Climate Perception and Adaptation Strategies of Women Smallholder Farmers in the Global South Rural Communities: A Systematic Review

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KEYWORDS

gender, smallholder farmers, climate change adaptation, perception, global south

ABSTRACT

This paper presents a systematic review of gendered climate change perceptions and adaptation strategies among women smallholder farmers in the Global South, complemented by expert interviews. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, it synthesises evidence from 30 empirical studies published since 2019 to examine climate perceptions, adaptation behaviours, dominant narratives, and key research gaps. Eight expert interviews further enrich the analysis, particularly addressing the relative underrepresentation of Southeast Asia and Latin America in existing scholarship. Although awareness of climate change is widespread among both men and women, perceived impacts and vulnerabilities are strongly gender-differentiated, shaped by socially constructed roles, responsibilities, and structural inequalities. Women farmers employ a range of absorptive, adaptive, and transformative strategies, including on-farm adjustments, livelihood diversification, and collective action. These responses are further differentiated by intra-gender factors such as age, marital status, and socio-economic position, underscoring the importance of context-specific approaches. The review identifies a geographical imbalance in the literature, with a predominant focus on Africa, and highlights contrasting narratives that frame women either as vulnerable victims or as active agents of change. It calls for more nuanced, agency-centred and gender-transformative research and policy design that recognise women's knowledge, lived experiences, and critical contributions to climate resilience.

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I. **Introduction**

Global temperature rise and extreme weather events such as droughts and floods pose significant threats to rural livelihoods in the Global South, reducing agricultural production and exacerbating food insecurity and the well-being of households.[1]

[1] Cinner, Joshua, et al. "Potential impacts of climate change on agriculture and fisheries production in 72 tropical coastal communities." *Nature Communications*, vol. 13, no. 1, 2022, pp. 1-11; Kompas, Tom, et al. "Global impacts of heat and water stress on food production and severe food insecurity." *Scientific Reports*, vol. 14, 2024, pp. 1-9; Raj, Subhashni, et al. "Food Security and Climate

Smallholder farmers are particularly vulnerable, as they are predominantly subsistence farmers relying mainly on family labour to produce crops, with their food and nutrition security depending on the consumption of this produce. These farmers typically practice rain-fed agriculture and have limited resources and capital, making them even more susceptible to climate variability and related shocks.[2] Moreover, it has been estimated that climate variability will continue to induce a reduction in maize production in Africa, South Asia and Latin America.[3]

According to the FAO,[4] smallholder farmers refer to small-scale farmers who manage farms of less than 10 hectares. Of the 2.5 billion people in low-income countries engaged in agriculture, 1.5 billion depend on small-scale farming.[5] Notably, smallholder farmers provide up to 80% of the food supply in Asia and sub-Saharan Africa,[6] highlighting the importance of understanding how smallholders are addressing and coping with climate change and its impacts on agricultural production.

Women and girls in rural areas are disproportionately affected by climate change due to pre-existing gender inequality and gender-differentiated roles and responsibilities such as reproduction and raising children.[7] Acknowledging this vulnerability, there have been academic efforts addressing the intersectionality of gender[8] and climate change impacts, pinpointing that climate vulnerability is not innate but (re)produced by political economic and patriarchal institutions in the form of discrimination and exclusions.[9] It is notable that because of this vulnerability, coupled with a lack of access to assets, information, financial services and social capital, women in rural areas find it more challenging to adopt adequate adaptation strategies compared to their male counterparts.[10]

Despite these challenges, female farmers have developed various adaptation methods. The strategies typically involve on-farm activities such as changing planting dates and cropping patterns, as well as diversifying livelihoods and engaging in collective actions like savings

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Change: Differences in Impacts and Adaptation Strategies for Rural Communities in the Global South and North." *Frontiers in Sustainable Food Systems*, vol. 5, 2022, pp. 1-18; Thornton, Philip, et al. "Climate variability and vulnerability to climate change: A review." *Global Change Biology*, vol. 20, no. 11, 2014, pp. 3313-3328.

[2] Atkinson, Christopher, and Allison Atkinson. "Impacts of Climate Change on Rural Communities: Vulnerability and Adaptation in the Global South." *Encyclopedia*, vol. 3, no. 2, 2023, pp. 721-729; Devendra, Canagasaby, and Derrick Thomas. "Smallholder farming systems in Asia." *Agricultural Systems*, vol. 71, no. 1–2, 2002, pp. 17-25; Harvey, Celia, et al. "Climate change impacts and adaptation among smallholder farmers in Central America." *Agriculture & Food Security*, vol. 7, no. 57, 2018, p. 1-20; Morton, John. "The impact of climate change on smallholder and subsistence agriculture." *Proceedings of the National Academy of Sciences*, vol. 104, no. 50, 2007, pp. 19680-19685.

[3] Aryal, Jeetendra, et al. "Climate change and agriculture in South Asia: Adaptation options in smallholder production systems." *Environment, Development and Sustainability*, vol. 22, 2020, pp. 5045-5075; Jones, Peter, and Philip Thornton. "The potential impacts of climate change on maize production in Africa and Latin America in 2055." *Global Environmental Change*, vol. 13, no. 1, 2003, pp. 51-59.

[4] *Factsheet: Smallholders and Family Farmers*. FAO, 2013.

[5] ibid.

[6] ibid.

[7] Singh, Pushpa. "Exploring gender approach to climate change and agroecology: Women farmer's search for agency in India." *Asian Journal of Social Science*, vol. 51, no. 1, 2023, pp. 18-24; Skinner, Emmeline. *Gender and Climate Change Overview Report*. Bridge, 2011, pp. 1-85.

[8] Although gender can refer to the social identities beyond being a man or woman, to incorporate general concepts being used in relevant literature, the present study follows the definition of gender suggested by FAO: social identities or roles that are related to being a man or woman; *see*, *The state of food and agriculture: Women in agriculture closing the gender gap*. FAO, 2011.

[9] Resurrección, Bernadette. "Gender, climate change and disasters." *UN Women*, 2021; Bryan, Elizabeth, et al. "Addressing gender inequalities and strengthening women's agency." *CGIAR GENDER Impact Platform Working Paper, vol.13*, 2023, pp. 1-34; Nchu, Innocent, et al. "Diagnosing Climate Adaptation Constraints." *Sustainability*, vol. 11, no. 14, 2019, p. 1-16.

[10] Carr, Edward, et al. "Understanding Women's Needs for Weather and Climate Information." *Weather, Climate, and Society*, vol. 8, 2016, pp. 247–264; Nyantakyi-Frimpong, Hanson. "Unmasking difference: Intersectionality and smallholder farmers' vulnerability." *Gender, Place & Culture*, vol. 27, no. 11, 2020, pp. 1536-1554.

and loan groups.[11] Some utilise indigenous knowledge about seeds and farming or their traditional roles as household caregivers.[12] These practices are not homogeneous; it is essential to understand intra-gender or intra-household differences based on socio-economic determinants including age, education level and marital status, which affect women farmers' adaptation behaviours.[13]

While an increasing number of studies explore the intersectionality between gender and climate change adaptation, they often portray women farmers solely as vulnerable 'victims' or 'less able' than their male counterparts.[14] This perspective is often valid, especially given ample evidence of women smallholder farmers' constraints in climate adaptation, as they are not only more vulnerable to climate change but also face greater barriers in adopting coping strategies.[15] However, it might hinder constructive considerations in policymaking and interventions that are more gender transformative. For instance, providing access to certain assets only to women within a community based on the binary understanding of women's vulnerability compared to men may not reflect the community's perception of collaboration between male and female farmers, nor does it capture heterogeneity within female groups.[16] Recognising 'gendered' perceptions and adaptation is important, yet, examining women farmers' unique way of understanding and coping with climate change, aligned with their 'agency,'[17] is equally significant.[18] A nuanced investigation into women farmers' adaptation strategies can offer insights into the domains of these practices and how effectively (or ineffectively) they utilise their options.

In line with this, it is crucial to explore the narratives in the literature, as they tend to vary even within the same geographical region, depending on the framework and approach.[19] While some studies focus more on women farmers' vulnerability, others explore their agency or potential as active participants in climate adaptation, with a few advocating for a more transformative approach that acknowledges the significance of women farmers' roles. This variation can lead to different policy implications, highlighting the importance of examining different narratives in the literature. Hence, the present study endeavours to suggest an alternative form of narrating women farmers' climate challenges and actions by incorporating broader literature on gender relations in agriculture

[11] Haque, A. T. M. Sanaul., et al. "Gendered perceptions of climate change and agricultural adaptation practices: A systematic review." *Climate and Development*, vol. 15, no. 10, 2023, pp. 885-902.
[12] Howard-Borjas, Patricia, and Willemijn Cuijpers. "Gender relations in local plant genetic resource management and conservation." *BIOTECHNOLOGY (EOLSS sample chapters)*, vol. 14, 2002, pp.1-11; Nyadzi, Emmanuel, et al. "Indigenous knowledge and climate change adaptation in Africa." *CABI Reviews*, 2021.
[13] Antwi, Kwabena, and Philip Antwi-Agyei. "Intra-gendered perceptions and adoption of climate-smart agriculture." *Environmental Challenges*, vol. 12, 2023, p. 1-11; Carr, Edward, and Mary Thompson. "Gender and Climate Change Adaptation in Agrarian Settings." *Geography Compass*, vol. 8, no. 3, 2014, pp. 182-197.
[14] Barooah, Prapti, et al. "Gender, agriculture policies, and climate-smart agriculture in India." *Agricultural Systems*, vol. 212, 2023, pp. 1-12; Garcia, Alicea, et al. "'Less able': How gendered subjectivities warp climate change adaptation." *Gender, Place & Culture*, vol. 27, no. 11, 2020, pp. 1602-1627.
[15] Gonda, Noémi. "Climate Change, "Technology" and Gender." *Gender, Technology and Development*, vol. 20, no. 2, 2016, pp. 149-168; Liru, Pauline, and Lindy Heinecken. "Building Resilience: The Gendered Effect of Climate Change." *Sustainability*, vol. 13, no. 7, 2021, pp. 1-13; Singh (n 7) *supra*.
[16] Khoza, Sizwile, et al. "Understanding gender dimensions of climate-smart agriculture adoption." *Disaster Prevention and Management*, vol. 28, no. 5, 2019, pp. 530-547.
[17] Agency is a concept frequently used in gender and developmental studies, referring to an individual's ability to make decisions and act accordingly; *see* Rao, Nitya, et al. "A qualitative comparative analysis of women's agency and adaptive capacity in climate change hotspots in Asia and Africa." *Nature Climate Change*, vol. 9, no. 12, 2019, pp. 964-971; Kabeer, Naila. "Resources, Agency, Achievements: Reflections on the Measurement of Women's Empowerment." *Development and Change*, vol. 30, no. 3, 1999, pp. 435-464.
[18] Liru and Heinecken (n 15) *supra*.
[19] Carranza, Marissa, and Meredith T. Niles. "Smallholder Farmers Spend Credit Primarily on Food." *Frontiers in Sustainable Food Systems*, vol. 3, 2019, pp. 1-14; Liru and Heinecken (n 15) *supra*.

and discussing relevant points in the Discussion section.

