggarwal (2018). Climate–agriculture–gender inequality hotspots are identified at national and subnational levels using geospatial information and large, publicly available socioeconomic datasets representative at each level.

The methodology is then applied to identify climate–agriculture–gender inequality hotspot LMICs, and hotspots in subnational areas in selected hotspot countries. This methodology is broader in scope than the study by Khatri-Chhetri et al. (2017), both in terms of geographical coverage as well as using a theoretical framework and a number of indicators to identify the hotspots.

In this section, the theoretical framework is discussed; along with the indicators and method to identify, rank and map climate–agriculture–gender inequality hotspot countries and subnational areas.

3.1. The framework for identification of climate–agriculture–gender inequality hotspots

The framework of risk proposed by IPCC (2020) is used as a basis to identify hotspots of climate–agriculture–gender inequality. In its ***Sixth Assessment Report*** on the concepts of risks, the IPCC (2020) ascertained those risks that can "arise from potential impacts of climate change as well as human responses to climate change". Risk or impact is derived from the interaction of social and environmental processes, from the combination of physical hazards and the vulnerabilities of exposed elements (figure 2; box 1 for definitions) (IPCC 2014).

Components of risk

Hazard refers to the possible, future occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.

Exposure refers to the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

Vulnerability refers to the propensity of exposed elements such as human beings, their livelihoods, and assets to suffer adverse effects when impacted by hazard events. Vulnerability is related to predisposition, susceptibilities, fragilities, weaknesses, deficiencies, or lack of capacities that favor adverse effects on the exposed elements.

Box 1. The IPCC AR5 Risk Framework (IPCC 2014)

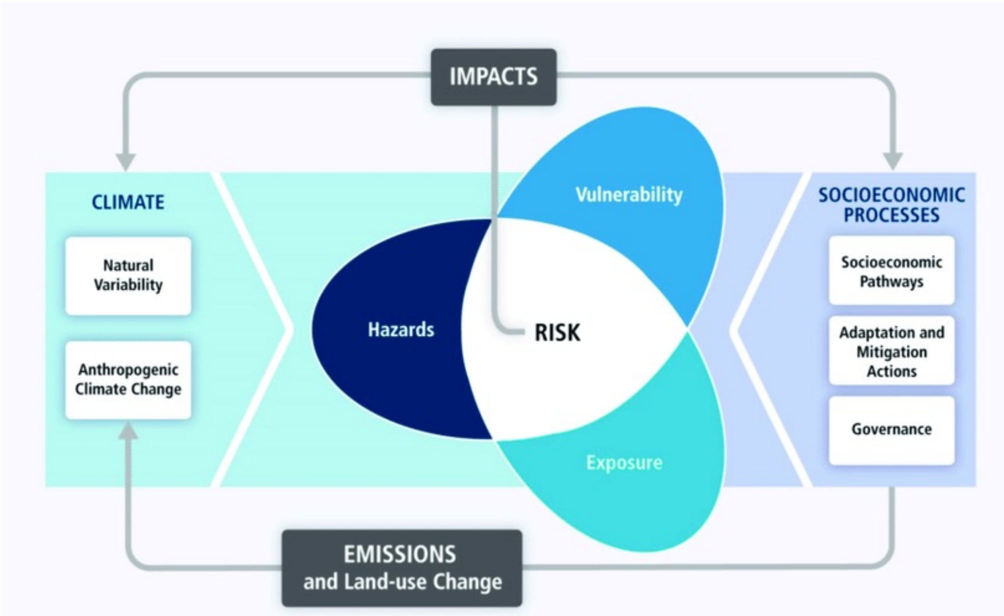


Figure 2. The Intergovernmental Panel on Climate Change's AR5 risk framework (IPCC 2014)

3.1.1. Climate hazards

For the purposes of this paper, the concept of hazards in the climate–agriculture–gender inequality hotspots is based on the predominant 'Climate Hazard Types' data developed by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) (figure 1), which includes five types of climate risks relevant to changes in crop suitability (e.g., drought, flood, climate variability, crop growing-season reductions, and high growing-season temperatures) and their combinations.

3.1.2. Women's exposure to climate hazards affecting food systems

In this methodology, exposure is proxied by the extent to which women farmers, compared to men farmers, are exposed to climate hazards due to their relatively heavy (labor) involvement in agriculture and/or livestock production.

Socioeconomic context and cultural norms affect women's preference for cultivating certain crops and the management practices they adopt. Doss (2002) analyzed the Ghana Living

Standards Survey (GLSS 3) to study the gender patterns of cropping in Ghana. Although there were no clear gender patterns in the crop choice (i.e., no crops were grown primarily by women), the study found that many crops were disproportionately grown by men or women depending on the ecological zone. De Brauw (2015) analyzed a panel survey in northern Mozambique and reported that women farmers were more likely to grow crops with less complicated production techniques. In Kenya, Ndiritu et al. (2014) found that women farmers are less likely to adopt minimum tillage and animal manure.

To identify areas where such gender patterns exist, nationally representative Labor Force Surveys (LFSs) are used to identify countries, and specific areas within these countries, where women provide a large share of labor in agriculture.

3.1.3. Vulnerability of women to climate hazards affecting food systems due to gender inequalities

Pre-existing barriers and constraints define the vulnerabilities of women exposed to climate hazards because they significantly limit women's capacity to mitigate and adapt to climate change (Neumayer and Plümper 2007). Such constraints relate to land rights, access to resources, rural services and financial services. Discriminatory social institutions in the form of formal laws (e.g., inheritance or marriage laws) and informal rules and practices (e.g., customary rules about resource access) set further barriers to women's equal access to resources, decision-making power, and agency. Restricted physical integrity and civil liberties of women can also form barriers. Social norms can further restrict women's decision-making power and agency.

3.1.4. Defining climate–agriculture–gender inequality hotspots

Following IPCC's climate risk framework, the climate–agriculture–gender inequality hotspots are broadly defined as the geographic areas in the global South that experience high levels of climate **hazards**, high levels of women's engagement in crop production and/or livestock rearing (**exposure**), and high levels of women's **vulnerability** due to gender inequities (figure 3).

In this paper, climate–agriculture–gender inequality hotspots are identified at two levels: national and subnational. For the national level, hotspot LMICs in the continents of Latin America, Asia and Africa are identified under warming scenario RCP 8.5 (or 'business as usual') by the year 2050 (Moss et al. 2008). The ranking of countries by hotspot score is then illustrated in a world map. For the subnational level, climate–agriculture–gender inequality hotspot areas are identified and mapped at the subnational level for a selection of hotspot countries identified in the first step.

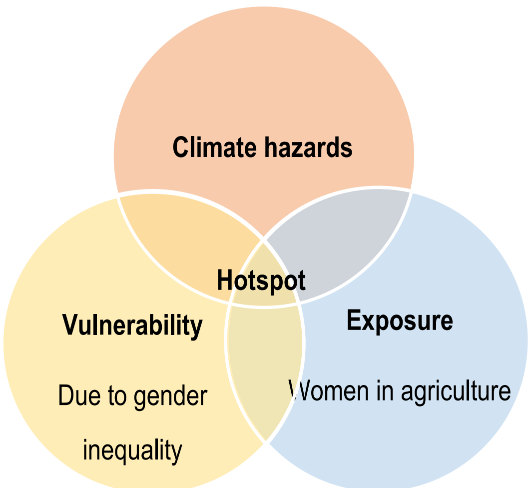


Figure 3. Components of climate–agriculture–gender inequality hotspots

3.2. Method for identifying climate–agriculture–gender inequality hotspots

The method for identifying climate–agriculture–gender inequality hotspot LMICs and for identifying subnational hotspot areas in selected hotspot countries follow the same framework and principles, but differ in the extent of detail in the data used for measuring the three components (hazards, exposure, and vulnerability). This is due to data limitations. The publicly available datasets that we use in this paper do not permit us to compute indicators of women's exposure for specific crops and livestock for all LMICs, but this is possible for subnational areas in selected countries where such detail is available in the datasets. Similarly, while we can rely on an indicator that proxies vulnerability due to gender inequalities calculated for most countries based on nationally representative data, such an indicator is not available at subnational level of LMICs. Hence, vulnerability due to gender inequalities relies on similar but slightly different proxies for the subnational hotspots.

We take a two-step approach. We first compute the climate–agriculture–gender inequality hotspot index at the national level, after which we rank LMICs based on the overall risk (i.e., the concurrence of climate hazards, women's exposure and women's vulnerability due to gender inequalities). Secondly, within hotspot countries in Africa and Asia—where rich subnationally representative data is available—we compute a subnational level climate–agriculture–gender inequality hotspot index that takes into account women's exposure in specific crop and livestock production. In this section, we first describe the indicators and data sources for the components in the national and subnational hotspot indices, after which we explain the method for computing the indices. Lastly, we describe how the climate–agriculture–gender inequality hotspots were identified.

3.2.1. Indicators of and data sources for climate hazards

At the national level to quantify the extent of location-specific hazards, the Gridded Population headcount (Tatem 2017) and the extent of urban and rural areas (EC-JRC 2019) with the geospatial data layer of climate hazards (Jarvis et al. 2021) are overlaid to estimate the rural population facing climatic hazards across LMICs on 10 kilometer grids. The grid-level data is aggregated at the country level and the first level of administrative boundaries to estimate the share of rural population facing climate hazards at the national and subnational levels, respectively.

The same indicator for climate hazards is used in the identification of climate–agriculture–gender inequality hotspots at the subnational level in hotspot countries.

Table 1 includes an overview of indicators used for the identification of climate–agriculture–gender inequality hotspots at national and subnational level: climate hazards, women's exposure to climate hazards affecting food systems, and women's vulnerability due to gender inequalities.

Table 1. Indicators used to identify climate–agriculture–gender inequality hotspots at national and subnational levels

Risk/impact component	Indicators for country-level identification of climate–agriculture–gender inequality hotspot countries	**Indicators for subnational climate–agriculture–gender inequality hotspot identification** (admin level 1)
Climate hazards	Share of rural population under projected climate risks (Jarvis et al. 2021; Tatem 2017; EC-JRC 2019), aggregated at the country level	Share of rural population under projected climate risks (Jarvis et al. 2021; Tatem 2017; EC-JRC 2019), aggregated at the subnational-level (admin-1)
Women's exposure to climate hazards in food systems	Gender participation in agriculture: share of women employed in agriculture (national figure)	Gender participation in agriculture: - six crop/category-specific indicators of the relative importance/weight (in terms of labor participation) of each crop/category in the first administrative division - six crop/category-specific indicators on the female share in labor participation in each crop/ category in the first administrative division - six crop/category-specific indicators on the share of hours worked by women (relative to men) in each crop/category
Vulnerability of women to climate hazards in food systems due to gender inequalities	Social Institutions and Gender Index 2014 which captures five dimensions of discriminatory social institutions that drive gender inequalities in social and economic outcomes, including: - discriminatory family code - restricted civil liberties - restricted resources and assets - restricted physical integrity - son bias.	Women's vulnerability due to gender inequalities at the subnational level is captured by a set of four indicators: - Subnational Gender Development Index (2019), which captures gender inequality in education, health and standard of living - prevalence of child marriage (i.e., percentage of girls aged 15–19 years ever married, divorced, widowed or in an informal union) (source: calculated from the 2018 LFS of Mali (INSTAT 2019), Pakistan and Zambia (ZSA 2019) and the 2013 LFS of Bangladesh (IFPRI 2016)) - prevalence of domestic violence (i.e., percentage of ever-partnered women who ever suffered intimate partner physical and/or sexual violence and/or women aged 15–49 who ever experienced physical/domestic violence since age 15 in their lifetime) (source: calculated from the Demographic and Health Survey (DHS) for Mali (INSTAT 2009), Pakistan and Zambia (2018); calculated from the Integrated Household Survey for Bangladesh (2015)) - missing women (son bias) (i.e., ratio male children per female children among 0–4 year olds) (source: computed from 2010 census for Zambia (Zambia Central Statistical Office 2010), 2009 census for Mali, 2011 for Bangladesh (BBS 2011), and 2017 census for Pakistan).

3.2.2. Indicators of and data sources for women's exposure to climate hazards

At the national level, women's exposure to climate hazards affecting food systems is identified by women's relative participation in agricultural employment[2] —that is, the share of female agricultural workers of the total (i.e., female and male) agricultural workers. Data for this indicator is obtained from the latest nationally representative and comparable LFS dataset, which estimates the labor force participation in different activities and sectors in 2019, retrieved from the World Development Indicators database (The World Bank 2021)[3] .

As mentioned earlier, the approach to measure exposure at the subnational level is different than at the country level due to data limitations. To measure women's exposure to climate hazards at the subnational level for the first level of administrative division, a crop/category-specific index of women's exposure to climate hazards is constructed by combining (a) the relative importance of each of the six crop/categories listed in the LFS datasets measured by overall labor participation, regardless of sex; (b) the crop/category-specific women's share of labor participation; and (c) the crop/category-specific share of hours worked by women (relative to men) (table 1). The six crop/categories are: (i) cereals, leguminous crops and oilseeds; (ii) rice; (iii) vegetables, melons, roots and tubers; (iv) perennial crops; (v) livestock; and (vi) mixed farming.

The crop/category-specific women's exposure layer is thus a combination of relative importance (i.e., overall labor participation), share of female labor participation, and share of hours worked by women. This way, the crop/category-specific women's exposure captures the overall weight of that crop/category in the local economy, as well as the relative contribution of women both in terms of participation as well as intensity of effort.