Perception is an under-researched area compared to adaptation in the context of gender and climate change[20] despite the empirical evidence that adaptation choice is often shaped by farmers' awareness and attitudes toward climate change.[21] Female farmers often have different awareness and attitudes toward climate change and demonstrate unique adaptation strategies compared to their male counterparts.[22] It is important to understand that perception is not a single, simple concept: it consists of a complex process of understanding climate change that shapes one's attitude, belief and concern and affects their perceived impacts and thereby their behaviours.[23] For instance, both men and women farmers may have similar awareness and understanding about climate change, but the attitude toward adaptation might be different, depending on how risk-averse or risk-taking they are.[24] Furthermore, their perceived impacts and vulnerability might vary; whilst men are more concerned about planting and harvesting, women may be concerned about food security and environmental degradation.[25] The present study aims to fill this gap by encompassing studies that address women smallholder farmers' climate perceptions and how these lead to specific adaptation behaviours. Additionally, expert interviews were conducted to gather nuanced and up-to-date information about the farmers' perceptions and gender differences.

Lastly, because many of the studies that examine women farmers' climate change perception and adaptation are centred on the African context, evidenced in Section 3, a research gap has been identified. More insights about Southeast Asia and Latin America, whose rural areas are severely vulnerable to recent changes in climate and related shocks, are supplemented by interviews with eight subject matter experts who are based in Southeast Asia and Central and South America to comprehensively provide a scoping review regarding women smallholders in the regions.

More recent studies about gender and climate change adaptation tend to approach the matter more holistically, focusing on intersectionality with other socio-economic determinants and identifying 'gendered' perception and adaptation.[26] Yet, the scholarship still lacks more detailed and nuanced examination of women farmers' agency and important roles in rural communities, specific adaptation strategies, linkage with perceptions, different narratives and the importance of collective action. The study aims to fill this gap by analysing a selection of 30 empirical studies drawn from a wide range of published papers between 2019 and 2023, deriving generalisable conclusions and identifying gaps for further research by answering these research questions:

(1) What are climate perceptions and adaptation strategies of women

[20] Haque et al. (n 11) *supra*.
[21] Makate, Clifton, et al. "Smallholder Farmers' Perceptions on Climate Change." *Social Sciences*, vol. 6, no. 1, 2017, pp. 1-14; Nyang'au, Jared O., et al. "Smallholder farmers' perception of climate change." *Heliyon*, vol. 7, no. 4, 2021, pp. 1-10.
[22] Ngigi, Marther W., et al. "Gender Differences in Climate Change Adaptation Strategies." *Ecological Economics*, vol. 138, 2017, pp. 99-108; Zamasiya, Byron, et al. "Factors influencing smallholder farmers' behavioural intention." *Journal of Environmental Management*, vol. 198, 2017, pp. 233-239.
[23] Madhuri, and Upasna Sharma. "How do farmers perceive climate change? A systematic review." *Climatic Change*, vol. 162, no. 3, 2020, pp. 991-1010; Ricart, Sandra, et al. "Climate change awareness, perceived impacts, and adaptation." *Regional Environmental Change*, vol. 23, no. 82, 2023, pp. 1-24.
[24] Molua, Ernest. "Farm income, gender differentials and climate risk in Cameroon." *Sustainability Science*, vol. 6, no. 1, 2011, pp. 21-35.
[25] Ayanlade, Ayansina, et al. "Gendered vulnerabilities to climate change." *Humanities and Social Sciences Communications*, vol. 10, no. 911, 2023, pp. 1-15; Barooah et al. (n 14) *supra*; Ge, Yuhang, et al. "Gender differences in smallholder farmers' adoption of crop diversification." *Climate Risk Management*, vol. 39, 2023; Meyiwa, Thenjiwe, et al. "Women in selected rural municipalities." *Agenda*, vol. 28, no. 3, 2014, pp. 102-114.
[26] Niemann, Johanne, et al. "Gender relations and decision-making on climate change adaptation." *PLOS Climate*, vol. 3, no. 1, 2024.

smallholder farmers in the Global South?

(2) What are the research gaps in gendered climate change perceptions and adaptation?

(3) What are the narratives in the gendered climate change perceptions and adaptation literature?

The next section of the present study illustrates the search strategy, eligibility criteria and details about interviews. Section 3 presents key findings, providing an analysis of the selected studies. Section 4 discusses the interpretation and limitations of the studies, introducing broader literature regarding gender relations in agriculture, and Section 5 synthesises the overall arguments of this paper.

II. **Research Methods**

This paper is based on a formal systematic review and expert interviews. The systematic literature review follows the main points from the 27 checklists proposed by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) protocol.[27] The checklists provide a useful guideline to capture the domains of the studies' findings and assessment. A systematic review is a review that collects and synthesises findings of studies, examining clear research questions.[28] By conducting this review, the research systematically synthesises the existing literature to provide a comprehensive overview of the topic encompassing climate perceptions, adaptation behaviours and different narratives, and discover consensuses, if any. Expert interviews were conducted as a supplementary tool to generate region-specific information on women farmers' perceptions and adaptation strategies in Southeast Asian and Latin American regions.

A. *Systematic Review*

Data sources include peer-reviewed journal articles from two electronic databases, *Scopus* and *Web of Science*, discussing gender and climate change perception/adaptation in agriculture in the Global South from 2019 to 2023, written in English. Since many of the existing systematic reviews address research done until 2019 or 2020,[29] the present study endeavours to complement that by retrieving the papers during that five-year period.

1. Search Strategy and Selection

A search string was developed using the main keywords including 'gender,' 'climate change,' 'adaptation,' 'perception' and 'smallholder.' The operators 'OR' for yielding as many possible studies as possible and 'AND' for narrowing down were used. To retrieve all relevant articles possible, wildcards were used where applicable, such as 'wom*' and 'small*.' A full search string is noted in **Appendix 1**. Field tags 'TITLE-ABS-KEY' for Scopus and 'Topic' (including title, abstract and keywords) for Web of Science were used.

The final selection of 30 papers included in the research followed a thorough process demonstrated in Figure 1 according to the eligibility and exclusion criteria. Initially, 914 studies were identified, and after excluding duplicates and irrelevant papers based on titles and abstracts, 102 studies were eligible for the full-text screening. Both studies addressing perception and adaptation, and those focusing on either, were included to comprehensively explore the perception and adaptation of smallholder farmers. Following the full-text screening, 72 studies were discarded, leaving 30 studies for the review. During the final screening, several exclusion criteria were applied to ensure the relevance of the findings. Non-empirical studies, those

[27] Page, Matthew, et al. "The PRISMA 2020 statement: An updated guideline for reporting systematic reviews." *BMJ*, 2021.

[28] Higgins, Julian, et al. *Cochrane Handbook for Systematic Reviews of Interventions*. Cochrane, 2019.

[29] Akinyi, Devinia, et al. "Trade-offs and synergies of climate change adaptation strategies among smallholder farmers in sub-Saharan Africa: A systematic review." *Regional Sustainability*, vol. 2, no. 2, 2021, pp. 130-143; Dev, Debashish, and Jaime Manalo. "Gender and adaptive capacity in climate change scholarship of developing countries: A systematic review of literature." *Climate and Development*, vol. 15, no. 10, 2023, pp. 829-840; Haque et al. (n 11) *supra*.

not focused on smallholder farmers, or those addressing solely climate vulnerability without clear implications for perception or adaptation, were excluded. Studies covering women smallholders' perception or adaptation toward *other* social- or environment-related topics that are not directly related to climate change were also not considered. Additionally, studies focusing primarily on other socio-economic factors, such as age, rather than gender were excluded. On the contrary, studies investigating intra-gender differences by examining various socio-economic determinants while focusing on gender analysis were considered. Lastly, articles that focus solely on female farmers were also included, with the aim to broadly capture women farmers' adaptation behaviours.

The studies' authors, publication years, study designs, theoretical frameworks, along with sample sizes, key variables, definitions of core terms, and narratives, were collected and examined. Particularly the analysis focused on the perceptions and/or adaptations of women farmers to climate change. The review finds key trends, such as the geographical focus on African countries, which are analysed in Section 3. Detailed information of selected studies is available in **Appendix 2**.

B. *Expert Interviews*

To supplement the study in Southeast Asia and Latin America as well as women smallholders' perceptions, subject matter expert interviews were conducted. The interviews served a dual purpose: identifying the general landscape of gendered climate vulnerability and adaptation in the regions of interest and understanding the experts' and beneficiaries' (women farmers') perceptions on the issue. Semi-structured interviews were conducted in May and June 2024 via online video meetings for up to 60 minutes with eight experts (four based in India and the Philippines and the other four based in Central and South America). The experts consist of six women and two men, who had experience working with women smallholder farmers in rural areas *and* in regard to climate change adaptation so that they can provide insights into the female farmers' perception and adaptation behaviours.

The interviews included the following main questions examining how the smallholders that experts have worked with perceive and adapt to climate change. The full questionnaires are noted in **Appendix 3**.

(1) What do you think are (or have been) the major barriers that women smallholders face in terms of climate variability and related hazards, especially compared to their male counterparts?

(2) What do you think are the women smallholders' perceptions on climate change and variability?

(3) What are the major adaptation behaviours/strategies that women smallholders take to cope with climate change?

(4) How are these perceptions and adaptation behaviours different from (or similar to) those of the male counterparts?

(5) Can you provide any examples or some anecdotal evidence of the sorts of issues that you have raised?

The ethical protocols to ensure data confidentiality and respondent anonymity were adhered to in accordance with the Data Protection Act.

III. **Results**

The findings of this study present general characteristics of the selected studies, the climate vulnerability and perceptions of women smallholders, and the diverse adaptation strategies they employ. The section also incorporates direct testimony from expert interviews to supplement the systematic review with lived experiences and regional nuances. The synthesis demonstrates that while climate awareness may be broadly

shared, vulnerability and perceptions remain gendered. The adaptation measures are categorised into absorptive, adaptive and transformative strategies, illustrating how they are utilised by women farmers across varying geographical and socio-economic landscapes. By highlighting the heterogeneity with female groups and research areas, this section identifies research gaps that are further scrutinised in Section 4.

A. *Characteristics of Selected Studies*

Among the 30 studies selected, 20 address both climate perception and adaptation, nine examine adaptation strategies or practices, and only one study focuses solely on perception. The study locations of most of the studies (n=23) are in Africa (with seven studies predominantly in Ghana). Six are in Asia (including one that spans both African and Asian countries), and only one study originates from the Latin American region. Figure 2 illustrates the detailed geographical distribution of these studies.

The concentration of studies in sub-Saharan Africa can be attributed to the region's high dependence on rain-fed agriculture[30] as well as active climate adaptation initiatives by governments and external entities, evidenced by the highest adaptation financial flows in the region in 2021.[31]

Data from 12,318 smallholder farmers and key informants were collected, with sample sizes ranging from 16 to 2,859. Fourteen studies employed mixed methods, incorporating climate data analysis, household surveys and interviews. Eight studies used qualitative research methods, while four utilised quantitative methods. A higher tendency to examine intra-household or intra-gender differences was found in quantitative studies, whereas qualitative studies often focused more on women's narratives and agency, occasionally using conceptual frameworks such as feminist theory or 'gendered' climate change.

All the selected studies met the inclusion and exclusion criteria, focusing on smallholder farmers engaged in rain-fed agriculture. Some studies included other key informants such as extension agents, experts or larger-scale farmers. However, only a few studies provided a clear definition of smallholder farmers. Additionally, many studies did not offer precise definitions of 'gender' or other critical terms under examination.

B. *Climate Vulnerability and Perceptions*

Most of the studies primarily address temperature rise, increased climatic events such as droughts and floods and erratic rainfall. For instance, a study in Nigeria confirmed significant warming based on temperature data from 1984 to 2020, indicating an increased likelihood of more frequent heat waves and warm dry spells.[32] Similarly, a study in Ghana traced the rainfall and temperature patterns from 2000 to 2015, finding substantial rain variability along with increased temperatures.[33] In Honduras, according to the World Bank Group data, the average temperature over five-year periods increased between 1991 and 2019.[34] Some studies focus on specific contexts such as farming near coastal areas or regions prone to floods and bushfires.[35]

These climate variabilities and related hazards affect the agricultural production of

[30] *World Development Report 2008: Agriculture for Development*. World Bank, 2008.
[31] *Adaptation Gap Report 2023*. United Nations Environment Programme, 2023.
[32] Akyala, Abraham, et al. "Gender-responsive approaches to rapid climate warming among smallholder farmers." *Current Research in Environmental Sustainability*, vol. 5, no. 1, 2023, pp. 1-10.
[33] Jamal, Alawi, et al. "Gendered perceptions and adaptation practices of smallholder cocoa farmers to climate variability in the Central Region of Ghana." *Environmental Challenges*, vol. 5, 2021, pp. 1-7.
[34] Palacios, Hazel, et al. "Gendered adaptations to climate change in the Honduran coffee sector." *Women's Studies International Forum*, vol. 98, 2023, pp. 1-39.
[35] Ahmed, Saleh, and Elizabeth Kiester. "Do gender differences lead to unequal access to climate adaptation strategies in an agrarian context? Perceptions from coastal Bangladesh." *Local Environment*, vol. 26, no. 5, 2021, pp. 650-665; Owusu, Victor, and Gordon Yiridomoh. "Assessing the determinants of women farmers' targeted adaptation measures in response to climate extremes in rural Ghana." *Weather and Climate Extremes*, vol. 33, 2021, pp. 1-7.

smallholder farmers, impacting their food and nutrition security, labour efficiency and overall household health.[36] However, these climate impacts are not gender neutral. All the selected studies begin by recognising that women farmers are more adversely affected by climate change than their male counterparts. They agree that men and women farmers have different levels of access to land resources such as water and firewood, which can disproportionately impact women in terms of food and nutrition security and increased drudgery.[37]

Of the 18 studies dealing with perception, 13 found no significant gender difference in climate perception. This can be attributed to the exacerbation of recent climate variability and hazards in terms of both magnitude and frequency. Expert interviews corroborate this finding. An expert based in India noted that the severity of recent climate struggles affects everyone equally, leading to similar perceptions between male and female farmers:

> *"It's just they're struggling right now. It affects everyone. The whole community is suffering". (Expert C, India)*

Another expert who was based in Guatemala agreed that the pervasive impact of climate change on daily life makes both men and women acutely aware of its effects:

> *"I think what is very astonishing is really that people, both men and women, have a very strong consciousness of climate change. [...] People are very well-informed. Their livelihoods depend on the climate, so they know very well". (Expert E, Guatemala)*

However, similar awareness does not imply identical ways of perceiving impacts or experiencing climate change. While the awareness might be similar, the way women farmers associate climate change with their circumstances differs from that of their male counterparts. For example, Barooah et al. found that women farmers in India linked climate change impacts to the purchase of household commodities, household well-being and food and nutrition security, whereas male farmers reflected them on agricultural productivity and income.[38] Bessah et al. discovered that while men perceive climate change through extreme cases, gender roles in agriculture shape their perceived climate vulnerability differently in a Ghanaian community.[39] Men, who are more involved in land preparation, are concerned about the onset of rainfall, while female farmers, who are more responsible for farm maintenance, respond more to its cessation.[40]

Akyala et al. also show that women farmers have a better grasp of climate change because they are more attached to their immediate environment, especially given their daily tasks involving natural resources.[41] Similarly, Ayanlade et al. found that Nigerian female farmers, who often engage in rain-fed subsistence farming, promptly perceive changes in rainfall or water availability, while male farmers are more likely to respond to market fluctuations or production performance.[42]

[36] Bessah, Enoch, et al. "Gender-based variations in the perception of climate change impact, vulnerability and adaptation strategies in the Pra River Basin of Ghana." *International Journal of Climate Change Strategies and Management*, vol. 13, no. 4/5, 2021, pp. 435-462; Nchanji, Eileen, et al. "Gender differences in climate-smart adaptation practices amongst bean-producing farmers in Malawi: The case of Linthipe Extension Planning Area." *Frontiers in Sustainable Food Systems*, vol. 6, 2022, pp. 1-13.

[37] Assan, Elsie, et al. "Climate change perceptions and challenges to adaptation among smallholder farmers in semi-arid Ghana: A gender analysis." *Journal of Arid Environments*, vol. 182, 2020; Barooah et al. (n 14) *supra*.

[38] Barooah et al. (n 14) *supra*.

[39] Bessah et al. (n 36) *supra*.

[40] ibid.

[41] Akyala et al. (n 32) *supra*.

[42] Ayanlade et al. (n 25) *supra*.

There is no consensus on whether men or women farmers perceive climate change more severely, yet these findings indicate that women and men might understand its impacts differently. This difference can lead to varied adaptation strategies, influenced by socio-economic and regional contexts such as access to land and assets. For example, the association of climate change with the food security of the family can induce women into consuming less food to ensure their children's well-being,[43] while men seek adaptive, innovative measures to compensate for crop loss due to climate variability.

This underscores that climate perception should be understood in a gender-disaggregated way, considering diverse facets that ultimately affect adaptation choices. Based on the conceptualisation of Madhuri and Sharma, the 'awareness' of climate change and variability in different forms (e.g., erratic rainfall, droughts or temperature rise) and the 'conceptual understanding' of its causes can be similar for both genders.[44] However, the 'perceived impacts' or 'perceived vulnerability' on crop yields, income and household food security and well-being (i.e., the specific impacts with which farmers most strongly associate climate change) can vary according to gender norms and roles.[45] Coupled with other socio-economic variables and structural barriers discussed in the next section, these varied perceptions can lead to different adaptation behaviours and strategies.

Experts also emphasised these gender-specific perceptions:

> *"For men what is going on with the productivity of the land [is the first]. […] Rain patterns are switching from year to year. […] But for women it is what is going on in their household – 'what do I get to feed my children'". (Expert F, Mexico)*

> *"Women relate a lot of weather stuff with diseases. Women are able to tell you, 'We flooded, and all kids got diarrhoea or something'. Men come and talk about production, 'Yeah, I lost all the maize and beans'". (Expert H, Guatemala)*

Ultimately, although levels of climate awareness across genders might be similar, the perceived impacts remain gendered, leading to distinct adaptation measures. These findings highlight the necessity of capturing gender-specific understandings of climate change and integrating them into the design of adaptation policies and programmes.