3.2.3. Indicators of and data sources for women's vulnerability due to gender inequalities

At the national level, vulnerability of women to climate hazards due to gender inequalities is proxied by the Social Institutions and Gender Index (SIGI) developed by the Organisation for Economic Co-operation and Development (OECD) Development Centre (OECD 2014) (table 1).[4] While several data sources capture specific elements of gender inequalities, we opted for SIGI because it captures a range of gender-inequality elements relevant for women's capabilities to mitigate and adapt to climate-change effects. The SIGI 2014 measures discriminatory social institutions that restrict women's access to opportunities, resources and power; and act as drivers of gender inequalities in economic and social outcomes (OECD 2014). It distinguishes five broad dimensions of discriminatory social institutions, including

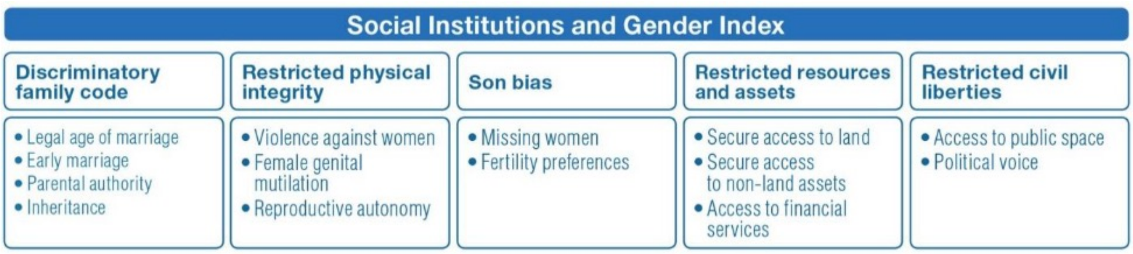


Figure 4. Composition of the Social Institutions and Gender Index 2014 (OECD 2014)

---

2 Definition of employment is based on individual-level information about being involved in agriculture for at least one hour during the week before the interview (see Nico and Azzarri (2021) for a discussion of the implications of this definition).

3 The exact values of the indicator values may differ depending on how the share of female agricultural workers is defined in the dataset used.

4 The SIGI 2019 has missing data for a number of countries and was therefore less suitable than the SIGI 2014 for this exercise, because the principal component analysis is sensitive to missing data.

discriminatory family code, restricted physical integrity, son bias, restricted resources and assets, and restricted civil liberties (figure 4). The dimensions capture existing gaps between women and men in rights and opportunities as reflected in legislation, practices and attitudes at formal and informal systemic levels as underlying factors leading to unequal outcomes for women and men. It measures each of these dimensions with a number of indicators, selected on the basis of their conceptual relevance, addition of new information, statistical association within the social institutions dimensions, data quality, reliability and coverage.

To capture women's vulnerability due to gender inequalities at the subnational level, another set of indicators are identified—as the SIGI 2014 used for identifying national-level hotspots is not available at the subnational level. At the subnational level, the set of indicators includes the Subnational Gender Development Index representative at the first level of administrative division for most countries across the globe (table 1). Additionally, it includes sub-indicators from the SIGI 2014 that can be constructed using publicly available data representative at the first level of administrative division for the selected hotspot countries.[5] These sub-indicators include prevalence of child marriage, prevalence of lifetime physical and/or sexual violence for ever-married women, and the ratio of male/female children between zero and four years old as an indicator of missing women.

The Subnational Gender Development Index measures the gender gap in human development achievements by the disparity between women and men in three basic dimensions of human development, including education (mean years of schooling of adults aged 25 and above), health (life expectancy at birth) and standard of living (gross national income per capita) (GDL 2020b).[6] The data for the four focus hotspot countries identified—namely Mali, Zambia, Pakistan and Bangladesh (see section 4.2)—was extracted from the Subnational Gender Development Index database for the year 2019 (GDL 2020a).[7]

The second indicator is the prevalence of child marriage among girls aged 15–19 years that reflects the SIGI 2014 dimension of discriminatory family code. The indicator capturing the prevalence of child marriage is calculated using the 2018 LFSs of Mali, Zambia and Pakistan (PBS 2017); and the 2013 LFS of Bangladesh.[8]

The third indicator is the prevalence of lifetime physical and/or sexual violence for ever-married women that reflects the SIGI 2014 dimension of restricted physical integrity. For Mali, Zambia and Pakistan this indicator is extracted from the 2018 demographic and health surveys; for Bangladesh it is calculated using the 2015 Integrated Household Survey.

5 The SIGI 2014 captures restricted resources and assets, however, we could not include such a proxy given the lack of sex-disaggregated data of land access in publicly available datasets representative at the first level of administrative division. The SIGI 2014 also considers formal and informal laws, social norms and practices that exist in different types of legal systems including civil or common law, customary law, and religious laws and defines different dimensions of gender discrimination. These are not captured in our subnational level indicators of women's vulnerability due to gender inequalities because it is unlikely that formal laws vary across subnational regions in countries. Informal laws, social norms and practices may be more likely to differ across subnational regions, yet data (specific for each of the first level administrative divisions of the countries) is not readily available and collection of such data falls out of the scope of this study.

6 More specifically, the SGDI is calculated by dividing the women-specific Subnational Human Development Index (i.e., based on data on education, health and standard of living specific for women) by the men-specific Subnational Human Development Index. A SGDI value below one indicates gender inequality to the disadvantage of women, values above one indicate the disadvantage of men, and a value of one indicates gender parity (see https://globaldatalab.org/shdi/about/)

7 See https://globaldatalab.org/shdi/sgdiBGD+MLI+PAK+ZMB/?levels=1%2B4&interpolation=1&extrapolation=0&nearest_real=0&colour_scales=global

8 The LFS used for Mali (EMOP 2017–18) can be downloaded from: https://demostaf.web.ined.fr/index.php/catalog/328 ; the 2018 LFS for Zambia can be downloaded from: https://www.zamstats.gov.zm/nada ; the 2017-18 LFS for Pakistan can be downloaded from: https://www.pbs.gov.pk/content/data-information-request-form . The 2013 Bangladesh National Child Labour Survey can be downloaded from https://www.ilo.org/ipecinfo/product/viewProduct.do?productId=28157 .

The fourth indicator is the ratio of male/female children between zero and four years old, which is a measure of missing women, and reflects the SIGI 2014 dimension of son bias. National census data of each of the focus hotspot countries is used to construct this indicator (2010 census for Zambia, 2009 census for Mali, 2011 census for Bangladesh, and 2017 census for Pakistan).

3.2.4. Defining, ranking and mapping by climate–agriculture–gender inequality hotspot scores

We use Principal Component Analysis (PCA), which is a statistical technique for data reduction, to calculate a climate–agriculture–gender inequality hotspot ranking index at the national level for LMICs in the continents of Latin America, Asia and Africa. Given that the hazard, exposure and gender-inequality driven vulnerability indicators for national-level hotspots are expressed in different metrics and measure different characteristics of risk (figure 2), they are combined in an ordinal index using PCA. PCA constructs a series of uncorrelated linear combinations of the variables that contain most of the variance (principal components). This reduces the dimensionality of the variables without imposing arbitrary weights, but allows the data to identify the linear combinations of the components that explain the greatest share of the variation in risk (as derived from the interaction of hazard, exposure and gender-inequality driven vulnerability). Subsequently, an index value of overall risk is calculated for each country using the estimated coefficients of the first principal component as weights.[9] Hence, this index of risk—i.e., the climate–agriculture–gender inequality hotspot index—is based on the hazard, exposure, and vulnerability due to gender inequality indicators.

As the risk index is standardized, it provides a ranking of countries reflecting their relative cross-country standing in terms of concurrent climate hazards, women's exposure, and women's vulnerability due to gender inequalities. The index is then illustrated on a global map.

The climate–agriculture–gender inequality hotspot index at subnational level is based on (1) the climate hazards indicator, (2) six crop/category-specific indicators of the relative importance (in terms of labor participation) of each crop/category in the subnational area (first administrative division), (3) six crop/category-specific indicators of the female share in labor participation in each crop/category, (4) six crop/category-specific indicators of the share of hours worked by women (relative to men) in each crop/category, and (5) a composite index for vulnerability due to gender inequalities.

As subnational women's exposure to climate hazards layer is proxied by a set of sub-indicators measuring crop/category-specific exposure (relative importance of crop/category, female share of labor participation per crop/category, and female labor intensity), the correlation among all exposure indicators is first analyzed to check eventual complementarity in cultivating specific crops/categories.[10]

The subnational indicator for women's vulnerability due to gender inequalities is a composite index statistically representative at the first level of administrative division that is constructed using PCA. It is based on the following four indicators: (a) Subnational Gender Development Index (2019); (b) prevalence of domestic violence (percentage of ever-partnered women who ever suffered intimate partner physical and/or sexual violence, or women aged 15–49 who have ever experienced physical/domestic violence since age 15 or in their lifetime); (c) prevalence of child marriage (percentage of girls aged 15–19 years ever married, divorced,

---

9 This index is constructed using factor analysis (principal-component factor method) based on the predicted value of the first factor in the principal component based on the variables included. Weights assigned to each variable in the index are obtained according to the methodology proposed by Filmer and Pritchett (2001).

10 A positive correlation is observed between growing cereals and vegetables, and a negative correlation between being involved in rice and in mixed farming systems (where the main characteristics are growing crops and livestock). This finding suggests that cereal and vegetable production are complementary, while there is some degree of ability to substitute between rice cultivation and mixed farming systems. When female farmers are considered, no specific correlation patterns are observed, which guarantee unbiased results when including these dimensions in the subsequent PCA framework to compute the composite risk index.

widowed or in an informal union); and (d) missing women (ratio of male/female children among zero to four year olds: number of men per 100 women).

Subsequently, six crop/category-specific risk indices (i.e., climate–agriculture–gender inequality hotspot indices) at the subnational level in four selected hotspot countries were constructed using PCA, based on the climate hazards indicator, the three sub-indicators defining women's crop/category-specific exposure to climate hazards (relative importance, female share of labor participation, and female labor intensity per crop/category) and the composite index for vulnerability due to gender inequalities.[11] (The components and their associated weights in the six PCA-based crop/category-specific climate–agriculture–gender inequality hotspot indices are available in annex A.)

The index values of each of the six crop/category-specific climate–agriculture–gender inequality hotspot (risk) indices are relative to all subnational areas across the four focus countries included in the PCA. Then, for each of the six crops/categories, subnational areas within each country can be ranked based on the crop/category-specific climate–agriculture–gender inequality hotspot index values. This allows us to identify relative crop/category-specific hotspot or cold-spot subnational areas in each of the focus countries we investigated.

3.2.5. Identifying climate–agriculture–gender inequality hotspots

In this paper, the identification of focus hotspot countries for fine-tuned climate–agriculture–gender inequality hotspot mapping at the subnational level is based on two criteria. The first criterion is the overall hotspot index value. The second criterion is the availability of secondary data representative at a subnational, first level of administrative division to construct subnational hotspot scores reflecting climate hazards, women's exposure to climate hazards, and women's vulnerability due to gender inequalities.

The identification of subnational climate–agriculture–gender inequality hotspot areas in the selected focus hotspot countries can be based on different criteria. An obvious first criterion to identify a crop/category-specific subnational hotspot area is a relatively high hotspot index value for a particular crop or category. To illustrate the methodology, in this paper we use this criterion for identifying a crop/category-specific subnational hotspot area in each of this paper's focus hotspot countries.

Another way of identifying a subnational hotspot area within a country could be based on a relatively 'hot' area for multiple crops and categories (i.e., an area with high risk for the most crops/categories compared to other areas in the same country). A possible criterion for identifying such a subnational hotspot area is the highest number of highest rankings of crop/category-specific index values. Alternatively, depending on the focus of a policy, project or study, it may be relevant to identify a subnational hotspot area for a particular set of crops or categories—e.g., cereals, rice, vegetables, perennials, livestock, or mixed farming. In such a case, the criterion for identifying a subnational hotspot area could be ranking highest in the index value(s) for that specific set of crops or categories. Otherwise the policy, project or research objectives may require a comparison between the climate–agriculture–gender inequality riskiness of subnational areas with different types of key livelihoods (e.g., maize- and livestock-based versus cassava-based livelihoods), or subnational areas with different kinds of climate hazards (e.g., droughts versus floods).

Data availability, feasibility of primary data collection for in-depth research, or feasibility of implementing interventions could necessitate 'zooming in' on particular climate–agriculture–gender inequality hotspot subnational areas that do not necessarily rank highest.

---

11 An overall index was also computed combining the 20 variables reported above (the hazard index; the 18 crop/category-specific exposure variables; and, finally, the vulnerability index), although it was not used in the final analysis. This was because of the concern that different crop/categories are impacted by climatic risks differently, so they need to be treated separately.

4. Results

This section presents results of how we applied the climate–agriculture–gender inequality hotspot methodology. The results illustrate the methodology. They will also inform subsequent research in subnational areas identified as hotspots within African and Asian hotspot countries.

4.1. Global ranking and mapping of hotspot LMICs using national-level data

The first result of the methodology is a global ranking of 87 LMICs in the continents of Latin America, Asia and Africa by climate–agriculture–gender inequality hotspot score, using national-level data (annex B). The ranking is illustrated on a global map (figure 5). Darker orange-colored countries are 'hotter' as they have a relatively high climate–agriculture–gender inequality hotspot index value. Darker blue-colored countries have relatively low climate–agriculture–gender inequality hotspot index values; therefore are 'colder'.