C. *Women Smallholder Farmers' Adaptation Strategies*

Despite the significant challenges posed by climate change and related hazards, women and men farmers develop various strategies to adapt. However, as no unified typology comprehensively captures these measures, this research inductively categorises these strategies based on frameworks by Liru and Heinecken[46] as well as International Institute for Environment and Development (IIED)[47] and OECD's classification.[48] The strategies are categorised into three main types: absorptive, adaptive and transformative (See Table 1). These categories are not mutually exclusive; for instance, livelihood diversification is not only an adaptive strategy but also can be transformative, essential to resilience.[49]

[43] Dibakoane, Siphosethu, et al. "Vulnerability, impact and adaptation strategies of female farmers to climate variability." *Jàmbá: Journal of Disaster Risk Studies*, vol. 14, no. 1, 2022.
[44] Assan et al. (n 37) *supra*; Madhuri and Sharma (n 20) *supra*.
[45] Akyala et al. (n 32) *supra*; Ayanlade et al. (n 25) *supra*; Barooah et al. (n 14) *supra*; Bessah et al. (n 36) *supra*.
[46] Liru and Heinecken (n 15) *supra*.
[47] Kaur, Nanki, et al. "Building resilience to climate change through social protection: Lessons from MGNREGS, India." *IIED Working Paper*, IIED, 2019.
[48] Wreford, Anita, et al. *Climate Change and Agriculture: Impacts, Adaptation and Mitigation*. OECD, 2010.
[49] Leal Filho, Walter, et al. (Eds.). *African Handbook of Climate Change Adaptation*. Springer, 2021; Mohammed, Kamaldeen, et al. "Livelihood diversification strategies

Absorptive strategies are reactive or consumption-based measures that address immediate impacts without long-term consideration, including consuming less, selling assets or migrating. Adaptive strategies focus on securing agricultural production to respond promptly to climate change, thereby minimising crop loss or mitigating food insecurity risks. Transformative strategies entail structural changes in livelihoods or collective behavioural shifts at the community level, aimed at building mid- or long-term resilience.

1. Absorptive Strategies

Women farmers often resort to absorptive strategies during climate-related shocks, primarily through dietary adjustments (i.e., eating less) or by prioritising their children's nutrition.[50] In other cases, farmers choose to migrate to urban areas or other parts of the country for job opportunities, although it is less common among women.[51] These strategies are predominantly reactive, providing short-term relief but not necessarily contributing to long-term resilience.[52] They can in effect lead to 'maladaptation,' with increased risk of climate-related outcomes, including reduced welfare.[53]

Two studies highlight women farmers' absorptive behaviours, such as reducing food consumption for their children and selling household belongings.[54] These behaviours are associated with women farmers or female-headed households having more responsibilities for household food security and well-being.[55] Notably, since this association is strong, i.e., female farmers are in charge of food security of their family, inability to secure resources can lead to gender-based violence.[56] Under such constraints, farmers often rely on food borrowing and social networks such as neighbours or friends.[57] Expert testimony validates the negative strategy of women and men farmers when hit by climate shocks.

> *"We realised that most people do not have any kind of coping mechanisms. I mean, they are just reacting. [...] If they get flooded, they will sell pigs or chickens. They stop sending children to school because they cannot afford. They migrate, especially men. [...] They just do like 'I don't have food; I will eat less'". (Expert H, Guatemala)*

Migration is less common among female farmers because they are often tied to their households or communities due to child-rearing and household responsibilities. When household breadwinners (i.e. male farmers) migrate for job opportunities, this shapes a dynamic of the abandoner and abandoned, making women farmers even more vulnerable. Women manage the farming operations and household responsibilities, frequently without the ability to own land in the absence of their husbands.[58] On the other hand, some studies examined the 'feminisation' of agriculture once men out-migrate, albeit with varying

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and resilience to climate change in semi-arid northern Ghana." *Climatic Change*, vol. 164, no.53, 2021.

[50] Kaur et al. (n 47) *supra*; Liru and Heinecken (n 15) *supra*.

[51] Ahmed and Kiester (n 35) *supra*; Ayanlade et al. (n 13) *supra*; Barooah et al. (n 14) *supra*; Bessah et al. (n 36) *supra*; Jamal et al. (n 33) *supra*; Lawson, Elaine, et al. "Dealing with climate change in semi-arid Ghana: Understanding intersectional perceptions and adaptation strategies of women farmers." *GeoJournal*, vol. 85, no. 2, 2020, pp. 439-452; Najjar, Dina, et al. "A feminist political ecology of agricultural innovations in smallholder farming systems: Experiences from wheat production in Morocco and Uzbekistan." *Geoforum*, vol. 146, 2023; Palacios et al. (n 34) *supra*; Singh (n 7) *supra*.

[52] Rao, Nitya, et al. "Gendered vulnerabilities to climate change: Insights from the semi-arid regions of Africa and Asia." *Climate and Development*, vol. 11, no. 1, 2019, pp. 14-26; Lawson et al. (n 51) *supra*.

[53] IPCC. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, 2022.

[54] Dibakoane et al. (n 43) *supra*; Liru and Heinecken (n 15) *supra*.

[55] Assan et al. (n 37) *supra*; Ayanlade et al. (n 25) *supra*.

[56] Liru and Heinecken (n 15) *supra*.

[57] Carranza and Niles (n 19) *supra*; Jamal et al. (n 33) *supra*.

[58] Jamal et al. (n 33) *supra*; Khoza et al. (n 16) *supra*.

consequences. Some show that women's double responsibilities of farm work are intensified,[59] while others imply that women can gain decision-making power in the absence of men.[60] Nonetheless, Khoza et al. found that while *de jure* female-headed households may make decisions more independently compared to women in coupled households, adoption of adaptive measures can still be limited by women's lack of ownership and access to land, underscoring the importance of a land reform.[61]

In specific instances, younger female farmers migrate due to inexperience in farming and presumably fewer household-related responsibilities.[62] This can possibly exacerbate the already feminised agriculture, burdening the women farmers who remain. Notwithstanding temporary improvements in gender dynamics, however, migration is less likely to be a transformative strategy since long-term, community level resilience-building requires both genders. A study in Ghana notes that the communities view gender equality as a collaboration of both genders,[63] implying that migration can hinder this collaboration in agricultural or non-agricultural activities, leading to increased food insecurity and excessive burdens on women who stay.[64]

Consequently, these findings illustrate that women's adaptation is frequently circumscribed by absorptive or reactive measures such as adjustments in storage, consumption or localised mobility. While women manage diet and food security, their male counterparts more commonly pursue to migrate in search of diverse opportunities. These patterns naturally vary across socio-economic contexts; nevertheless, the resulting 'feminisation' of local responsibilities can stifle broader community engagement and collective resilience, rendering migration an inadequate strategy for long-term transformative adaptation.

2. Adaptive Strategies

Crop and land management measures are the most common adaptation practices among both women and men farmers. Twenty-four studies mention crop management practices including changing the planting/harvesting dates, crop rotation, intercropping/mixed cropping, changing cropping patterns such as using crop varieties and using improved seeds like drought-resistant or early maturing crops. Occasionally, farmers also use bed raising and bush fallowing.[65] Some studies (n=5) examined climate-smart agriculture (CSA) as an adaptive strategy, an approach that aims to increase agricultural productivity while mitigating greenhouse gas emissions and building resilience,[66] which often includes various crop management practices mentioned above. Crop management, especially planting and cropping stages, involves significant decision making, and women are often less included in this process.[67] This exclusion is linked to social contexts where women farmers lack land ownership or control. To illustrate, in rural Ghana, while women generally hold legal rights to own and inherit land, entrenching these rights in practice remains challenging, thereby hindering their capacity to adopt adequate agricultural measures.[68]

In Kenya, women's access to assets significantly influences their ability to diversify crops.[69] Acheampong et al. concluded that land ownership does not show a significant gender association in the

[59] Singh (n 7) *supra*.
[60] Najjar et al. (n 51) *supra*; Owen, Mafongoya. "Social Capital and Food Security amongst Women in Smallholder Farming in the Face of Climate Change in Bikita, Zimbabwe." *Africa Development*, vol. 47, no. 3, 2022, pp. 253-272.
[61] Khoza et al. (n 16) *supra*.
[62] Owusu and Yiridomoh (n 35) *supra*.
[63] Khoza et al. (n 16) *supra*.
[64] Jamal et al. (n 33) *supra*; Singh (n 7) *supra*.
[65] Ayanlade et al. (n 25) *supra*; Shahbaz, Pomi, et al. "Adoption of Climate Smart Agricultural Practices through Women Involvement in Decision Making Process: Exploring the Role of Empowerment and Innovativeness." *Agriculture*, vol. 12, no. 8, 2022.
[66] *Climate-Smart Agriculture Sourcebook*. FAO, 2014.
[67] Ge et al. (n 25) *supra*; Khoza et al. (n 16) *supra*.
[68] Jamal et al. (n 33) *supra*; Lawson et al. (n 51) *supra*.
[69] Liru and Heinecken (n 15) *supra*.

smallholding context but asserted that there might be other factors explaining why men are typically in a better position to make crop-related decisions, supported by the larger farm sizes they own.[70] Women's participation in different steps of the farming process, such as harvesting and post-harvesting, often excludes them from decision-making processes related to planting dates or cropping patterns.[71]

Studies that examine socio-economic determinants imply that the adoption of these measures differs by age, marital status and household size, while the aspects are varied by the study areas. For instance, in Ghana, married farmers are less inclined to adopt crop rotation because it necessitates decision-making, and households with more family members tend to avoid mixed cropping in favour of monoculture or cash crops, presumably due to the immediate need to feed more mouths.[72] On the contrary, another study, also from Ghana, found that larger household sizes increase the likelihood of adopting crop diversification to boost food production levels.[73] These divergent findings may be due to the different crops studied (the former covers bean and cowpea while the latter has not specified a type of crops) or varying local contexts.

Eleven studies examine the use of improved seeds or resilient crops, such as early maturing crops or disaster-resilient crops like millets. Studies in Ghana and India associated them with female agency, emphasising their roles as seed custodians who possess valuable indigenous knowledge about seeds.[74] However, men often have better access to improved seeds, including salinity-tolerant crops in coastal Bangladesh and quality seeds or hybrid seeds through formal networks like government institutions or seed companies.[75] This access disparity is due to men's greater social capital and assets, while women farmers rely more on informal networks like neighbours or female groups. In an article that researched Kenya, Tanzania and Uganda, the types of crop varieties accessed through these networks differ by gender, reflecting gender roles in production of certain crops.[76] For instance, in Tanzania and Uganda, women predominantly mention bean varieties, while this tendency is not seen in Kenya.

Livelihood diversification is another adaptive strategy, involving shifts to off-farm activities (n=11). Livelihood diversification in the climate adaptation context is the process of creating diversity in livelihood strategies to spread the risk and respond to hardships by either intensifying the efforts in the farming sector or moving from on-farm to off- or non-farm activities.[77] Crop diversification can also be characterised as one of the livelihood diversification activities, however, in this study it is categorised under crop management practices. Women farmers are engaged in various livelihood diversification activities more actively than men farmers, which include changing occupations or seeking income-generating practices, such as livestock farming, shea butter processing, handicrafts, basketry, petty trading or hairdressing. This concurs with one of the experts' responses about how the livelihood diversification is preferred by women farmers.

> *"They (women farmers) won't necessarily make the investments of which fertilisers to buy or which productive*

[70] Acheampong, Patricia., et al. "Gendered perceptions and adaptations to climate change in Ghana: What factors influence the choice of an adaptation strategy?" *Frontiers in Sustainable Food Systems*, vol. 7, 2023.
[71] Nuhu, Mohammed, and Kenichi Matsui. "Gender Dimensions of Climate Change Adaptation Needs for Smallholder Farmers in the Upper East Region of Ghana." *Sustainability*, vol. 14, no. 16, 2022.
[72] Acheampong et al (n 70) *supra*.
[73] Antwi and Antwi-Agyei (n 13) *supra*.
[74] ibid; Singh (n 7) *supra*.
[75] Ahmed and Kiester (n 35) *supra*. Marimo, Pricilla, et al. "The Role of Gender and Institutional Dynamics in Adapting Seed Systems to Climate Change: Case Studies from Kenya, Tanzania and Uganda." *Agriculture*, vol. 11, no. 9, 2021.
[76] ibid.
[77] Mohammed et al (n 49) *supra*; Yaro, Joseph. "Is deagrarianisation real? A study of livelihood activities in rural northern Ghana." *The Journal of Modern African Studies*, vol. 44, no. 1, 2006, pp. 125-156.

> *assets for the field to buy – those would be made by men. […] The work they (women farmers) also do a lot with the house animals such as chickens is very intensive [but] doesn't require them to travel those extra metres or kilometres to the farm". (Expert G, Central and South America)*

Not surprisingly, the extent and nature of women's engagement in these activities vary by regional context. For example, a study in Ghana attributes female-headed households having more income-generating options than male-headed households to women's diverse cultural and gender roles,[78] while women in Honduras face mobility limitations that restrict their job opportunities.[79]

Parallel to existing literature, women in male-dominated agricultural communities often seek off-farm income sources,[80] which is parallel to existing literature that shows the relationship between gender of farmers and seeking non-agricultural income sources as an adaptation strategy.[81] This can be attributed to women's lack of decision-making power and capital to make diversification choices in crop farming. Meanwhile, in some areas, men migrate for long-term job opportunities, leading to the feminisation of agriculture.[82] This trend and women's extensive roles in agriculture are particularly noted in studies from Asia, aligning with insights from interviews.

> *"In the Philippines, women are [involved] in farming, and it's not just vegetation and trees and producing fruit, but it's also taking care of animals or husbandry". (Expert D, The Philippines)*

> *"Women largely take roles in agriculture. […] Women do like a lot of manual hard work, which is taking out the weeds or sowing the seeds. […] Technical stuff like putting spraying fertiliser or purchasing the inputs, when it comes to money control or finance, is always in the hand of the male". (Expert C, India)*

Technological or infrastructural measures such as irrigation, fertilisers or pesticides are mentioned in nine studies but are more common among male farmers due to better access to assets or credits.[83]

Adaptation behaviours for coping with specific climate-related disasters, such as floods or bushfires, are mentioned in one study.[84] Examples include moving away from flood-prone areas, using drains to control floods or building fire belts for bushfires. Adoption of these measures varies with the age of female farmers; younger women tend to move away, while older women rely on their farming knowledge and experiences.

Finally, some studies examined 'exchange' strategies, as Agrawal suggested,[85] where farmers transact assets to offset crop loss or mitigate income loss.[86] While selling assets can provide short-term 'cushion' and improve

[78] Mensah, Michael, et al. "Gender and climate change linkages in the semi-arid region of Ghana." *GeoJournal*, vol. 87, no. 1, 2022, pp. 363-376.
[79] Palacios et al. (n 34) *supra.*
[80] Lawson et al. (n 51) *supra*; Mensah et al. (n 78) *supra*.
[81] Fadina, Adégnandjou, and Dominique Barjolle. "Farmers' Adaptation Strategies to Climate Change and Their Implications in the Zou Department of South Benin." *Environments*, vol. 5, no. 1, 2018; Yiridomoh, Gordon, et al. "Climate variability and rural livelihood sustainability: Evidence from communities along the Black Volta River in Ghana." *GeoJournal*, vol. 86, no. 4, 2021, pp. 1527-1543.
[82] Najjar et al. (n 51) *supra*; Shahbaz et al. (n 65) *supra*; Singh (n 7) *supra*.
[83] Ayanlade et al. (n 25) *supra;* Dibakoane et al. (n 43) *supra*.
[84] Owusu and Yiridomoh (n 35) *supra.*
[85] *see*, Agrawal, Arun. "The role of local institutions in livelihoods adaptation to climate change." The World Bank Social Dimensions of Climate Change Workshop, 2008.
[86] Liru and Heinecken (n 15) *supra*; Mensah et al. (n 78) *supra*.

food security, however, although categorised as an adaptive measure in this study, it may have long-term negative impacts on well-being. To illustrate, households may sell livestock to supplement food, ensuring immediate food security but potentially losing a valuable asset for long-term resilience and hence arguably functioning more as an absorptive measure.[87]

A few studies mention women farmers' crop trading in the market as an adaptive strategy for extra income to secure household food availability. However, they agree that due to gender norms and women's lack of capital, crop trading is usually dominated by men's networks,[88] which is consistent with an expert's observation:

> *"It is the work of the female farmer to remove the milk every day. Twice. It's the work of the female farmer to remove the cow dunk. But when the milk is sold at the market, it is the male farmer who goes and sells the milk and takes accountability of the money". (Expert A, India)*

Despite these constraints, women farmers engage in selling products such as handicrafts or baskets.[89] Meanwhile, commercialising agricultural products may negatively impact women's control in households, while diversifying crops can provide a 'social safeguard,' suggesting that market activities for women farmers need careful design to avoid further marginalisation.[90]

Ultimately, while women farmers actively employ adaptive measures, ranging from crop management and livelihood diversification to the exchange of assets, their strategies are shaped by gendered socio-economic factors and constraints. Male farmers typically control high-value assets, formal networks and market-based decisions; on the contrary, women are often relegated to informal or absorptive measures. This disparity is driven by persistent inequalities in land ownership, capital access and decision-making power, creating a gendered landscape where women's adaptation strategies remain more localised and reactive than those of their male counterparts.

3. Transformative Strategies

Certain female farmers adopt strategies that yield long-term benefits, empowering themselves to gain more decision-making power and respond effectively to climate-related hazards.

Conservation practices in this sense can be transformative, providing a buffer to minimise risk while offering additional assets (e.g., tree shade for crops or natural fertilisers from compost manure). 14 studies examine conservation measures including agroforestry (usually tree planting), mulching, cover cropping and compost manure, though some of these practices are introduced as part of CSA. The studies indicate that women farmers tend to be more environmentally concerned and thereby prefer practices that minimise environmental harm, such as using natural fertilisers instead of chemical pesticides and participating in nature restoration activities.[91] On the other hand, despite their environmental concerns, women often face barriers to adopting conservation practices, such as sustainable forestry or strategically planting targeted crops against warming, due

[87] Asale, Maxwell, et al. "Livestock ownership and household food security in Northern Ghana: Is there a nexus?" *SN Social Sciences*, vol. 4, no. 3, 2024; Liru and Heinecken (n 15) *supra*

[88] Ahmed and Kiester (n 35) *supra*; Otieno, Gloria, et al. "Gender and Social Seed Networks for Climate Change Adaptation: Evidence from Bean, Finger Millet, and Sorghum Seed Systems in East Africa." *Sustainability*, vol. 13, no. 4, 2021.

[89] Ahmed and Kiester (n 35) *supra*.

[90] Tavenner, Katie, et al. "Intensifying Inequality? Gendered Trends in Commercializing and Diversifying Smallholder Farming Systems in East Africa." *Frontiers in Sustainable Food Systems*, vol. 3, 2019.

[91] Barooah et al. (n 14) *supra*; Huluka, Admassu. "Is there any gender difference in environmental concern? Evidence from the smallholder farmers in Oromia regional state of Ethiopia." *Cogent Social Sciences*, vol. 8, no. 1, 2022; Mensah et al. (n 75) *supra*.

to less control over land and resources.[92] To illustrate more, Nchanji et al. found that male respondents preferred conservation agriculture as it is less labour-intensive and less costly, particularly where herbicides are used.[93] The positive correlation between land tenure as well as size and the use of conservation agriculture, however, underscores that male farmers (who often possess larger farms) are better positioned to adopt these practices compared to women in the first place. This can potentially hinder more proactive engagement of women farmers in conservation activities, despite their awareness of environmental degradation. Recognising this barrier, an expert also emphasised the importance of education and capacity building with a gender focus when promoting sustainable farming, because women are better at knowledge dissemination:

> *"It took a while to educate them, and I think that's very important. The education piece was critical to have that change of behaviour […] [about] how they get into a new way of earning and making money and living. […] They're more conscious about like reserving resources and not wasting them, given that they have limited resources to begin with. […] They talk about it more to their peers and become an advocate of sustainable farming. […] It's more of the women that are convincing in the Philippines when there's something new. […] They're the bearer of the news". (Expert D, The Philippines)*

Four studies emphasise the importance of communal resilience-building activities, especially for women empowerment and enhancing the gender-transformative approach of climate change adaptation programmes. Women farmers actively use their social networks to spread and mitigate risks by joining self-help groups, savings and loans groups, cooperatives and producers' groups. In a study from Ghana, where women are often excluded from land management decision-making, many female respondents participate in mutual help groups called *susu*, saving cash for the future and sharing information.[94] Liru and Heinecken[95] found that nearly all female farmers in their sample belong to social groups like self-help groups, securing loans and accessing training by connecting to formal institutions. This collective effort helps women farmers participate in mitigating climate risks and responding promptly to potential harm to agriculture. This is evidenced in the responses of experts who have worked on climate adaptation and resilience-building projects in Central America.