The global climate–agriculture–gender inequality hotspot map of LMICs clearly shows that significant climate hazards, women's significant exposure to climate hazards affecting food systems, and women's increased vulnerability due to gender inequalities occur particularly in West, Central and East Africa; in West and South Asia; and in a few countries in Southeast Asia. The 'hottest' countries (global rank 1 to 15) are all situated in Africa.

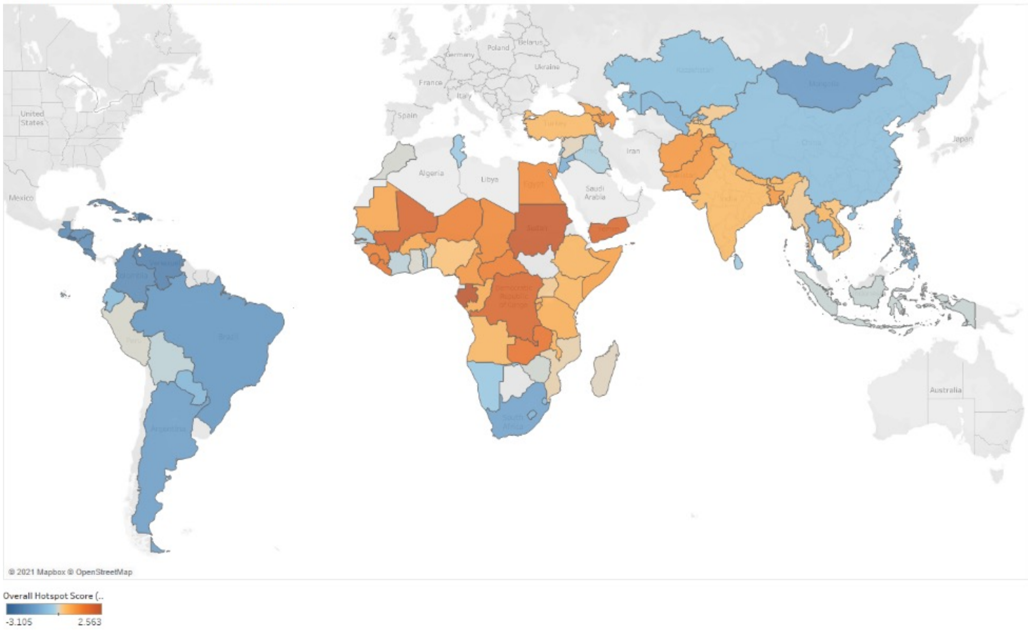


Figure 5. Climate–agriculture–gender inequality hotspot LMICs across the globe

Note: Darker orange-colored countries are 'hotter' as they have a relatively high climate–agriculture–gender inequality hotspot index value. Darker blue-colored countries have relatively low climate–agriculture–gender inequality hotspot index values; therefore are 'colder'. LMICs with a light gray color have not been ranked due to data limitations.

In this paper, two African and two Asian countries were selected as focus countries for climate–agriculture–gender inequality hotspot mapping at the subnational level, based on their ranking by the overall climate–agriculture–gender inequality hotspot index value and subnational indicator data availability. The two countries in Africa are Mali, ranked the fourth-hottest LMIC country globally, and Zambia, the seventh-hottest LMIC country. The two countries in (South) Asia are Pakistan and Bangladesh. These are the first two Asian countries in the global hotspot ranking, ranked 16 and 17 respectively (table 2).

Table 2. Ranking and scores of focus hotspot countries in Asia and Africa selected for subnational climate–agriculture–gender inequality hotspot mapping

Ranking	Country	Index values of the components of risk			
		Overall risk: Climate–agriculture–gender inequality hotspot index values (the higher, the 'hotter')	Share of total rural population under climate hazard in 2050 (CCAFS)	Share of adult female agricultural labor in 2019 (ILO 2021)	Social Institutions and Gender Index in 2014 (OECD)
4	Mali	2.028	0.192	0.501	0.516
7	Zambia	1.639	0.381	0.548	0.449
16	Pakistan	1.029	0.749	0.687	0.301
17	Bangladesh	1.026	0.909	0.656	0.390

Mali, a country of the Sahel region, is majorly dependent on agriculture, as the sector contributes 37 percent to its the national gross domestic product and is a source of income for more than 65 percent of its population. Increasingly variable and unpredictable rainfall, and droughts and floods have often led to crop failures and food shortages in the country. Women constitute half of the sector's labor force, and are more likely to engage in income-generating activities in the sector. However, they have less control over agricultural and household assets (especially land) and have limited representation in decision-making spheres (encouraged by restrictive customary laws) (CIAT et al. 2021).

Similarly, Zambia employs almost 50 percent of its economically active population in agriculture, and its smallholder farmers are majorly reliant on a few staple crops (especially maize). Climate risks such as drought and dry spells, seasonal and flash floods, extreme temperatures, and changes in season onset and cessation—combined with relatively low yields, high deforestation rates and localized land degradation—make the country's food security very vulnerable. This is especially the case for its women farmers, who constitute a major proportion of agricultural labor force (CIAT and World Bank 2017c).

Agriculture in Bangladesh contributes 16.5 percent to the national gross domestic product; 87 percent of its rural households use it as (at least one) source of livelihood. Climate risks, including sea-level rise and saltwater intrusion, mean temperature increases significantly affect agricultural yields. Women constitute the majority of the agricultural labor force, as highlighted by the analysis in table 2. However, gender gaps limit their empowerment via lack of decision-making power and control over productive resources and income (CIAT and World Bank 2017a).

Agriculture in Pakistan, contributing 23 percent to its gross domestic product, is already severely affected by a range of climate risks: from droughts and floods in the Punjab province, to extreme temperatures in the Sindh province. Women contribute to livestock management as well as crop production—but have limited access to technologies and income-generating assets due to weak extension systems, illiteracy and lack of legal ownership of land (CIAT and World Bank 2017b; Wilderspin et al. 2019).

4.2. Ranking and mapping hotspots at the subnational level in selected hotspot LMICs

In this section, we map the ranking of subnational areas in Zambia, Mali, Bangladesh and Pakistan by crop/category-specific climate–agriculture–gender inequality hotspot index values. Note that while the crop/category-specific climate–agriculture–gender inequality hotspot index values are relative to all subnational administrative areas in all four focus countries (annex C), the maps of subnational areas per country reflect within-country ranking. The maps use a similar color coding where darker orange-colored subnational areas indicate these are relatively 'hot' for a specific crop/category (i.e., have a relatively high crop/category-specific climate–agriculture–gender inequality index value) compared to other subnational areas in that country. Subnational areas with darker blue-color are 'colder' for that specific crop/category.[12] As mentioned earlier, in this paper, as an illustration, we identify one crop/category-specific climate–agriculture–gender inequality subnational hotspot area per focus country, and include a brief discussion of evidence that contextualizes the respective subnational area as a hotspot for that specific crop/category.

4.2.1. Zambia

The maps showing crop/category-specific subnational hotspot areas inequality in Zambia reveal that Luapula Province is a hotspot for perennial crops, compared to other provinces in Zambia (figure 6; annex C for details). The identification of Luapula as a hotspot area for perennials crops in Zambia resonates with empirical data. In terms of climate hazards, there is evidence that Luapula Province witnesses heavy annual rainfalls. This helps the growing season, which is mostly rain-fed, but makes the area prone to flooding between January to April (USAID 2014). Farming is a key livelihood option in Luapula, followed by fishing. The perennial crop cassava is grown extensively in the province, and the crop's poor nutritional value is somewhat compensated by its ability to survive in very poor soils (Curran et al. 2009; White et al. 2015). Cassava is widely consumed and is the second most important staple food in the province. Its contribution to the province's food security is acknowledged (Poole 2010). Cassava is commonly labeled as 'a woman's crop'. Women are also more likely than men to control cassava processing and use at the household level. In Samfya and Mansa districts of Luapula province, for instance, men are involved in less than 10 percent of cassava-processing activities (Alamu et al. 2019). Cassava processing into flour for preparation of a meal is done with rudimentary, technically inefficient tools such as mortars and drums, and is time-consuming (Alamu et al. 2019).

Overall, Zambia experiences high levels of gender inequalities in multiple domains, and the Gender Inequality Index points to an increasing gender inequalities between 2017 and 2018. This was linked to rising inequalities in women participating in the labor market, in parliament, in secondary and higher education; and increasing birth rates in adolescence (GIZ 2021). Luapula province is marked by low levels of women's empowerment and the highest fertility rate in the country. It has the highest percentage of women in the country facing challenges in accessing their basic needs. The literacy levels of women are low. Luapula has the highest absolute gender gap in primary school enrolment (at the disadvantage of girls) of all provinces in 2018, despite an improvement compared to 2017. However, more girls are enrolled than boys in secondary schools (FAO 2018; GRZ 2021).

---

12 Although survey data are assumed to be representative at the first level of administrative division, the number of observations was insufficient to derive reliable statistics for some crop/categories in some countries—for example, rice in Zambia (48 observations), vegetables and melons, roots, and tubers in Mali (3 observations), perennial crops in Pakistan (7 observations), and mixed farming in Bangladesh (21 observations). Therefore, the associated maps were left out here due to the lack of reliable statistics, because of small sample size.

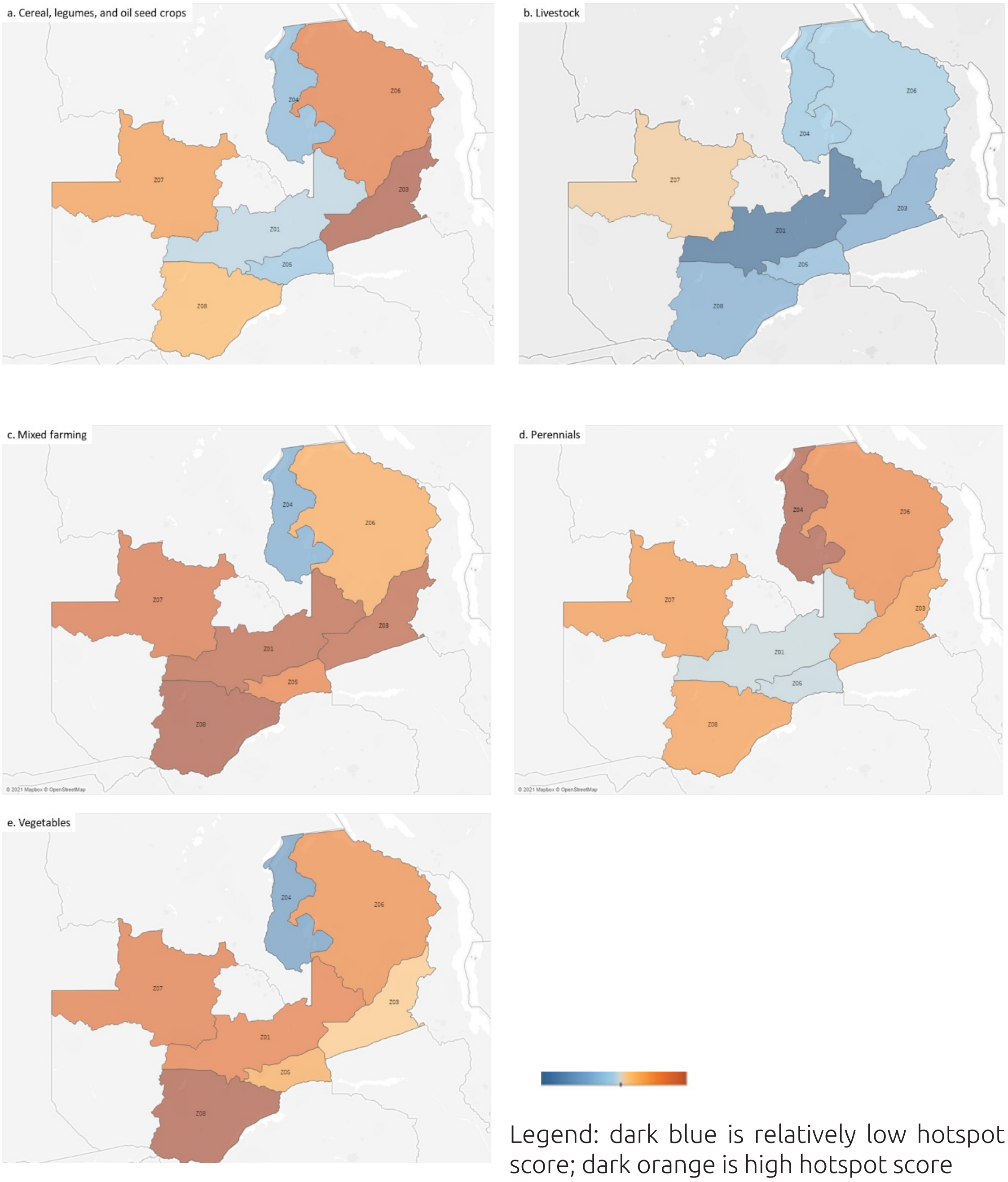


Figure 6. Crop/category-specific climate–agriculture–gender inequality hotspot maps at the subnational level in Zambia

Names of the provinces are Z01: Central; Z02: Copperbelt; Z03: Eastern; Z04: Luapula; Z05: Lusaka; Z06: Northern; Z07: North-Western; Z08: Southern; Z09: Western.

4.2.2. Mali

The subnational climate–agriculture–gender inequality hotspot mapping reveals the Tombouctou Region in the northern part of Mali as a hotspot for livestock (figure 7; annex C for details), suggesting that women livestock-keepers are experiencing high climate-change risk.