> *"When the COVID first hit and the lockdown happened, when all the husbands lost their jobs [as day labourers], the women coming together from those savings groups think 'Okay, we have these savings'. […] [And they discussed] 'how we are going to distribute this to provide some kind of cushion, a protection for the families that were most affected'. This is, I think, a very positive example not only of a protection that people have in case of a shock but also of how women kind of become these agents of positive change in their own communities". (Expert E, Guatemala)*

> *"So, what we start with women is these loans and savings groups. […] We try to make them create them this new 'money-thinking'. We try to develop the idea that money*

[92] Akyala et al. (n 32) *supra*.
[93] Nchanji et al. (n 36) *supra*.
[94] Nuhu and Matsui (n 71) *supra*.
[95] Liru and Heinecken (n 15) *supra*.

> *brings money". (Expert H, Guatemala)*

Typically through associations or women's groups, female farmers also engage in joint community development activities, including constructing small dams or communal gardening. One study examined a community in Zimbabwe where various on- and off-farm projects were implemented with other entities, assessing their effectiveness in climate change adaptation.[96] One example is communal gardening with high-value horticulture crops, where women could explore their potential without male interference, as men had little interest in gardening. It was observed that social relations among women contributed to the success of the project, supplementing food availability. As supported by the case study, communal pooling of resources and joint community-building projects can create a space for not only resilience-building of the entire community but also where women can be empowered. Moreover, community engagement can facilitate communication among the farmers and go a long way towards sustainable development.[97]

Access to information, resources and technologies through extension services is crucial for women and men farmers to adopt other adaptation measures. Some CSA practices are most effectively transmitted to farmers through extension services.[98] Lawson et al. also argue that along with education, extension services equip female farmers with applying better technologies in their farming.[99] Acheampong et al. found that targeted efforts to provide extension services to women farmers empowered them to adopt adaptation strategies more effectively.[100] However, women farmers are often marginalised in accessing these services and hence climate information due to a stereotype that they are not agrarians, coupled with pre-existing gender inequalities and lack of land control as well as social capital.[101]

Lack of media assets like radios, televisions or mobile phones, which are crucial for accessing services and information, exacerbates this constraint.[102] Men are typically more exposed to extension services, gaining necessary climate information and improved seeds, while women rely on secondary information from neighbours or informal networks.[103] Expert interviews confirm that indigenous women are particularly marginalised due to language barriers.

> *"All women are what we call at the end of line. [...] When you add the transversality of being indigenous, it goes way back. So the main challenge is that these women do not speak Spanish.". (Expert H, Guatemala)*

Structural constraints that hamper women farmers to adopt transformative strategies underscore the need for inclusive, gender-sensitive approaches in climate adaptation, ensuring women have equal access to resources, information and decision-making opportunities.

In essence, these findings demonstrate that women farmers, often as through collective action, adopt long-term, transformative strategies to build climate resilience. These measures encompass conservation practices, community development initiatives and engagement with extension services. The efficacy of these transformative pathways, however, is frequently constrained by structural inequalities, resource scarcities and gender norms, implying that these

[96] Owen (n 60) *supra*.
[97] Ringler, Claudia, et al. "Enhancing women's assets to manage risk under climate change: Potential for group-based approaches." *International Food Policy Research Institute (IFPRI)*, 2014.
[98] Barooah et al. (n 14) *supra*.
[99] Lawson et al. (n 51) *supra*.
[100] Acheampong et al. (n 70) *supra*.
[101] Assan et al. (n 37) *supra;* Bessah et al. (n 36) *supra*; Marimo et al. (n 75) *supra*; Owusu and Yiridomoh (n 35) *supra*; Singh (n 7) *supra*.
[102] Barooah et al. (n 14) *supra*; Lawson et al. (n 51) *supra*.
[103] Marimo et al. (n 75) *supra*; Otieno et al. (n 88) *supra*.

interventions should be designed with a deliberate and intersectional gender lens.

D. *Research Gap*

Several research gaps were identified, as illustrated in Figure 3. These gaps are conceptualised across three distinct layers: the thematic scope of the research (distinguishing between studies covering both perception and adaptation behaviour, adaptation only, or perception only); the geographical focus (categorised by Africa, Asia and the Americas); and the analytical narrative (contrasting frameworks of vulnerability versus agency). While the evidence map intuitively illustrates the frequency and distribution of the selected studies, the specific substantive gaps are detailed in the following subsections.

Twenty out of 30 studies explore women's and men's perceptions of climate change, primarily focusing on 'awareness.' Consequently, many conclude that there is no significant difference between these perceptions. It is true that recent climate changes and variations have become so severe that they affect everyone; however, the way men and women associate climate change with their gendered roles in households and communities is often overlooked. More in-depth research on the intersectionality between gender and climate change perception in agricultural settings (i.e., how gender roles and responsibilities shape climate perceptions) and how these perceptions lead to different adaptation behaviours can provide valuable insights for policymakers and intervention entities when designing gender-integrated programmes.

Similarly, as seen in the evidence gap map (**Figure 3**), referring to Annor et al.,[104] perception is a less researched area despite empirical evidence showing farmers' awareness and attitudes of climate change construct their adaptation choices.[105] Expert interviews as well as the selected studies suggest that while both genders may have similar awareness and understanding of climate change, their perceived impacts and association with vulnerability could vary.[106] This difference implies varied adaptation choices for women farmers and thus different policy suggestions for climate change adaptation programmes.

Adaptation strategies can vary also by socio-economic determinants such as age, marital status, education level, household size, religion and stratified class, such as caste. Recognising that adaptation practices are not homogeneous even among women farmers and addressing these intra-gender differences can offer more nuanced, tailored approaches in designing adaptation programmes. For instance, in India, women from certain hierarchy castes may have less access to assets and credits, affecting their ability to demonstrate agency.[107]

Moreover, the discussed topics in Asia and Latin America are under-researched. This can be attributed to the substantial climate adaptation programmes and funds available in Africa, especially sub-Saharan African regions, as well as their significant climate vulnerability. The exclusion of studies that are not written in English may also contribute to this gap. However, as indicated by the finance gap between needed and actual funds for adaptation in Southeast Asia and high adaptation costs in Latin America and the Caribbean in 2021,[108] these regions require more interest and investigation, particularly with advanced gender analyses of cultural

[104] Annor, Frank, et al. "Insurance Under-performance: What is the Future of Index Insurance? – A systematic review and evidence gap analysis." *Report for Working Group*, 2023.

[105] Makate et al. (n 21) *supra*; Nyang'au et al. (n 21) *supra*; Nyantakyi-Frimpong, Hanson, and Rachel Bezner-Kerr. "The relative importance of climate change in the context of multiple stressors in semi-arid Ghana." *Global Environmental Change*, vol. 32, 2015, pp. 40-56.

[106] Ayanlade et al. (n 25) *supra*; Barooah et al. (n 14) *supra*; Bessah et al. (n 36) *supra*.

[107] Barooah et al. (n 14) *supra*; Singh (n 7) *supra*.

[108] *Adaptation Gap Report 2023: Underfinanced. Underprepared. Inadequate investment and planning on climate adaptation leaves world exposed*. United Nations Environment Programme, 2023.

norms and distinct local contexts. Southeast Asia is experiencing feminisation of rural areas,[109] adding another layer of understanding of women's burdens in the context of climate adaptation. This could also be interpreted as women's increased roles and autonomy, although it necessitates scrutiny. Either way, such dynamics offer an opportunity to understand women's agency more holistically and could be relevant for comparative analysis of regions with different patriarchal/matriarchal systems.

Many studies acknowledge 'gendered' adaptation but often focus on the binary view of 'more able-less able' dynamics of male and female farmers, potentially overlooking women's unique ways of understanding and coping with climate change. This binary view may also fail to notice intersecting determinants such as age, marital status and class that can affect female farmers' adaptation choices.[110] Furthermore, it can lead to short-sighted, simplistic adaptation programmes that still consider 'gender equality,' e.g., providing assets only to women, which might induce conflicts or, in some cases, gender-based violence.[111] A nuanced understanding of what community members perceive as gender equality can offer insightful guidelines for holistic and locally contextualised adaptation programmes.[112]

Ultimately, these gaps reveal a critical need for a more multidimensional approach to gendered climate research. Current literature remains constrained by a focus on general awareness rather than the depth of gendered perceptions, often overlooking how socio-economic determinants, such as age, class and marital status, create intra-gender diversities in adaptation. This is compounded by a notable regional skewness, where the lack of evidence from Asia and Latin America limits our understanding of how different cultural systems influence resilience. Furthermore, by moving beyond a binary view of gender that frames women solely as victims or men as the default 'enablers,' research can better capture the complexities of agency. These intersecting gaps, explored in depth in the following section, underscore the need to shift from simplistic, top-down interventions toward gender-transformative policies that reflect the lived realities of women farmers in the Global South.

IV. **Discussion**

The present study gives a comprehensive overview of climate perception and adaptation among women smallholder farmers in the Global South's rural communities by systematically reviewing the recent studies on the topic. The selected articles provide useful empirical evidence of women farmers' climate vulnerability, reaffirming the existing literature on gender dynamics in the context of climate change[113] and their similar or varied perception and adaptation strategies compared to male counterparts, suggesting critical implications for pre-existing gender norms and socio-economic determinants affecting these farmers' attitudes toward climate change and their coping mechanisms. By addressing structural barriers such as lack of land ownership, they imply useful guidelines for policymakers on fundamental policy changes considering cultural norms and adopting a more gender-transformative approach in climate change adaptation programmes.