Empirical evidence corroborates the Tombouctou region being identified as a hotspot region in Mali. While the rural economy of Mali is dominated by rain-fed and subsistence agricultural production, and livestock rearing (FAO 2017); the northern part of the country, where Tombouctou region is located, is centered around a pastoralist livestock economy (Djoudi and Brockhaus 2011). Throughout the Sahel—including in Mali—climate change has made a pastoral livelihood strategy difficult, because access to water and foraging resources has greatly contracted due to increasingly warm and dry weather patterns, and extended dry periods (McOmber 2020; Segnon et al. 2021).

Pastoralist livelihoods in the Sahel have gendered roles and responsibilities. Women are less likely to control cattle than men, but more likely to control small livestock. Nevertheless, women contribute labor for both types of livestock. For instance, women tend to be responsible for milking and dairy processing. Few women own agricultural land, and most have restricted access not only to land but other productive resources. Heavy productive and reproductive work burdens, in addition to other structural and logistic barriers, constrain women's access to livestock extension and information about raising new breeds of livestock more resistant to ecological changes (McOmber 2020).

While differences exist by community and class, women in Toumbouctou are subject to restrictive norms and roles hindering their access to resources, extension and information, their options for diversifying livelihoods, and their mobility; as well as burdening them with heavy reproductive and productive workloads (Djoudi and Brockhaus 2011). The region has been seriously affected by conflict—driving outmigration—often in gendered patterns as women has less access than men to financial assets and transportation, or face mobility restrictions (McOmber 2020). As a result of male outmigration, women's tasks now also include traditionally male activities (SPRING 2016; Djoudi and Brockhaus 2011).

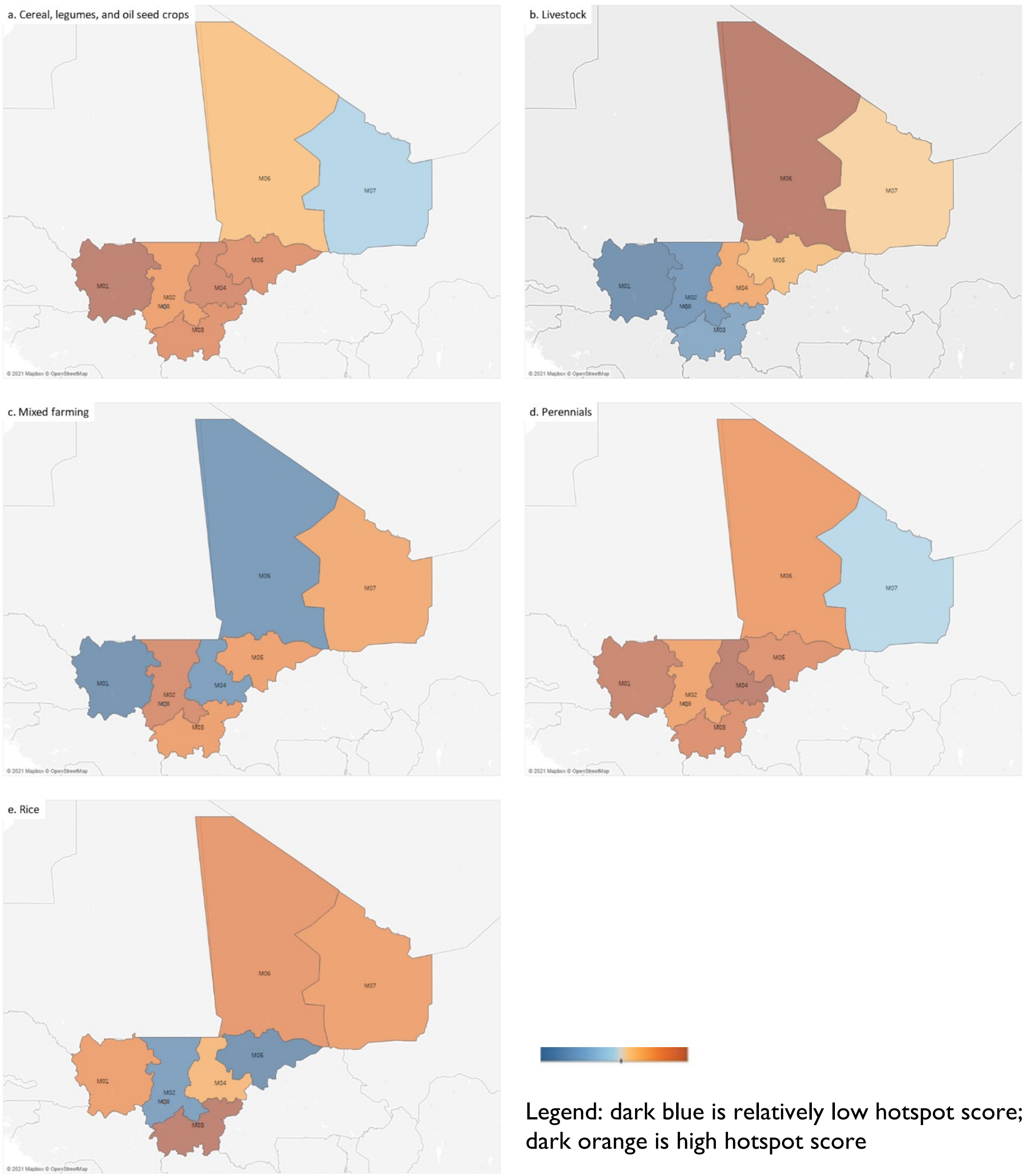


Figure 7. Crop/category-specific climate–agriculture–gender inequality hotspot maps at the subnational level in Mali

Names of the regions are M01: Kayes; M02: Koulikoro; M03: Sikasso; M04: Segou; M05: Mopti; M06: Tombouctou; M07: Gao and Kidal; M08: Bamako.

4.2.3. Bangladesh

Based on the crop/category-specific climate–agriculture–gender inequality hotspot mapping, we can identify the Kishoreganj-Mymensingh-Netrokona districts (the first in the Dhaka Division, the others in the Mymensingh Division) (B11 in figure 8; annex C for details) as a hotspot for rice. Overall, Bangladesh faces multiple climate hazards, including frequent flooding, droughts, cyclones and rising salinity (Ferdushi et al. 2019; Ahmed and Eklund 2021). In the Kishoreganj-Mymensingh-Netrakona districts, where substantial areas are characterized by wetland ecosystems (called 'haor') (CEGIS 2012), the occurrence of flash floods before the harvesting season affects crop output and causes severe livelihood losses to the farmers (Sharmin and Islam 2013; GOB 2018; Rahaman et al. 2019; Hoq et al. 2021). Siltation and sedimentation of major rivers, as well as riverbank erosion, are other challenges in this region (CEGIS 2012).

Rice—and more particularly Boro rice—which is grown in waterlogged, low-lying or medium-elevation lands using irrigation, is sown in winter and harvested in spring. It is the major crop cultivated in this region (Singh 2002; Hoq et al. 2021). Women in northern Bangladesh typically have a substantial role in rice farming and are increasingly involved in farm management. Yet, women's role and contributions are not always acknowledged by their male counterparts (Rahman et al. 2020). And while women and men daily spend similar amounts of time working in Bangladesh, women spend 86 percent of their working time engaged in unpaid domestic activities—and men only 25 percent (Seymour and Floro 2016).

In addition in Bangladesh, patriarchal gender norms restrict women's access to resources, their mobility, and decision-making power in their households (including about rice production)—although such normative restrictions may vary by women's level of education, household wealth and NGO membership (Rahman et al. 2020). Studies found that women had a lower adaptive capacity to climate shocks than did men because they faced limited choices for livelihood diversification in North-Western Bangladesh (Tanny et al. 2017, Naz and Saqib 2021). In wetland areas, such as the Kishoreganj-Mymensingh-Netrakona districts, women's mobility restrictions hinder them to access to timely warnings about floods and other information that would enable them to mitigate or adapt to the climate adversities (Rahman and Haider 2020). Women's work burdens increase, not only in times of acute crises but also because of soil and riverbank erosion, which necessitates moving fields. Male migration in response to climate challenges leaves women with increased productive and domestic workloads.

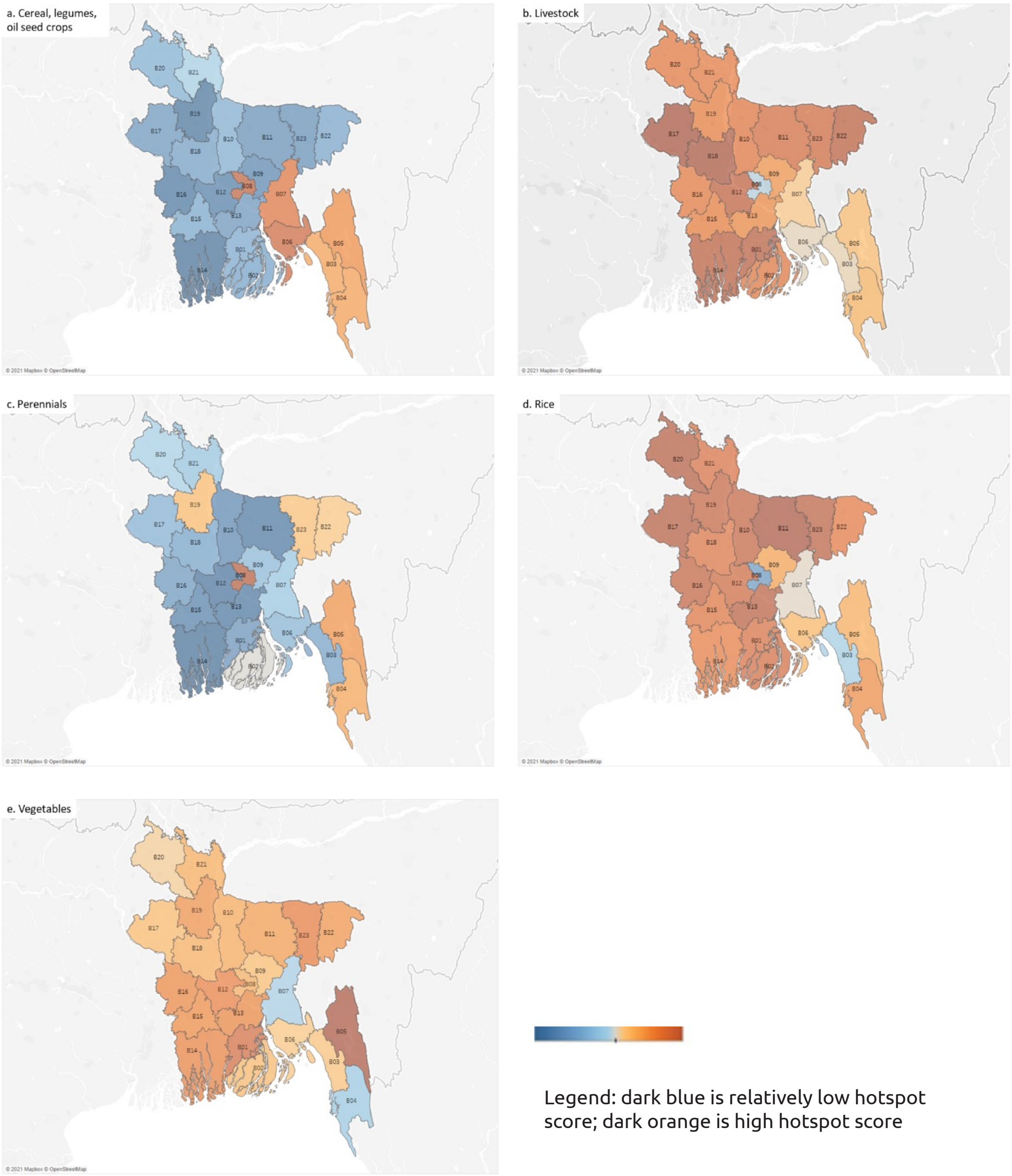


Figure 8. Crop/category-specific climate–agriculture–gender inequality hotspot maps at the subnational level in Bangladesh

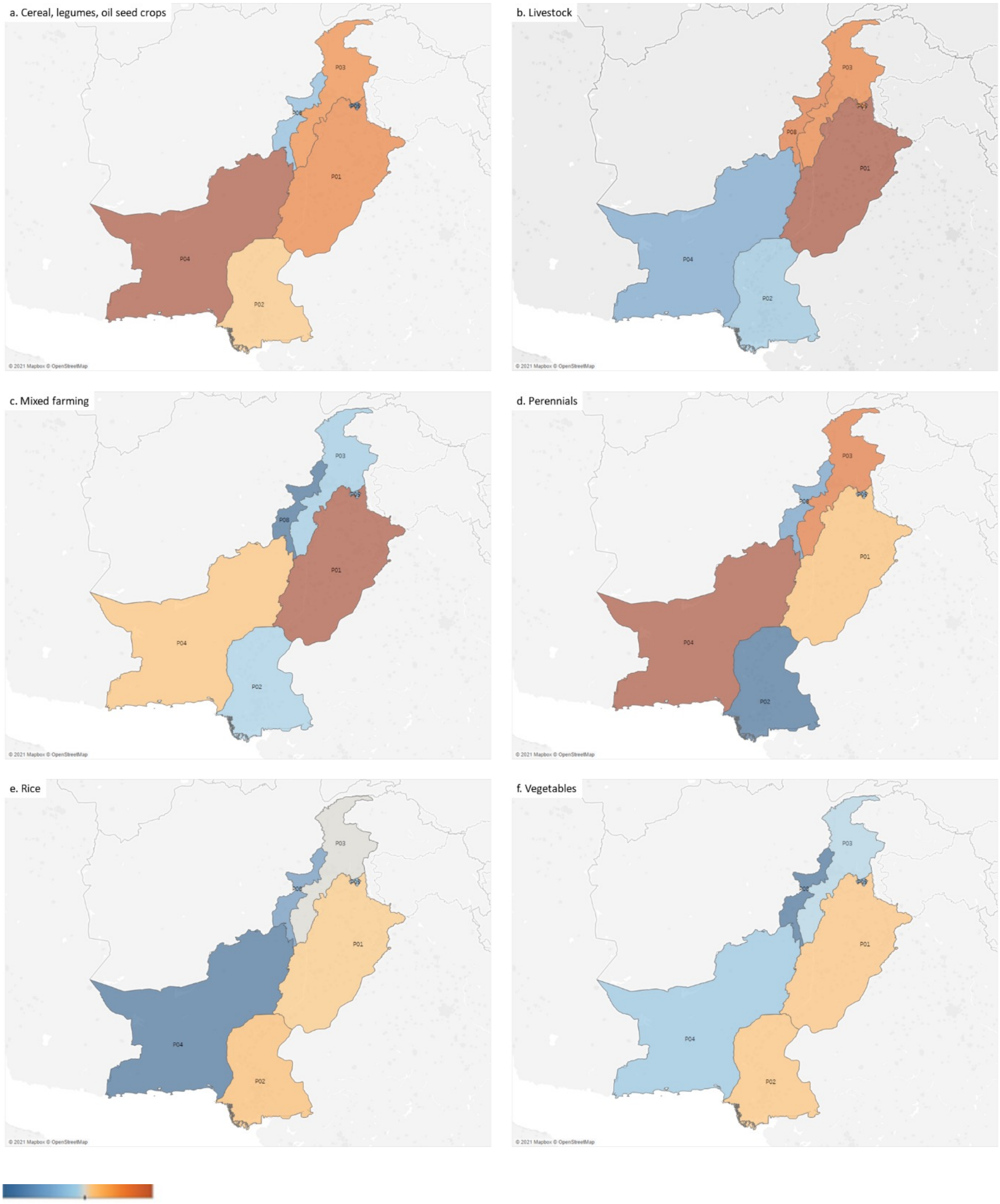
Name of the district groups are B01: Barisal–Jhalokati–Pirojpur; B02: Barguna–Bhola–Patuakhali; B03: Chittagong; B04: Bandarban–Cox's Bazar; B05: Khagrachhari–Rangamati (Chattagram); B06: Feni–Lakshmipur–Noakhali; B07: Brahmanbaria–Chandpur–Comilla; B08: Dhaka; B09: Gazipur–Narayanganj–Narsingdi; B10: Jamalpur–Sherpur–Tangail; B11: Kishoreganj–Mymensingh–Netrakona; B12: Faridpur–Manikganj–Rajbari; B13: Gopalganj–Madaripur–Munshiganj–Shariatpur; B14: Bagerhat–Khulna–Satkhira; B15: Jessore–Magura–Narail; B16: Chuadanga–Jhenaidah–Kushtia–Meherpur; B17: Naogaon–Nawabganj–Rajshahi; B18: Natore–Pabna–Sirajganj; B19: Bogra–Gaibandha–Jaypurhat; B20: Dinajpur–Nilphamari–Panchagarh–Thakurgaon; B21: Kurigram–Lalmonirhat–Rangpur; B22: Maulvibazar–Sylhet; B23: Habiganj–Sunamganj.

4.2.4. Pakistan

In Pakistan, the Balochistan Province emerges as a climate–agriculture–gender inequality hotspot region for cereals (figure 9; annex C for details).

Balochistan is a poor, rural and water-scarce province. Climatic conditions are arid, ranging from dry to hyper-arid. Only 2 percent of Balochistan is cultivated at any time due to the scarcity of water. Drought is a recurring feature of the province, and people are heavily dependent on the monsoon for irrigation (Rafiq and Blaschke 2012; FAO 2015). The main cereal crops grown in the province include wheat (except in Gwadar), millet (mainly in Dera Bugti and Gwadar) and maize (mainly in Dera Bugti, Khuzdar, Kharan, Lasbela and Panjgur) (IPC 2021). In Balochistan, women have a high participation rate in agriculture—they are solely responsible for weeding, seed cleaning and storing crops, which are all manual, labor-intensive activities (FAO 2015). Demographic and health survey data confirms that 99.5 percent of women in rural Balochistan do not own land (NIPS 2019). Women work and produce on land mostly owned by men who enjoy the economic fruits of the labor by selling the harvest in the market.

Other factors that limit women's empowerment include lack of access to credit, gender bias in transfer of new technologies and required training, and lack of access to education. A study conducted in the Jaffarabad District of Balochistan illustrates how male dominance, sociocultural notions and traditions, limited land access, and time poverty constrain women's knowledge of and access to agricultural extension services (Baloch 2015). The patriarchal ideology in Balochistan, which is characterized as a 'tribal' district, is maintained through people, cultural practices and discourses which overtly assert idealized notions of masculinity and honor (Drucza and Peveri 2018). This ideology excludes women from decision-making in their households and reinforces economic subordination of women in the province (Baloch 2015; FAO 2015) and constrains their empowerment.



Legend: dark blue is relatively low hotspot score; dark orange is high hotspot score

Figure 9. Crop/category-specific climate–agriculture–gender inequality hotspot maps at the subnational level in Pakistan

Names of the regions are P01: Punjab; P02: Sindh; P03: Khyber Pakhtunkhwa (NW Frontier); P04: Balochistan; P05: Islamabad (ICT); P06: Gilgit Baltistan; P07: AJK; P08: FATA.

5. Conclusion

There is growing recognition and increasing evidence that, in some contexts, women in agriculture and food systems are more vulnerable to the adverse impacts of climate change than men. Structural inequalities in society can exacerbate these negative impacts by limiting women's adaptive capacity. The methodology proposed and applied in this study highlights areas where a combination of factors related to climate-change hazards, women's exposure to those impacts, and social conditions that disadvantage women can be considered climate–agriculture–gender inequality hotspots.

Climate hazards, women's exposure to climate hazards, and women's vulnerability due to gender inequalities influence the climate-change risks that women are facing; and each of these elements differs by context. The types of climate hazards are influenced by geography, topography and climatic and agro-ecological conditions; among other factors. Women's exposure to climate hazards depends on the extent to which women are involved in specific agricultural livelihood activities and the vulnerability of these activities to climate hazards. Women's vulnerability depends on prevailing formal and informal gender inequalities at systemic and individual levels including constraints to women's agency, gendered social norms, access to and control over resources, and policies and governance (Njuki et al. 2021). Additionally, these different elements (i.e., climate hazards, women's exposure to climate hazards, and women's vulnerability due to gender inequalities) overlap each other in complex ways specific to the location and context.

The development of a climate–agriculture–gender inequality hotspot mapping methodology aids the identification of high-risk countries and subnational areas where these vulnerabilities most acutely converge. The climate–agriculture–gender inequality hotspot LMICs and subnational areas in the four selected focus hotspot countries—Mali, Zambia, Bangladesh and Pakistan—identified through this methodology are therefore areas where a high number of women in agriculture are exposed to and impacted by physical and biological changes in climate, and are particularly vulnerable to such changes due to prevailing gender inequalities.

Hotspot mapping has various uses. First, it can contribute to risk management by identifying regions for either mitigating the risks of climate change or developing adaptation assistance by allocating scarce resources to populations at highest risk (de Sherbinin 2014). Second, it can provide important contextual information for projects or research that aim to address issues at the nexus of climate change, gender, agriculture and food systems. The indicators used for hotspot mapping can support identifying the various local challenge(s) the population faces within identified national boundaries. Other possible uses include cross-country or cross-regional comparisons; tracking changes over time in climate–agriculture–gender inequality hotspot rankings; or even correlations of hotspot rankings with changes in gender, climate and/or agricultural policies over longer-term periods. The climate–agriculture–gender inequality hotspot mapping holds the potential to underpin decision-making and can guide investments in mitigation or adaptation assistance.

The ranking and mapping of climate–agriculture–gender inequality hotspot LMICs, as well as the subnational gender inequality–climate hotspot ranking and mapping in the focus hotspot countries, documented in this paper fits into a larger research project. That project aims to identify which aspects from a gender transformative food-systems framework at which points in food systems—that is, norms and masculinity; women's leadership; structures, policies and institutions; access and control over resource and income—can trigger the transformations needed to optimize gender equality and food-system outcomes in contexts with high climate-change risks for women. It also aims to test the effectiveness of diverse sets of interventions which can influence one or many of these dimensions for transformative, equitable, and more climate resilient food systems for women and their families in these climate–agriculture–gender inequality hotspot settings.

The hotspot mapping methodology could be fine-tuned further with the inclusion of additional variables for women's exposure to climate hazards beyond agriculture and livestock production; and for women's vulnerability due to gender inequalities by including measures of inequalities in access to finance and technology, information, education, time poverty and land ownership. However, availability of data representative at country or first administrative subnational levels has proven to be a constraint. Future research could extend the hotspot mapping methodology to help in identifying populations at highest risk of climate-change adversities differentiated not only by gender and subnational area, but also by age, ethnicity, race, dis(ability), and/or socioeconomic status.

6. References

Acosta, M., S. van Bommel, M. van Wessel, E.L. Ampaire, L. Jassogne, and P.H. Feindt. 2019. "Discursive translations of gender mainstreaming norms: The case of agricultural and climate change policies in Uganda." ***Women's Studies International Forum*** 74, 9–19. https://doi.org/10.1016/j.wsif.2019.02.010

Aggarwal, P. K., A. Jarvis, B. M. Campbell, R. B. Zougmoré, A. Khatri-Chhetri, S. J. Vermeulen, A. Loboguerrero, L. S. Sebastian, J. Kinyangi, O. Bonilla-Findji, M. Radeny, J. Recha, D. Martinez-Baron, J. Ramirez-Villegas, S. Huyer, P. Thornton, E. Wollenberg, J. Hansen, P. Alvarez-Toro, A. Aguilar-Ariza, D. Arango-Londoño, V. Patiño-Bravo, O. Rivera, M. Ouedraogo and B. Tan Yen. 2018. "The climate-smart village approach: framework of an integrative strategy for scaling up adaptation options in agriculture." ***Ecology and Society*** 23, no. 1: 14. https://doi.org/10.5751/ES-09844-230114

Ahmed, S., and E. Eklund. 2021. "Climate Change Impacts in Coastal Bangladesh: Migration, Gender, and Environmental Justice." ***Asian Affairs*** 52, no.1: 155–174. https://doi.org/10.1080/03068374.2021.1880213

Akter, S., T.J. Krupnik, F. Rossi, and F. Khanam. 2016. "The influence of gender and product design on farmers' preferences for weather-indexed crop insurance." ***Global Environmental Change*** 38, 217–229. https://doi.org/10.1016/j.gloenvcha.2016.03.010

Alamu, E.O., P. Ntawuruhunga, T. Chibwe., I. Mukuka, and M. Chiona. 2019. "Evaluation of cassava processing and utilization at household level in Zambia." ***Food Security*** 11, 141–150. https://doi.org/10.1007/s12571-018-0875-3

Allen, T., P. Heinrigs, and I. Heo. 2018. "Agriculture, Food, and Jobs in West Africa." ***West African Papers*** 14. Paris: OECD Publishing. https://doi.org/10.1787/24142026

Amjath-Babu, T.S., P.K. Agarwal, and S. Vermeulen. 2019. "Climate action for food security in South Asia? Analyzing the role of agriculture in nationally determined contributions to the Paris agreement." ***Climate Policy*** 19, no. 3: 283–298. https://doi.org/10.1080/14693062.2018.1501329

Anugwa, I.Q., A.E. Agwu, M. Suvedi, and S. Babu. 2020. "Gender-Specific Livelihood Strategies for Coping with Climate Change-Induced Food Insecurity in Southeast Nigeria." ***Food Security*** 12, no. 5: 1065–1084. https://doi.org/10.1007/s12571-020-01042-x

Babugura, A.A., 2020. "Gender and green jobs in agriculture." ***Agenda*** 34, no. 1: 108–116. https://doi.org/10.1080/10130950.2020.1719705

Baloch., S.K. 2015. "Women's Role in Agriculture and their Constraints." Balochistan Review XXXII, no. 1: 169–178. Available at: http://web.uob.edu.pk/uob/Journals/Balochistan-Review/data/BR%2001%202015/169-178%20Women%E2%80%99s%20Role%20in%20Agriculture%20and%20Their%20Constraints,%20Shah%20Khalid%20Baloch.pdf

BBS (Bangladesh Bureau of Statistics). 2011. ***Population and Housing Census 2011***. Dhaka: Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning.