Most studies employ adequate research methods to capture the effect of socio-economic factors, including gender, on certain adaptation behaviours or the narrative of the respondents (farmers and key informants). Qualitative-based articles provide insights into farmers' knowledge, understanding of livelihoods, environmental changes and their reactions and strategies to climate variability and shocks. While most studies are well-

[109] Shahbaz et al. (n 65) *supra*; Singh (n 7) *supra*.
[110] Bryan et al. (n 9) *supra*; Djoudi, Houria, et al. "Beyond dichotomies: Gender and intersecting inequalities in climate change studies." *Ambio*, vol. 45, no. S3, 2016, pp. 248-262.
[111] Owen (n 60) *supra*; Palacios et al. (n 34) *supra*.
[112] Khoza et al. (n 16) *supra*.
[113] Agrawal, Arun. *Social Dimension of Climate Change*. The World Bank, 2008; Carr et al. (n 10) *supra*; Nyantakyi-Frimpong and Bezner-Kerr (n 105) *supra*.

structured and focused with clear research questions and findings, some fail to pinpoint structural reasons or unveil local contexts explaining the differences in climate perception and adaptation between genders. For instance, a study in Ghana notes the gender difference in extension and credit services but does not sufficiently explain why this occurs or how it leads to different adaptation strategies.[114] Rosen et al., while providing useful insights into male out-migration and negative coping strategies among women farmers, do not offer a gender-disaggregated analysis of on-farm adaptation strategies.[115]

The following sections introduce further points that situate the findings in the broader subject of gender in agriculture in the context of climate change, through a discussion and consideration of implications for future research and policymaking.

A. *'Gendered' Perceptions?*

Gender norms, including specific roles and responsibilities in society, often (re)shape one's perception of the environment. As Massey conceptualised, there is a multiplicity in understanding spaces, meaning that even in the same geographical region, gender and other socio-economic factors can define spaces differently.[116] This aligns with Boserup's implications on how labour in agriculture is divided by gender, where men often handle tasks that involve physical work or market-oriented jobs, while women focus on household responsibilities.[117] This variation can undervalue women's traditional knowledge that could be useful in farming and shape how women and men farmers differently perceive and adapt to climate change.

Only three studies specifically note 'gendered' perceptions. Other studies concluding no significant differences in perceptions emphasise the severity of recent change in climate, often perceived as a 'hard fact' rather than an 'attitudinal' problem,[118] attribute the similarity to pre-existing climate change adaptation interventions in the study regions,[119] or do not investigate the reason behind this similarity. One study leads to the rather inconsistent conclusion that the *differences* in socio-economic factors account for the variation in adaptation strategies, while the similarity in climate perception between genders is due to their *similar* socio-economic circumstances.[120] This conclusion suggests a need for more rigorous empirical analysis of understanding, attitudes and their association with underlying gender roles or norms rather than resorting to existing literature.

Similarly, most of these examinations stop at 'awareness' and 'understanding' among farmers, except for one study distinguishing awareness and environmental concern.[121] Comprehensive studies that cover climate perception holistically and at a deeper level often distinguish elements or stages of perception including awareness, conceptual understanding, concern, belief, attitude, experience and perceived impacts or vulnerability.[122] While women and men farmers' 'awareness' and 'understanding' of climate change might be similar, the perceived vulnerability could differ.[123] This difference is strongly associated with regional gender norms and roles. Such distinctions could lead to different policy implications for climate adaptation programmes targeting smallholder farmers, necessitating more rigorous and careful analysis of perceptions.

[114] Mensah et al. (n 75) *supra*.
[115] Rosen, Joseph, et al. "Burnt by the scorching sun: Climate-induced livelihood transformations, reproductive health, and fertility trajectories in drought-affected communities of Zambia." *BMC Public Health*, vol. 21, no. 1, 2021.
[116] Massey, Doreen. *Space, place, and gender*. University of Minnesota Press, 1994.
[117] Boserup, Ester. *Woman's role in economic development*. George Allen & Unwin, 1970.
[118] Huluka (n 91) *supra*.
[119] Acheampong et al. (n 70) *supra*.
[120] Jamal et al. (n 33) *supra*.
[121] Huluka (n 91) *supra*.
[122] Madhuri and Sharma (n 20) *supra*; Ricart et al. (n 23) *supra*.
[123] Akyala et al. (n 32) *supra*; Ayanlade et al. (n 25) *supra*; Ge et al. (n 25) *supra*.

B. *Local Contextualisation and Intra-Gender Differences in Adaptation*

Findings of the selected studies confirm that the local context of each region matters. For example, in Southeast Asian countries, rural communities are increasingly feminised: women play an active role in major farming activities, bearing an intensified burden due to men's out-migration.[124] In these areas, women are likely to participate more in crop management practices compared to regions where men dominate agriculture. In contrast, women in male-dominated agricultural communities tend to prefer livelihoods diversification, including off-farm activities.[125] Furthermore, it is essential to understand a region's cultural norms around land ownership. For instance, despite laws securing women's land rights, lands are often deemed to belong to men in practice.[126]

Within the same group of female farmers, adaptation behaviours can vary based on other socio-economic factors such as age, marital status, education level and household size. Almost all mixed or quantitative-based studies (n=20) analyse how socio-economic variables beyond gender affect climate perception or adaptation, with many providing gender-disaggregated data. To illustrate, younger women farmers are more likely to immigrate, while older women rely on traditional agronomical knowledge. Married women are more reluctant to use crop management practices due to a lack of decision-making power within households. Findings on household size vary: some suggest larger households prefer monoculture to immediately improve food security,[127] while others reveal a preference for livelihood diversification.[128] These mixed findings underscore that women farmers are not a homogeneous group. Understanding regional contexts and the social structure of patriarchy, along with intra-household and intra-gender differences, can enrich the analysis of adaptation choices of smallholders.

C. *Difference in Narratives: 'Less Able' to Adapt or 'Agents' of Adaptation*

Even within the same geographical region, studies present differing narratives about women farmers' roles in climate adaptation. While some of these studies utilise certain frameworks such as feminist political ecology or the sustainable livelihoods framework, there seems no clear trend in their approaches. Some emphasise women farmers' vulnerability,[129] while others explore their agency and potential as active participants in climate adaptation,[130] recognising the critical roles women play.

This variation can be attributed to diverse factors, including different socio-economic determinants of women, as illustrated in detail in the previous subsection, and social systems that may be more favourable to female farmers in certain regions. For instance, a study examining women's innovativeness in Pakistan acknowledges that the Punjab province offers relatively more working opportunities for women, enhancing their engagement in agricultural development.[131] Huluka found that Muslims in the study area of Ethiopia were more inclined to conduct conservation activities possibly because their religion allows them to work on weekends.[132]

On the other hand, supported by broader literature, social norms as well as other socio-economic factors, such as lower income or level of education, shape the barriers that hinder women from demonstrating their agency. For example, communal norms that assign fruit collection specifically to women may provide a 'safety net;' however, similar gender-based restrictions can hinder their broader engagement with land access and crop

[124] Shahbaz et al. (n 65) *supra*; Singh (n 7) *supra*.
[125] Lawson et al. (n 51) *supra*; Mensah et al. (n 75) *supra*.
[126] Jamal et al. (n 33) *supra*; Lawson et al. (n 51) *supra*; Nchanji et al. (n 36) *supra*.
[127] Acheampong et al. (n 70) *supra*.
[128] Antwi and Antwi-Agyei (n 13) *supra*.
[129] Assan et al. (n 37) *supra;* Carranza and Niles (n 19) *supra*; Marimo et al. (n 75) *supra*; Otieno et al. (n 88) *supra*.
[130] Liru and Heinecken (n 15) *supra*; Owusu and Yiridomoh (n 35) *supra*.
[131] Shahbaz et al. (n 65) *supra*.
[132] Huluka (n 91) *supra*.

cultivation.[133] Also, excessive domestic workloads of women, especially those with low income, can limit their participation in community-building activities, an opportunity to promote their agency.[134] Farmers with higher education levels are more likely to adopt new, innovative adaptation practices and utilise information provided by formal institutions.[135] However, Antwi and Antwi-Agyei pointed out that CSA adoption was significantly lower among female farmers with higher education levels because they had better access to off-farm income-generating opportunities instead.[136] These findings highlight the intricacy of various socio-economic positions occupied by women farmers in different regions. They remind the importance of understanding socio-economic factors such as class, income and religion, as well as underlying social norms and gender discrimination, when unravelling the reasons behind the variation in literature narratives.

Nonetheless, resorting to a binary view of 'able-less able' dynamics risks overlooking the nuanced ways women perceive and cope with climate change, as well as the intersectionality with other identities.[137] This view often homogenises women and men into static categories, which not only overlooks the local context of how gender equality is defined within a community but also results in short-sighted assessments of gender needs that fail to capture the holistic, complex circumstances of different female groups.[138] Studies like Marimo et al. and Singh highlight women (and men) farmers' joint crop management practices or traditional and indigenous knowledge in resilient crops,[139] which demonstrates their potential as agents of climate adaptation and resilience-building. These insights suggest that developing intervention programmes that appreciate local contexts and traditional knowledge and experiences could prevent the drawbacks of aggressive adoption of adaptation technologies.[140] Addressing an alternative view on women farmers can enable a more nuanced approach to adaptation programmes, incorporating holistic perspectives and local contextualisation.[141]

V. **Conclusion**

The present study offers a comprehensive review of recent studies on climate vulnerability, perception and adaptation strategies among women smallholder farmers in the Global South, revealing critical insights and notable research gaps. While numerous studies indicate that both men and women are increasingly aware of climate change, the perceived impacts and vulnerabilities, as well as associated adaptation strategies, vary significantly by gender. Women farmers' perceptions are often shaped by their gender roles, responsibilities and systemic social constraints within households and communities, leading to distinct adaptation behaviours.

Despite these challenges, women farmers adopt various adaptation strategies: absorptive, adaptive and transformative. It is evident that socio-economic determinants such as age, marital status, household size and social class further diversify these adaptive measures. These intra-gender differences underscore the necessity for localised and context-specific adaptation programmes that account for the diverse needs and capacities of women farmers.