Bernier, Q., R. Meinzen-Dick, P. Kristjanson, E. Haglund, C. Kovarik, E. Bryan, C. Ringler, and S. Silvestri. 2015. "Gender and Institutional Aspects of Climate-Smart Agricultural Practices: Evidence from Kenya." ***Working Paper*** 79, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available at: https://cgspace.cgiar.org/bitstream/handle/10568/65680/Gender%20and%20Institutions%20Working%20Paper%2079.pdf

Bryan, E., E. Kato, and Q. Bernier. 2021. "Gender differences in awareness and adoption of climate-smart agriculture practices in Bangladesh." In ***Gender, Climate Change and Livelihoods: Vulnerabilities and Adaptations***, edited by J. Eastin and K. Dupuy, Wallingford, UK: CABI. Available at: https://www.cabi.org/bookshop/book/9781789247077/

Bryan, E., S.C. Theis, J. Choufani, A. De Pinto, R. Meinzen-Dick, and C. Ringler. 2017. "Conceptual framework: Gender, climate change, and nutrition integration initiative." *GCAN Policy Note* 7, Washington, D.C.: International Food Policy Research Institute (IFPRI). http://ebrary.ifpri.org/cdm/singleitem/collection/p15738coll2/id/132300

CEGIS (Centre for Environmental and Geographic Information Services). 2012. *Master Plan of Haor Area*. Government of the People's Republic of Bangladesh. Bangladesh Haor and Wetland Development Board. Available at: https://dbhwd.portal.gov.bd/sites/default/files/files/dbhwd.portal.gov.bd/publications/baf5341d_f248_4e19_8e6d_e7ab44f7ab65/Haor%20Master%20Plan%20Volume%201.pdf

Chanana-Nag, N., and P.K. Aggarwal. 2018. "Woman in agriculture, and climate risks: hotspots for development." *Climatic Change* 158, 13–27. https://doi.org/10.1007/s10584-018-2233-z

CIAT and The World Bank. 2017a. "Climate-Smart Agriculture in Bangladesh." *CSA Country Profiles for Asia Series*. Washington, D.C.: International Centre for Tropical Agriculture (CIAT), World Bank. Available at: https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA-in-Bangladesh.pdf

CIAT and The World Bank. 2017b. "Climate-Smart Agriculture in Pakistan." *CSA Country Profiles for Asia Series*. Washington, D.C.: International Centre for Tropical Agriculture (CIAT), The World Bank. Available at: https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA-in-Pakistan.pdf

CIAT and The World Bank. 2017c. "Climate-Smart Agriculture in Zambia." *CSA Country Profiles for Africa Series*. Washington, D.C.: International Centre for Tropical Agriculture (CIAT), World Bank. Available at: https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA%20_Profile_Zambia.pdf

CIAT, ICRISAT and BFS/USAID. 2021. "Climate-Smart Agriculture in Mali." *CSA Country Profiles for Africa Series*. International Centre for Tropical Agriculture (CIAT), Bureau for Food Security, United States Agency for International Development (BFS/USAID). Washington, D.C: USAID. Available at: https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-mali

Curran, S., L.C. Anderson, M.K. Gugerty, and J. Cook. 2009. "Gender and Cropping: Cassava in Sub-Saharan Africa." *EPAR Research Brief* #32, Washington: Evans School Policy Analysis and Research Group. https://epar.evans.uw.edu/research/gender-cropping-sub-saharan-africa-cassava

De Brauw, A., 2015. "Gender, control, and crop choice in northern Mozambique." *Agricultural Economics* 46, no. 3: 435–448. https://doi.org/10.1111/agec.12172

de Sherbinin, A., 2014. "Climate change hotspots mapping: what have we learned?" *Climatic Change* 123, no.1: 23–37. https://doi.org/10.1007/s10584-013-0900-7

De Souza, K., E. Kituyi, B. Harvey, M. Leone, K.S. Murali, and J.D. Ford, J.D. 2015. "Vulnerability to climate change in three hot spots in Africa and Asia: key issues for policy-relevant adaptation and resilience-building research." *Regional Environmental Change* 15, 747–953. https://doi.org/10.1007/s10113-015-0755-8

Delaney, P. L., and E. Shrader. 2000. *Gender and Post-Disaster Reconstruction: The Case of Hurricane Mitch in Honduras and Nicaragua*. Washington DC: World Bank.

Diouf, N.S., M. Ouedraogo, I. Ouedraogo, G. Ablouka, and R. Zougmoré, R. 2020. "Using Seasonal Forecast as an Adaptation Strategy: Gender Differential Impact on Yield and Income in Senegal." *Atmosphere* 11, no. 10: 1127. https://doi.org/10.3390/atmos11101127

Djoudi, H., and M. Brockhaus. 2011. "Is adaptation to climate change gender neutral? Lessons from communities dependent on livestock and forests in northern Mali." *International Forestry Review* 13, no. 2: 123–135. https://www.cifor.org/knowledge/publication/3524

Doss, C.R. 2002. "Men's crops? Women's crops? The gender patterns of cropping in Ghana." *World Development* 30, no.11: 1987–2000. https://doi.org/10.1016/S0305-750X(02)00109-2

Drucza, K., and V. Peveri. 2018. "Literature on gendered agriculture in Pakistan: Neglect of women's contributions." *Women's Studies International Forum* 69, 2018, 180–189. https://doi.org/10.1016/j.wsif.2018.02.007

Duffy, C., V. Pede, G. Toth, K. Kilcline, C. O'Donoghue, M. Ryan, and C. Spillane. 2021. "Drivers of household and agricultural adaptation to climate change in Vietnam." ***Climate and Development*** 13, no. 3: 242–255. https://doi.org/10.1080/17565529.2020.1757397

Eastin, J., 2018. "Climate change and gender equality in developing states." ***World Development*** 107, 289–305. https://doi.org/10.1016/j.worlddev.2018.02.021

EC-JRC. 2019. ***Description of the GHS Urban Centre Database 2015***: Public Release 2019: Version 1.0. LU: Publications Office. https://data.europa.eu/doi/10.2760/037310.

Erman, A., S. A. De Vries Robbe, S. F. Thies, K. Kabir, and M. Maruo. 2021. ***Gender Dimensions of Disaster Risk and Resilience: Existing Evidence***. The World Bank and the Global Facility for Disaster Reduction and Recovery. Washington D.C: World Bank. http://hdl.handle.net/10986/35202

Evertsen, K.F., and K. van der Geest. 2020. "Gender, environment and migration in Bangladesh." ***Climate and Development*** 12, no. 1: 12–22. https://doi.org/10.1080/17565529.2019.1596059

FAO (Food and Agriculture Organization). 2020. ***Empowering rural women, powering agriculture***. FAO Brief. https://www.fao.org/3/ca2678en/CA2678EN.pdf

FAO. 2015. ***Women in Agriculture in Pakistan***. Rome: Food and Agriculture Organization of the United Nations. https://www.fao.org/3/i4330e/i4330e.pdf

FAO. 2017. ***Country Fact Sheet on Food and Agriculture Policy Trends: Mali***. Fact Sheet. Rome: Food and Agriculture Organization of the United Nations. Available at: https://www.fao.org/3/i7617e/i7617e.pdf

FAO. 2018. ***National Gender Profile of Agriculture and Rural Livelihoods – Zambia***. Country Gender Assessment Series. Lusaka. Zambia: FAO. Available at: https://www.fao.org/3/i8461en/I8461EN.pdf

Ferdushi, K. F., M. Ismail, and A.A. Kamil. 2019. "Perceptions, knowledge and adaptation about climate change: A Study on farmers of ***Haor*** areas after a flash flood in Bangladesh." ***Climate*** 7, no.7: 85. https://doi.org/10.3390/cli7070085

Filmer, D., L.H. Pritchett. 2001. "Estimating wealth effects without expenditure data—or tears: An application to educational enrolments in states of India." ***Demography*** 38, no.1: 115-132. 10.1353/dem.2001.0003

GDL (Global Data Lab). 2019. Sub-National GDI - Subnational HDI - Global Data Lab. n.d. Accessed May 5, 2022. https://globaldatalab.org/shdi/sgdi/?levels=1%2B4&interpolation=1&extrapolation=0&nearest_real=0&years=42019.

GDL (Global Data Lab). 2020a. ***Construction of the Subnational Human Development Index and Subnational Gender Development Index. Methodology Note***. Netherlands: Global Data Lab. https://globaldatalab.org/shdi/about/

GDL (Global Data Lab). 2020b. ***Human Development Indices***. Netherlands: Global Data Lab. https://globaldatalab.org/shdi/sgdi/BGD+MLI+PAK+ZMB/?levels=1%2B4&interpolation=1&extrapolation=0&nearest_real=0&colour_scales=global

Government of the People's Republic of Bangladesh. 2018. ***Nationwide Climate Vulnerability Assessment in Bangladesh***. Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh and GIZ. Germany: GIZ. Available at: https://moef.portal.gov.bd/sites/default/files/files/moef.portal.gov.bd/notices/d31d60fd_df55_4d75_bc22_1b0142fd9d3f/Draft%20NCVA.pdf

GRZ (Government of the Republic of Zambia). 2021. ***Gender Status Report 2017–19***. Ministry of Gender. Republic of Zambia, Lusaka.

Gumucio, T., J. Hansen, S. Huyer, and T. Van Huysen. 2020. "Gender-responsive rural climate services: a review of the literature." ***Climate and Development*** 12, no. 3: 241–254. https://doi.org/10.1080/17565529.2019.1613216

HLPE (The High-Level Panel of Experts on Food Security and Nutrition). 2017. ***Nutrition and food systems***. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome: FAO. https://www.fao.org/3/i7846e/i7846e.pdf

Hoq, M.S., S.K. Raha, and M.I. Hossain. 2021. "Livelihood Vulnerability to Flood Hazard: Understanding from the Flood-prone *Haor* Ecosystem of Bangladesh." *Environmental Management* 67, 532–552. https://doi.org/10.1007/s00267-021-01441-6

Huyer, S. 2016. "Closing the Gender Gap in Agriculture." *Gender, Technology and Development* 20, no. 2: 105–116. https://doi.org/10.1177/0971852416643872

IFPRI (International Food Policy Research Institute). 2016. *Bangladesh Integrated Household Survey (BIHS) 2015.* https://doi.org/10.7910/DVN/BXSYEL.

ILO (International Labour Organization). 2021. *Employment by sex and economic activity — ILO modelled estimates.* ILOSTAT database, https://ilostat.ilo.org/data. Accessed 08-12-2021.

INSTAT (National Institute of Statistics). 2009. *4th General Census Population and Housing Mali.* Mali: Institut National de la Statistique.

Institut National de la Statistique (INSTAT) and ICF. 2019. *Mali Demographic and Health Survey 2018.* Rockville, Maryland, USA: INSTAT and ICF.

IPC (Integrated Food Security Phase Classification). 2021. *Acute Food Insecurity Analysis: Balochistan, Pakistan.* IPC. https://reliefweb.int/sites/reliefweb.int/files/resources/IPC%20Acute%20Food%20Insecurity%20Analysis-Final%20Report-Balochistan.pdf

IPCC. 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf

IPCC. 2019. *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press. https://www.ipcc.ch/site/assets/uploads/sites/4/2021/07/210714-IPCCJ7230-SRCCL-Complete-BOOK-HRES.pdf

IPCC. 2020. *The concept of risk in the IPCC Sixth Assessment Report: a summary of cross-working group discussions* [Prepared by Reisinger, A., Howden, M., Vera, C., Garschagen, M., Hurlbert, M., Kreibiehl, S., Mach, K.J., Mintenbeck, K., O'neill, B., Pathak, M. and Pedace, R.] Intergovernmental Panel on Climate Change: Geneva, Switzerland. https://www.ipcc.ch/site/assets/uploads/2021/02/Risk-guidance-FINAL_15Feb2021.pdf

Iradukunda, F., R. Bullock, A. Rietveld, and B. van Schagen. 2019. "Understanding gender roles and practices in the household and on the farm: Implications for banana disease management innovation processes in Burundi." *Outlook on Agriculture* 48, no. 1: 37–47. https://doi.org/10.1177/0030727019831704

Jarvis, A, T. Rosenstock, J. Koo, P. Thornton, A. Loboguerrero, B. Govaerts, J. Ramírez-Villegas, S. Prager, A. Ghosh, and K. Fuglie. 2021. *Climate-Informed Priorities for One CGIAR Regional Integrated Initiatives.* CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). https://cgspace.cgiar.org/handle/10568/113289

Jost, C., F. Kyazze, J. Naab, S. Neelormi, J. Kinyangi, R. Zougmore, P. Aggarwal, G. Bhatta, M. Chaudhury, M.L. Tapio-Bistrom, and S. Nelson. 2016. "Understanding gender dimensions of agriculture and climate change in smallholder farming communities." *Climate and Development* 8, no. 2: 133–144. https://doi.org/10.1080/17565529.2015.1050978

Khatri-Chhetri, A., P.K. Aggarwal, P.K. Joshi, and S. Vyas. 2017. "Farmers' prioritization of climate smart agriculture (CSA) technologies." *Agricultural Systems* 151, 184–191. https://doi.org/10.1016/j.agsy.2016.10.005

Kristjanson, P., E. Bryan, Q. Bernier, J. Twyman, R. Meinzen-Dick, C. Kieran, C. Ringler, C. Jost, and C. Doss. 2017. "Addressing Gender in Agricultural Research for Development in the Face of a Changing Climate: Where Are We and Where Should We Be Going*?", International Journal of Agricultural Sustainability* 15, no.5: 482–500. DOI: 10.1080/14735903.2017.1336411

Lambrou, Y., and S. Nelson. 2010. ***Farmers in a changing climate: Does gender matter? Food Security in Andhra Pradesh***, India. Report. Rome: Food and Agriculture Organization. https://www.fao.org/3/i1721e/i1721e00.pdf

McGahey, D., J. Davies, N. Hagelberg, and R. Ouedraogo. 2014. ***Pastoralism and the Green Economy – a natural nexus?*** Nairobi: IUCN and UNEP. https://portals.iucn.org/library/sites/library/files/documents/2014-034.pdf

McOmber, C. 2020. "Women and climate change in the Sahel." ***West African Papers*** 27, Paris: OECD Publishing. https://doi.org/10.1787/e31c77ad-en

Moss, R., M. Babiker, S. Brinkman, E. Calvo, T. Carter, J. Edmonds, I. Elgizouli, S. Emori, L. Erda, K. Hibbard, R. Jones, M. Kainuma, J. Kelleher, J. F. Lamarque, M. Manning, B. Matthews, J. Meehl, L. Meyer, J. Mitchell, N. Nakicenovic, B. O' Neill, R. Pichs, K. Riahi, S. Rose, P. Runci, R. Stouffer, D. van Vuuren, J. Weyant, T. Wilbanks, J.P. van Ypersele, and M. Zurek. 2008. ***Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies***. Geneva: Intergovernmental Panel on Climate Change. https://archive.ipcc.ch/pdf/supporting-material/expert-meeting-report-scenarios.pdf

Naz, F., and S.E. Saqib. 2021. "Gender-based differences in flood vulnerability among men and women in the char farming households of Bangladesh." ***Natural Hazards*** 106, no. 1: 655–677. https://doi.org/10.1007/s11069-020-04482-y

Nchu, I.N., J.N. Kimengsi, and G. Kapp. 2019. "Diagnosing Climate Adaptation Constraints in Rural Subsistence Farming Systems in Cameroon: Gender and Institutional Perspectives." ***Sustainability***, 11, no. 14: 3767. https://doi.org/10.3390/su11143767

Ndiritu, S.W., M. Kassie, and B. Shiferaw. 2014. "Are there systematic gender differences in the adoption of sustainable agricultural intensification practices? Evidence from Kenya." ***Food Policy*** 49, 117–127. https://doi.org/10.1016/j.foodpol.2014.06.010

Nellemann, C., R. Verma, and L. Hislop. 2011. ***Women at the frontline of climate change: Gender risks and hopes. A Rapid Response Assessment***. United Nations Environment Programme, GRID-Arendal. https://www.ipcc.ch/apps/njlite/ar5wg2/njlite_download2.php?id=9719

Nelson, V., K. Meadows, T. Cannon, J. Morton, and A. Martin. 2002. "Uncertain predictions, invisible impacts, and the need to mainstream gender in climate change adaptations." ***Gender and Development*** 10, no. 2: 51–59. https://doi.org/10.1080/13552070215911

Neumayer, E., and T. Plümper. 2007. "The gendered nature of natural disasters: The impact of catastrophic events on the gender gap in life expectancy, 1981–2002." ***Annals of the Association of American Geographers*** 97, no.3: 551–566. https://doi.org/10.1111/j.1467-8306.2007.00563.x

Ngigi, M.W., U. Mueller, and R. Birner. 2017. "Gender Differences in Climate Change Adaptation Strategies and Participation in Group-Based Approaches: An Intra-Household Analysis from Rural Kenya." ***Ecological Economics*** 138, 99–108. https://doi.org/10.1016/j.ecolecon.2017.03.019

Nhat Lam Duyen, T., R.F. Rañola, B.O. Sander, R. Wassmann, N.D. Tien, and N.N.K. Ngoc. 2021. "A comparative analysis of gender and youth issues in rice production in North, Central, and South Vietnam." ***Climate and Development*** 13, no. 2: 115–127. https://doi.org/10.1080/17565529.2020.1734771

Nico, G., and C. Azzarri. 2021. "Reassessing sex-specific estimates of employment and dependence on agriculture in Africa." Paper presented at the 31st ***International Conference of Agricultural Economists (ICAE)***.

NIPS (National Institute of Population Studies) [Pakistan] and ICF. 2019. ***Pakistan Demographic and Health Survey 2017–18***. Islamabad, Pakistan, and Rockville, Maryland, USA: NIPS and ICF.

Njuki, Jemimah, Eissler, Sarah, Malapit, Hazel J., Meinzen-Dick, Ruth, Suseela, Bryan, Elizabeth, and Quisumbing, Agnes R., 2021. A review of evidence on gender equality, women's empowerment, and food systems. United Nations Food Systems Summit. https://dx.doi.org/10.48565/scfss2021-1q69

OECD. 2014. Social Institutions and Gender Index (SIGI). Synthesis Report. OECD Development Centre. https://www.oecd.org/dev/development-gender/BrochureSIGI2015-web.pdf

Osman-Elasha, B., 2012. In the shadow of climate change. *UN Chronicle* 46, no.4: 54–55. https://doi.org/10.18356/5d941c92-en

Oxfam. 2019. *Stories of Climate Change: Learn and think about the impacts of the climate crisis on people's lives*. Education Resource Brief. UK: Oxfam GB. https://oxfamilibrary.openrepository.com/bitstream/handle/10546/620919/edu-stories-of-climate-change-02122019-en.pdf?sequence=1

Partey, S.T., R.B. Zougmoré, M. Ouédraogo, and B.M. Campbell. 2018. "Developing climate-smart agriculture to face climate variability in West Africa: challenges and lessons learnt." *Journal of Cleaner Production* 187, 285–295. https://doi.org/10.1016/j.jclepro.2018.03.199

PBS (Pakistan Bureau of Statistics). 2017. *6th Population and Housing Census*. Islamabad: Pakistan Bureau of Statistics.

Perez, C., E. M. Jones, P. Kristjanson, L. Cramer, P. K. Thornton, W. Förch, and C. al Barahona. 2015. "How resilient are farming households and communities to a changing climate in Africa? A gender-based perspective." *Global Environmental Change* 34, 95–107. https://doi.org/10.1016/j.gloenvcha.2015.06.003

Poole, N. 2010. "Zambia cassava sector policy–recommendations in support of strategy implementation." *AAACP Paper Series* 16, All ACP Agricultural Commodities Programme, Food and Agricultural Organization of the United Nations (FAO).

Quisumbing, A.R., N. Kumar, and Behrman, J.A. 2018. "Do shocks affect men's and women's assets differently? Evidence from Bangladesh and Uganda." *Development Policy Review* 36, no.1: 3–34. https://doi.org/10.1111/dpr.12235

Rabbani, M.G., Z.M. Khan, and M.H. Tuhin. 2015. *Climate change and migration in Bangladesh: A gender perspective*. Dhaka, Bangladesh: Bangladesh Centre for Advanced Studies for UN Women. https://asiapacific.unwomen.org/en/digital-library/publications/2016/01/climate-change-and-migration-in-bangladesh

Rafiq, L., and T. Blaschke. 2012. "Disaster risk and vulnerability in Pakistan at a district level." *Geomatics, Natural Hazards, and Risk* 3, no. 4: 324–341. https://doi.org/10.1080/19475705.2011.626083

Rahaman, M. A., M.M. Rahman, and M.S. Hossain. 2019. "Climate-resilient agricultural practices in different agro-ecological zones of Bangladesh." In *Handbook of Climate Change Resilience*, edited by W.L. Filho, 2337–2363. Springer.

Rahman, M., M. Palash, H. Jahan, S.M. Jalilov, and M. Mainuddin. 2020. "An empirical investigation of men's views of women's contribution to farming in Northwest Bangladesh." *Sustainability* 12, no. 9: 3521. https://doi.org/10.3390/su12093521

Rahman, T., and M. Haider. 2020. "Struggles of Women with Soil Erosion in *Haor*: Gender Role and Adaptive Strategies." Presented at *Social Work and Sustainable Development Conference, SUST*, Sylhet, Bangladesh, February 2020.

Rao, N., and A. Mitra. 2013. "Migration, representations, and social relations: Experiences of Jharkhand labour to Western Uttar Pradesh." *The Journal of Development Studies* 49, no. 6: 846–860. https://doi.org/10.1080/00220388.2013.778399

Rao, N., C. Singh, D. Solomon, L. Camfield, R. Sidiki, M. Angula, P. Poonacha, A. Sidibé, and E.T. Lawson. 2020. "Managing risk, changing aspirations and household dynamics: Implications for wellbeing and adaptation in semi-arid Africa and India." *World Development* 125, 104667. https://doi.org/10.1016/j.worlddev.2019.104667

Rao, N., E.T. Lawson, T. Elaine, W.N. Raditloaneng, D. Solomon, and M.N. Angula. 2019. "Gendered vulnerabilities to climate change: insights from the semi-arid regions of Africa and Asia." *Climate and Development* 11, no. 1: 14–26. https://doi.org/10.1080/17565529.2017.1372266

Segnon, A.C., E. Totin, R.B. Zougmoré, J.C. Lokossou, M. Thompson-Hall, B.O. Ofori, E.G. Achigan-Dako, and C. Gordon. 2021. "Differential household vulnerability to climatic and non-climatic stressors in semi-arid areas of Mali, West Africa." *Climate and Development* 13, no. 8: 697–712. https://doi.org/10.1080/17565529.2020.1855097

Seymour, G., and M.S. Floro .2016. "Identity, household work, and subjective well-being among rural women in Bangladesh." *IFPRI Discussion Paper* 01580. Washington D.C.: International Food Policy Research Institute. Available at: https://www.ifpri.org/publication/identity-household-work-and-subjective-well-being-among-rural-women-bangladesh

Sharmin, Z., and M. Islam. 2013. "Consequences of Climate Change and Gender Vulnerability: Bangladesh Perspective." *SSRN Paper*. https://dx.doi.org/10.2139/ssrn.2200116

Singh, U.P. 2002. *Boro Rice in Eastern India*. Knowledge Brief. The Rice-Wheat Consortium Regional Technical Coordination Committee Meeting. 10–14 February 2002. New Delhi: Rice-Wheat Consortium for the Indo-Gangetic Plains. Available at: http://www.knowledgebank.irri.org/images/docs/boro-rice-and-opportunity-for-intensification.pdf

SPRING. 2016. *Agriculture and Nutrition in Mali through a Gender Lens: A Qualitative Study, Literature Review—2015*. Arlington, VA: Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) project. Available at: https://www.spring-nutrition.org/sites/default/files/publications/reports/spring_mali_study_agriculture_nutrition_gender.pdf

Tanny, N.Z., M.W. Rahman, and R.N. Ali. 2017. "Climate-induced Gender Vulnerabilities in Northwestern Bangladesh." *Indian Journal of Gender Studies* 24, no. 3: 360–372. https://doi.org/10.1177%2F0971521517716808

Tatem, A. J. 2017. "WorldPop, Open Data for Spatial Demography." *Scientific Data* 4, no. 1: 170004. https://doi.org/10.1038/sdata.2017.4.

Terry, G. 2009. *Climate change and gender justice*. UK: Oxfam GB. https://policy-practice.oxfam.org/resources/climate-change-and-gender-justice-115359/

The World Bank. 2020. *World Bank National Accounts Data*. https://data.worldbank.org/indicator/nv.agr.totl.zs?year_high_desc=true

The World Bank. 2021. *Employment Statistics*. Indicator: employment in agriculture (% of total employment). Available at https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS

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

UN Women (United Nations Women). 2020. "Rural Women, key for a world free from hunger and poverty. International Day of Rural Women." *Observations*. United Nations. https://www.un.org/en/observances/rural-women-day

UNDP (United Nations Development Programme), 2016. *Scaling Up Climate Action to Achieve the Sustainable Development Goals*, Susan Guthridge-Gould (ed.), UNDP and Climate Change Report, New York: UNDP. https://www.undp.org/content/dam/LECB/docs/pubs-reports/undp-Scaling-Up-Climate-Action-Change-SDGs-English-20161102.pdf

USAID. 2014. *Zambia Livelihood Zones and Descriptions. Famines Early Warning Systems Network* (FEWS NET). Washington: USAID.

Vermeulen, S., B.M. Campbell, and J.S.I. Ingram. 2012. "Climate Change and Food Systems." *Annual Review of Environment and Resources* 37, no. 1: 195–222. https://doi.org/10.1146/annurev-environ-020411-130608

Vincent, K., and T. Cull. 2014. "Using Indicators to Assess Climate Change Vulnerabilities: Are There Lessons to Learn for Emerging Loss and Damage Debates?" *Geography Compass* 8, no.1: 1–12. https://doi.org/10.1111/gec3.12105

White, P., G. Finnegan, E. Pehu, P. Poutiainen, and M. Vyzaki. 2015. *Linking Women with Agribusiness in Zambia: Corporate Social Responsibility, Creating Shared Value, and Human Rights Approaches*. Washington D.C: World Bank. https://openknowledge.worldbank.org/handle/10986/22681

Wilderspin, I., J. Giles, J. Hildebrand, M. Lizarazo, M. Khan, and G. Grosjean. 2019. "Climate-Smart Agriculture in Sindh, Pakistan." ***CSA Country Profiles for Asia Series***. International Centre for Tropical Agriculture (CIAT); Food and Agriculture Organisation of the United Nations (FAO). Rome: FAO. Available at: https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-disaster-risk-reduction-sindh-pakistan

Yadav, S.S. and Lal, R., 2018. Vulnerability of women to climate change in arid and semi-arid regions: The case of India and South Asia. ***Journal of Arid Environments***, 149, pp.4–17. https://doi.org/10.1016/j.jaridenv.2017.08.001

Zambia Central Statistical Office. 2010. ***Zambia 2010 Census of Population and Housing***. Lusaka: Central Statistical Office.

Zambia Statistics Agency, Ministry of Health (MOH) Zambia, and ICF. 2019. ***Zambia Demographic and Health Survey 2018***. Lusaka, Zambia, and Rockville, Maryland, USA: Zambia Statistics Agency, Ministry of Health, and ICF.