[133] Tangonyire, Damian, and George Akuriba. "Socioeconomic factors influencing farmers' specific adaptive strategies to climate change in Talensi district of the Upper East Region of Ghana." *Ecofeminism and Climate Change*, vol. 2, no. 2, 2021, pp. 50-68.
[134] Diendéré, Achille, and Djibril Ouédraogo. "Women farmers and climate change: Empirical evidence from Burkina Faso." *Agricultural and Resource Economics Review*, vol. 52, no. 3, 2023, pp. 451-475.
[135] Huffman, Wallace. "Human Capital and Adoption of Innovations: Policy Implications." *Applied Economic Perspectives and Policy*, vol. 42, no. 1, 2020, pp. 92-99; Lawson et al. (n 51) *supra*; Nuhu and Matsui (n 71) *supra*.
[136] Antwi and Antwi-Agyei (n 13) *supra*.
[137] Djoudi et al. (n 110) *supra*. Khoza et al. (n 16) *supra*.
[138] ibid.
[139] Marimo et al. (n 75) *supra*; Singh (n 7) *supra*.
[140] Gonda (n 15) *supra*; Singh (n 7) *supra*.
[141] Khoza et al. (n 16) *supra*.

Moreover, the regional focus of existing research highlights a significant geographic imbalance, with Asia and Latin America being underrepresented compared to Africa. This disparity necessitates more targeted research and funding in these regions to understand and address their unique climate vulnerabilities and adaptation needs effectively.

The discussion also reveals that while some studies primarily emphasise women's vulnerability, others highlight their agency and potential as active agents in climate adaptation. Recognising women's traditional knowledge and roles can enhance the effectiveness of adaptation strategies, thereby preventing the pitfalls of aggressive, top-down technological interventions.[142]

In conclusion, addressing the nuanced perceptions and diverse adaptation strategies of women smallholder farmers through gender-transformative and locally contextualised approaches is crucial for effective climate change adaptation. Policymakers and intervention entities must integrate these insights to design programmes that not only mitigate climate risks but also empower women and enhance community resilience. Ultimately, fostering climate-resilient futures requires viewing women farmers not as passive victims of environmental change, but as essential architects of local and global adaptation.

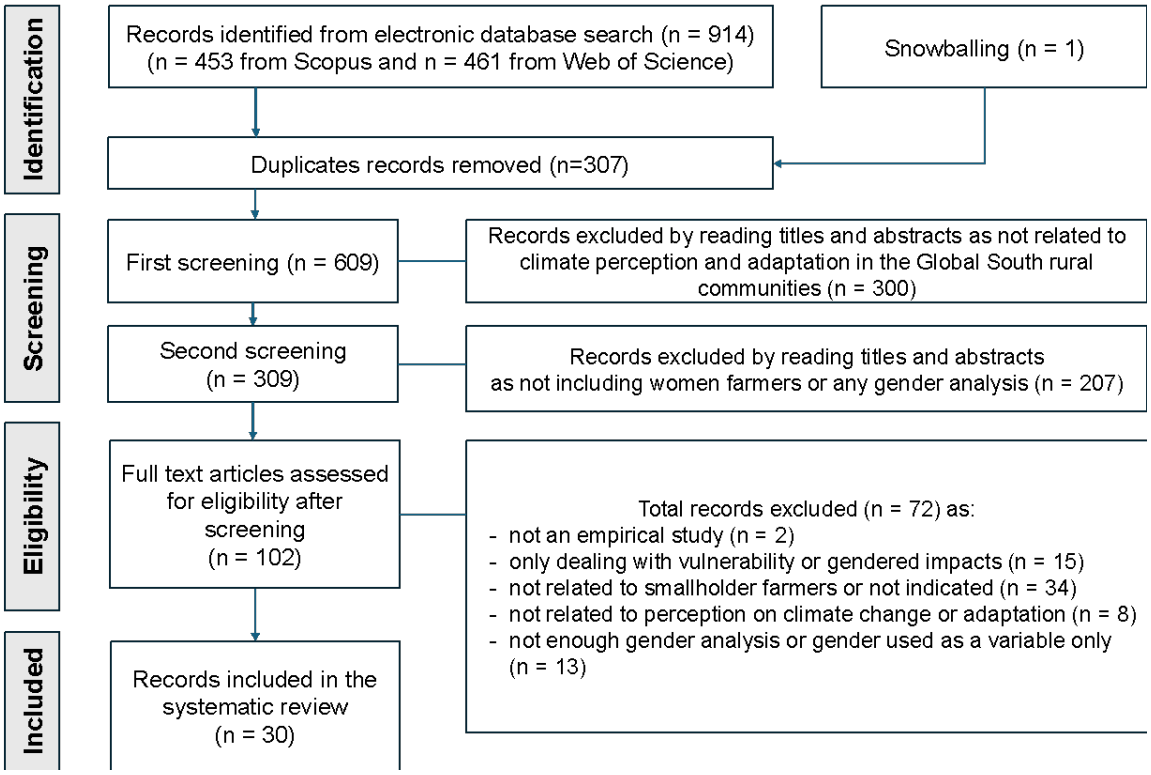


Figure 1: *PRISMA Flow Chart of the Selection Procedure.*

[142] Marimo et al. (n 75) *supra*; Singh (n 7) *supra*.

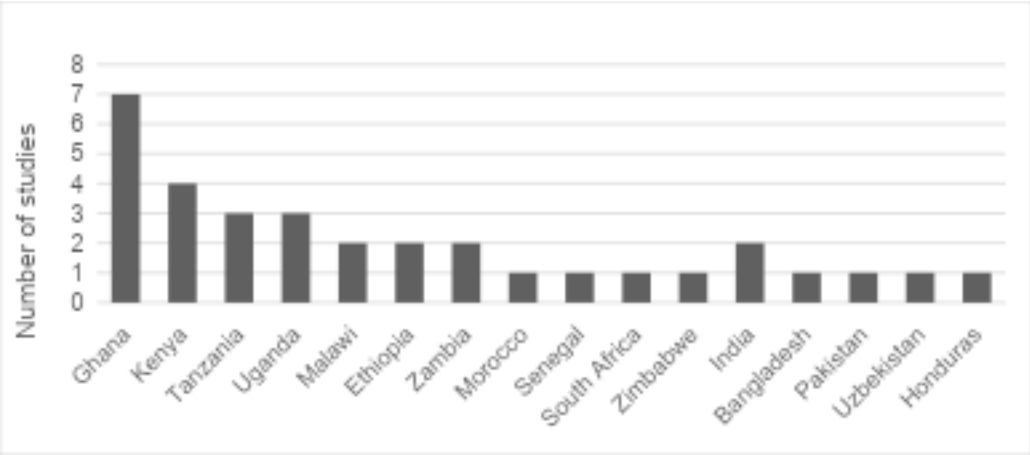


Figure 2: *Geographical Distribution of Study Areas.*

	Vulnerability			Agency		
	Perception and adaptation	Adaptation only	Perception only	Perception and adaptation	Adaptation only	Perception only
Africa	14	3	1	1	4	0
Asia	2	1	0	1	2	0
America	1	0	0	0	0	0

Figure 3: *Evidence Gap Map of Selected Studies.* *Note: The article that covers both countries in Asia and Africa is categorised under Asia.*

Broad category	Adaptation strategies	Specific measures	Regions
Absorptive	Change in storage and consumption	• Food or grains storage • Consuming less food • Food borrowing	Ghana, Kenya, Nigeria, Senegal, South Africa, Uganda
	Change in mobility	• Migration	Bangladesh, Ghana, Honduras, Morocco, Nigeria, Uzbekistan, Zambia, Zimbabwe
Adaptive	Crop and land management	• Changing in planting/harvesting dates • Changing cropping patterns (crop varieties) • Crop rotation, intercropping and mixed cropping • Use of improved seeds or indigenous resilient seeds • Bush fallowing or bed raising	Bangladesh, China, Ethiopia, Ghana, Honduras, India, Kenya, Malawi, Morocco, Nigeria, Pakistan, South Africa, Tanzania, Uganda, Uzbekistan, Zambia, Zimbabwe
	Livelihood diversification	• Livestock rearing • Off-farm income generating activities (e.g., petty trading, shea butter processing, basketry, hairdressing)	Bangladesh, Ethiopia, Ghana, Honduras, Kenya, South Africa, Tanzania, Uganda, Uzbekistan
	Technological adoption	• Irrigation • Use of pesticides, agrochemicals or fertilisers	Ethiopia, Ghana, Honduras, India, Kenya, Morocco, Nigeria, Tanzania, Uganda, Uzbekistan
	Disaster risk reduction	• Using drains to control floods • Creating fire belts for bushfire	Ghana
	Exchange of assets	• Selling assets (livestock, household belongings) • Market access (commercialisation) of their crops • Using loan	Ghana, Kenya, Senegal, Uganda
Transformative	Conservation practices	• Sustainable forestry such as tree planting • Cover cropping or mulching • Compost nature	Ethiopia, Ghana, Honduras, Nigeria, Pakistan
	Communal resilience-building	• Help-groups including savings and loans group • Community development (e.g., construction of dams, communal gardening) • Extension services	India, Kenya, Tanzania, Uganda, Zimbabwe

Table 1: *Adaptation Strategies of Women Smallholder Farmers.*

(gender* OR wom* OR female*) AND (“climat*-chang*” OR “climat*-variabilit*” OR “global-warming” OR “drought*” OR “flood*”) AND (adaptation* OR perception* OR perceiv* OR adapt*) AND (small* OR smallholder* OR farm*)

Appendix 1: *Search String.*

Appendix 2: List of Selected Studies *(online)*.

Category	Questions	Follow-up question topics
General/socio-economic factors	Q1. Please introduce yourself and your role in your organisation. Q2. What are the mission and main objectives of your organisation? Q3. Have you worked with women smallholder farmers in climate change adaptation (CCA) or resilience-building? Please describe your work/role in CCA-related programmes. Q4. What are the socioeconomic characteristics of your main beneficiaries (women smallholders) and the regional context of targeted areas? What are their roles and challenges in agricultural works?	
Women smallholders and climate change adaptation	Q1. What are the main issues that women smallholders face regarding sustainable rural development and climate change adaptation? Q2. What are the perceptions (or perspectives) of women smallholders on climate change? Q3. What are the main coping strategies of (women) smallholder farmers when adapting to climate change, before and after the intervention of your organisation? Q4. What are the perceptions (or reactions) of women smallholders on climate change adaptation activities? Q5. I have identified differences between men and women smallholder farmers in their social responsibilities and perception on and/or adaptation to climate change. Would you agree? Can you share your views on this?	Gendered perception and adaptation, intermediary groups, and collective or individual (household) actions

Appendix 3: *Interview Questions.*