Annexes

Annex A. Principal components of the crop/category-specific climate–agriculture–gender inequality hotspot index of subnational areas in the focus hotspot countries (Zambia, Mali, Bangladesh and Pakistan)

	Principle components		
	1	2	3
Cereals, legumes and oilseeds			
Share of rural population under climate hazard	–0.50	–0.04	0.64
Participation in cereal farming	0.65	–0.28	0.04
Participation in cereal farming by women	0.39	0.63	–0.04
Share of hours worked in cereal farming by women	0.27	0.43	0.67
Women's vulnerability to climate hazards due to gender inequalities index	0.34	–0.58	0.38
Rice			
Share of rural population under climate hazard	0.62	–0.05	0.19
Participation in rice farming	0.61	0.18	0.04
Participation in rice farming by women	–0.39	0.61	–0.14
Share of hours worked in rice farming by women	0.30	0.51	–0.65
Women's vulnerability to climate hazards due to gender inequalities index	0.01	0.58	0.72
Vegetables, melons, roots and tubers			
Share of rural population under climate hazard	0.65	0.30	–0.18
Participation in vegetable farming	–0.33	0.44	0.47
Participation in vegetable farming by women	–0.12	0.51	–0.75
Share of hours worked in vegetable farming by women	–0.27	0.61	0.19
Women's vulnerability to climate hazards due to gender inequalities index	0.61	0.29	0.39
Perennial crops			
Share of rural population under climate hazard	–0.44	0.45	0.60
Participation in perennial crop farming	0.32	0.56	0.04
Participation in perennial crop farming by women	0.67	–0.08	–0.04
Share of hours worked in perennial crop farming by women	0.44	0.45	0.24
Women's vulnerability to climate hazards due to gender inequalities index	0.23	–0.53	0.76
Livestock			
Share of rural population under climate hazard	0.50	0.21	0.37
Participation in livestock rearing	0.16	0.67	–0.71
Participation in livestock rearing by women	0.61	–0.06	0.14
Share of hours worked in livestock by women	0.57	–0.10	–0.10
Women's vulnerability to climate hazards due to gender inequalities index	–0.17	0.70	0.58
Mixed farming			
Share of rural population under climate hazard	–0.31	–0.29	0.87
Participation in mixed farming	0.39	0.50	0.24
Participation in mixed farming by women	0.61	–0.16	0.01
Share of hours worked in mixed farming by women	0.57	–0.04	0.38
Women's vulnerability to climate hazards due to gender inequalities index	–0.21	0.80	0.19

Annex B. Climate–agriculture–gender inequality hotspot ranking of low- and middle-income countries

Ranking	Country	Share of total rural population under climate hazard 2050 (CCAFS)	Share of adult female agricultural labour 2019 (ILO)	Social Institutions and Gender Index 2014 (OECD)	Overall hotspot score (the higher, the 'hotter')
1	Gabon	0.084	0.686	0.402	2.563
2	Sudan	0.422	0.607	0.555	2.328
3	Gambia	0.441	0.594	0.524	2.100
4	Mali	0.192	0.501	0.516	2.028
5	DR Congo	0.151	0.555	0.428	1.948
6	Yemen	0.707	0.615	0.563	1.939
7	Zambia	0.381	0.548	0.449	1.639
8	Liberia	0.027	0.474	0.383	1.565
9	Sierra Leone	0.002	0.472	0.372	1.549
10	Central African Republic	0.082	0.518	0.329	1.439
11	Niger	0.320	0.482	0.442	1.389
12	Guinea	0.089	0.511	0.321	1.356
13	Chad	0.482	0.490	0.467	1.277
14	Egypt	0.462	0.509	0.428	1.226
15	Cameroon	0.265	0.545	0.280	1.052
16	Pakistan	0.749	0.687	0.301	1.029
17	Bangladesh	0.909	0.656	0.390	1.026
18	Afghanistan	0.676	0.640	0.322	1.020
19	Azerbaijan	0.276	0.578	0.240	1.007
20	Burundi	0.041	0.545	0.166	0.902
21	Somalia	0.781	0.514	0.459	0.875
22	Armenia	0.282	0.554	0.236	0.864
23	Georgia	0.142	0.523	0.204	0.803
24	Mauritania	0.284	0.386	0.395	0.788
25	Burkina Faso	0.096	0.416	0.282	0.721
26	Congo	0.082	0.478	0.203	0.686
27	Nepal	0.744	0.587	0.323	0.663
28	Tanzania	0.334	0.512	0.250	0.646
29	Rwanda	0.201	0.572	0.134	0.624
30	Bhutan	0.119	0.560	0.114	0.611
31	Malawi	0.323	0.536	0.207	0.583
32	Ethiopia	0.190	0.444	0.245	0.536
33	Kenya	0.410	0.545	0.216	0.523
34	Lao PDR	0.136	0.517	0.145	0.514
35	Angola	0.341	0.560	0.172	0.508
36	India	0.679	0.580	0.265	0.474
37	Turkey	0.374	0.628	0.103	0.466
38	Tajikistan	0.562	0.629	0.139	0.331
39	Viet Nam	0.388	0.514	0.187	0.279
40	Nigeria	0.472	0.346	0.391	0.273
41	Kyrgyzstan	0.289	0.489	0.160	0.204
42	Myanmar	0.531	0.444	0.294	0.197
43	Uganda	0.573	0.532	0.216	0.196
44	Mozambique	0.527	0.571	0.138	0.105
45	Syrian Arab Republic	0.805	0.391	0.416	0.054
46	Madagascar	0.158	0.468	0.100	0.048
47	Ghana	0.483	0.378	0.299	–0.012

Ranking	Country	Share of total rural population under climate hazard 2050 (CCAFS)	Share of adult female agricultural labour 2019 (ILO)	Social Institutions and Gender Index 2014 (OECD)	Overall hotspot score (the higher, the 'hotter')
48	Peru	0.191	0.483	0.083	–0.017
49	Benin	0.469	0.390	0.278	–0.024
50	Morocco	0.769	0.656	0.105	–0.037
51	Zimbabwe	0.491	0.525	0.139	–0.047
52	Indonesia	0.393	0.469	0.153	–0.093
53	Bolivia	0.242	0.497	0.058	–0.146
54	Ivory Coast	0.508	0.400	0.254	–0.153
55	Senegal	0.458	0.423	0.199	–0.208
56	Iraq	0.710	0.446	0.263	–0.219
57	Sri Lanka	0.845	0.539	0.189	–0.333
58	Tunisia	0.436	0.369	0.199	–0.430
59	Lebanon	0.924	0.444	0.290	–0.458
60	Namibia	0.496	0.460	0.117	–0.466
61	Cambodia	0.549	0.529	0.048	–0.540
62	Togo	0.626	0.415	0.186	–0.580
63	Kazakhstan	0.610	0.448	0.120	–0.696
64	China	0.627	0.441	0.131	–0.707
65	Swaziland	0.855	0.420	0.212	–0.812
66	Ecuador	0.523	0.463	0.042	–0.834
67	Paraguay	0.320	0.362	0.058	–0.912
68	Thailand	0.736	0.453	0.106	–0.938
69	Uzbekistan	0.911	0.468	0.148	–0.966
70	Lesotho	0.754	0.455	0.088	–1.040
71	Jordan	0.682	0.211	0.312	–1.070
72	Philippines	0.642	0.322	0.177	–1.090
73	South Africa	0.621	0.370	0.060	–1.355
74	Argentina	0.302	0.273	0.011	–1.517
75	Mongolia	1.000	0.464	0.035	–1.641
76	Jamaica	0.794	0.282	0.135	–1.713
77	Brazil	0.422	0.239	0.046	–1.715
78	Haiti	0.780	0.236	0.147	–1.858
79	Nicaragua	0.631	0.156	0.160	–1.935
80	Colombia	0.653	0.228	0.086	–1.958
81	Honduras	0.534	0.164	0.107	–1.975
82	Guatemala	0.722	0.190	0.132	–2.048
83	Cuba	0.601	0.235	0.021	–2.140
84	Costa Rica	0.595	0.195	0.051	–2.182
85	Venezuela	0.245	0.070	0.039	–2.258
86	Dominican Republic	0.594	0.093	0.037	–2.725
87	El Salvador	0.934	0.118	0.049	–3.105

Note: Focus countries that were chosen for investigation are highlighted.

Annex C. Values of subnational crop/category-specific climate–agriculture–gender inequality hotspot index for subnational areas in the focus hotspot countries (Zambia, Mali, Bangladesh and Pakistan)

Country	Region	Cereals, legumes and oilseeds	Rice	Vegetables, melons, roots and tubers	Perennials	Livestock	Mixed farming
Bangladesh	Bagerhat, Khulna, Satkhira	−0.94	1.15	1.16	−1.75	1.49	−1.25
	Bandarban, Cox's Bazar	0.32	0.91	−0.45	0.53	0.36	−1.57
	Barguna, Bhola, Patuakhali	−0.48	1.45	0.43	−0.01	1.00	−1.44
	Barisal, Jhalokati, Pirojpur	−0.43	1.39	1.60	−1.16	1.52	−0.17
	Bogra, Gaibandha, Joypurhat	−0.92	1.68	0.94	0.31	0.90	0.65
	Brahmanbaria, Chandpur, Comilla	0.58	0.03	−0.26	−0.37	0.15	−0.55
	Chittagong	0.30	−0.27	0.30	−0.92	0.06	0.48
	Chuadanga, Jhenaidah, Kushtia, Meherpur	−0.89	1.71	1.08	−1.09	0.97	−1.43
	Dhaka	0.79	−1.22	0.56	1.57	−0.11	−0.43
	Dinajpur, Nilphamari, Panchagarh, Thakurgaon	−0.37	1.92	0.17	−0.18	0.96	0.36
	Faridpur, Manikganj, Rajbari	−0.80	1.55	1.21	−1.69	1.43	−1.28
	Feni, Lakshmipur, Noakhali	0.70	0.42	0.22	−0.62	0.05	0.47
	Gazipur, Narayanganj, Narsingdi	−0.73	0.66	0.36	−0.58	0.69	−1.50
	Gopalganj, Madaripur, Munshiganj, Shariatpur	−0.60	1.85	1.10	−1.63	0.80	0.37
	Habiganj, Sunamganj	−0.66	1.83	1.26	0.25	1.25	−1.30
	Jamalpur, Sherpur, Tangail	−0.39	1.68	0.65	−1.33	1.01	−0.82
	Jessore, Magura, Narail	−0.44	1.31	1.04	−1.44	0.90	−1.44
	Khagrachhari, Rangamati (Chittagong/ Chattagram)	0.42	0.56	2.31	0.70	0.28	1.42
	Kishoreganj, Mymensingh, Netrakona	−0.65	2.09	0.81	−1.59	1.18	−0.37

Country	Region	Cereals, legumes and oilseeds	Rice	Vegetables, melons, roots and tubers	Perennials	Livestock	Mixed farming
	Kurigram, Lalmonirhat, Rangpur	−0.12	1.39	0.60	−0.41	0.95	−1.54
	Maulvibazar, Sylhet	−0.48	1.19	0.90	0.17	1.49	−1.23
	Naogaon, Chapai Nawabganj, Rajshahi	−0.59	1.90	0.39	−0.67	1.74	−1.83
	Natore, Pabna, Sirajganj	−0.53	1.34	0.57	−0.91	1.69	0.08
Pakistan	Balochistan	−0.46	−1.18	−0.48	−0.23	−0.62	1.49
	Federally Administered Tribal Areas (FATA)	−1.95	−0.74	−2.05	−1.19	0.75	0.23
	Islamabad	−2.75	−0.38	−1.16	−1.15	0.68	0.72
	Khyber Pakhtunkhwa	−1.10	0.00	−0.17	−0.48	0.63	1.14
	Punjab	−1.04	0.11	0.25	−0.75	1.30	2.45
	Sindh	−1.49	0.20	0.28	−1.45	−0.26	1.21
Mali	Bamako	−1.36	−1.52	−2.12	0.88	−3.27	−0.62
	Gao and Kidal	−0.66	−1.51	−2.55	−0.34	−1.67	0.70
	Kayes	3.87	−1.51	−2.05	2.46	−3.51	−1.71
	Koulikoro	1.92	−2.80	−2.87	1.31	−3.27	1.29
	Mopti	2.61	−2.98	−2.58	1.88	−1.45	0.85
	Ségou	3.05	−1.71	−3.20	2.78	−1.17	−1.45
	Sikasso	2.52	−1.02	−1.16	2.00	−2.97	0.87
	Tombouctou	0.83	−1.42	−2.77	1.42	−0.11	−1.54
Zambia	Central	−0.13	−1.82	1.35	−0.09	−2.41	2.02
	Eastern	1.92	−1.44	0.21	0.84	−1.08	1.99
	Luapula	−0.68	−0.46	−1.46	2.22	−0.47	−1.07
	Lusaka	−0.41	−2.74	0.66	−0.10	−0.74	1.24
	Northern	1.13	−0.72	1.11	1.11	−0.28	0.67
	North-Western	0.72	−1.50	1.44	0.88	0.16	1.55
	Southern	0.38	−1.37	2.36	0.79	−0.98	2.28

* Note: Cells shaded green indicate where the number of observations was insufficient to derive reliable statistics for that crop/category. This is the case for rice in Zambia (48 observations); vegetables and melons, roots and tubers in Mali (3 observations); perennial crops in Pakistan (7 observations); and mixed farming in Bangladesh (21 observations). In addition, refer to annex D, available online (https://hdl.handle.net/10568/119602), for detailed data of sub-indicators on the basis of which the subnational crop/category-specific climate–agriculture–gender inequality hotspot index is calculated.

GENDER Platform

Generating Evidence and New Directions for Equitable Results (GENDER) is CGIAR's 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

CGIAR is a global research partnership for a food secure future dedicated to reducing poverty, enhancing food and nutrition security, and improving natural resources.

cgiar.org