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WHO ADAPTS, WHO DECIDES: A SYNTHESIS OF GENDER AND CLIMATE ADAPTATION IN PASTORALIST SOCIO-ECOLOGICAL SYSTEMS.

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Abstract

This article presents a systematic review of gendered dimensions of climate change adaptation in pastoralist socio-ecological systems (SES) in the developing world, drawing on 35 empirical studies. The review applies the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework while adopting the Synthesis Without Meta-analysis (SWiM) approach to structure and present the synthesis of predominantly qualitative and mixed-methods findings. The findings are organised around four core domains: labour and work roles, access to and control over resources, decision-making power, and knowledge systems and networks. Many studies document persistent gendered disparities in adaptive responsibilities, access to resources, and participation in institutional processes. Others show how women navigate these constraints through informal networks, negotiated authority, and collective strategies. The review concludes that effective adaptation policy must go beyond surface level gender inclusion, focusing instead on transforming structural inequalities in control, recognition, and value. It identifies the need for a relational framework of adaptation governance grounded in the lived experiences of pastoralist communities.

Keywords: Climate Adaptation, Gender, Pastoralism, PRISMA, Socio-Ecological Systems, SWiM.

Introduction

Pastoralist socio-ecological systems (SES) in the Global South are undergoing profound transformations under intensifying climate variability, livelihood disruption, and institutional neglect (Ng'ang'a & Crane, 2020). These systems, long characterised by ecological mobility and collective governance, now face increasing pressures from recurrent droughts, erratic rainfall, disease outbreaks, land fragmentation, and resource competition (Grillos, 2018; Ng'ang'a & Crane, 2020). While pastoralist communities exhibit historically embedded forms of resilience, including adaptive movement and indigenous knowledge systems, these capacities are increasingly undermined by tenure insecurity, extractive development models, and exclusion from national and global climate governance frameworks (Opiyo et al., 2016).

Adaptation to climate change is not experienced equally or similarly within pastoralist socio-ecological systems (Rao, 2019). Gender, particularly, plays a central role in shaping how individuals engage with and respond to climate stress (Mtupile & Liwenga, 2017). In many pastoralist contexts, men are positioned within formal structures of mobility, governance, and decision-making, while women undertake care labour, food security roles, and increasingly, livelihood diversification through informal trade and subsistence production (Sandstrom & Strapasson, 2017; Wangui & Smucker, 2018). These roles are not fixed. Climate-induced shifts have prompted substantial reorganisation of responsibilities, with women assuming expanded burdens as male migration and livelihood shifts reshape household economies (Rao et al., 2020; Walker et al., 2022).

Although gendered transformations in pastoralist SES are increasingly acknowledged in contemporary studies, existing research remains fragmented (Anbacha & Kjosavik, 2019; Venkatasubramanian & Ramnarain, 2018). There is limited systematic synthesis of how adaptation is shaped by gender relations across key domains such as labour, access to resources, knowledge systems, and decision-making. Much of the literature presents gender as a demographic category or a synonym for women, often reinforcing binary framings and universal victimhood narratives (Carr & Thompson, 2014; Rao, 2019). As a result, gendered adaptation is frequently interpreted through static lenses that fail to account for the dynamic, negotiated, and intersectional nature of power relations (Crenshaw, 1989). These limitations are especially pronounced in studies that neglect to examine how gender intersects with other

markers of social difference such as age, marital status, or class, which are critical in shaping adaptation pathways in pastoralist societies.

Therefore, this review addresses these gaps through a critical synthesis of empirical studies on gender and climate adaptation in pastoralist SES. The aim of the review is to systematically analyse how gender relations shape access to labour, resources, knowledge systems, and decision-making power in adaptation processes. Drawing on 35 studies across Africa, Asia, and Latin America, the review examines how adaptation is mediated by institutional arrangements, cultural norms, and social hierarchies, and how men and women negotiate authority, responsibility, and access in evolving climate contexts. It interrogates the extent to which adaptation interventions reinforce or challenge structural exclusions, and whether emergent forms of agency reflect transformation or accommodation within prevailing systems.

The review contributes to scholarship by offering a synthesis that centres power, negotiation, and institutional structure, and by identifying conceptual and empirical gaps in how gendered adaptation is currently studied. Understanding how climate adaptation reorganises labour, knowledge, and authority is essential to advancing equitable and contextually grounded adaptation strategies. This review positions gender not as a residual variable, but as a structuring force in adaptation governance within pastoralist SES.

Methodology

This review follows the PRISMA framework (Page et al., 2021) to ensure transparency and replicability in study identification, screening, and inclusion. Besides, the review applies the Synthesis Without Meta-analysis (SWiM) approach (Campbell et al., 2020), consistent with PRISMA Items 14 and 21, to transparently synthesise a methodologically diverse body of evidence. SWiM was selected due to substantial variation in study design, outcome types, and analytical focus. Findings were organised into four conceptual domains reflecting key dimensions of gendered adaptation in pastoralist socio-ecological systems. Thematic grouping was used to align comparable findings, supported by vote counting to track whether studies reported directional change across domains. This approach enhances transparency, clarifies synthesis logic, and limits reporting bias by acknowledging variation and documenting all

relevant findings. SWiM offers structured flexibility that supports contextual specificity while maintaining coherence across the synthesis.

Search Strategy and Selection

A comprehensive search was conducted in April 2023 across major databases, including Web of Science, and Scopus, covering the period 2013 to 2022. The search strategy combined terms related to climate adaptation (e.g. “climate change adaptation,” “resilience,” “coping”) and gender (e.g. “gender,” “women,” “men,” “masculinities”) with a contextual focus on pastoralist systems. Grey literature was excluded to ensure peer-reviewed quality. The inclusion criteria required studies to: (1) report empirical data; (2) focus on adaptation processes in pastoralist or agro-pastoralist SES; and (3) provide gender-disaggregated findings or analyse gender dynamics explicitly.

From an initial list of 707 articles found in 2023, the researcher screened titles/abstracts and full texts for eligibility. In total, 27 studies met the inclusion criteria and were retained for synthesis (Ref Figure 2). However, since much time had lapsed since the initial search, an update search in April 2025 covering 2023-2025 yielded 68 initial articles and upon screening 8 articles were included (Ref Figure 1 below). The results section bears characteristics of the 35 included articles. Below are the PRISMA flow diagrams detailing Figure 1(Articles from 2023-April 2025) and Figure 2 (Articles from 2013-2022) illustrating the study selection process**.**

Fig 1: Prisma flow diagram for study update with articles 2023-April 2025

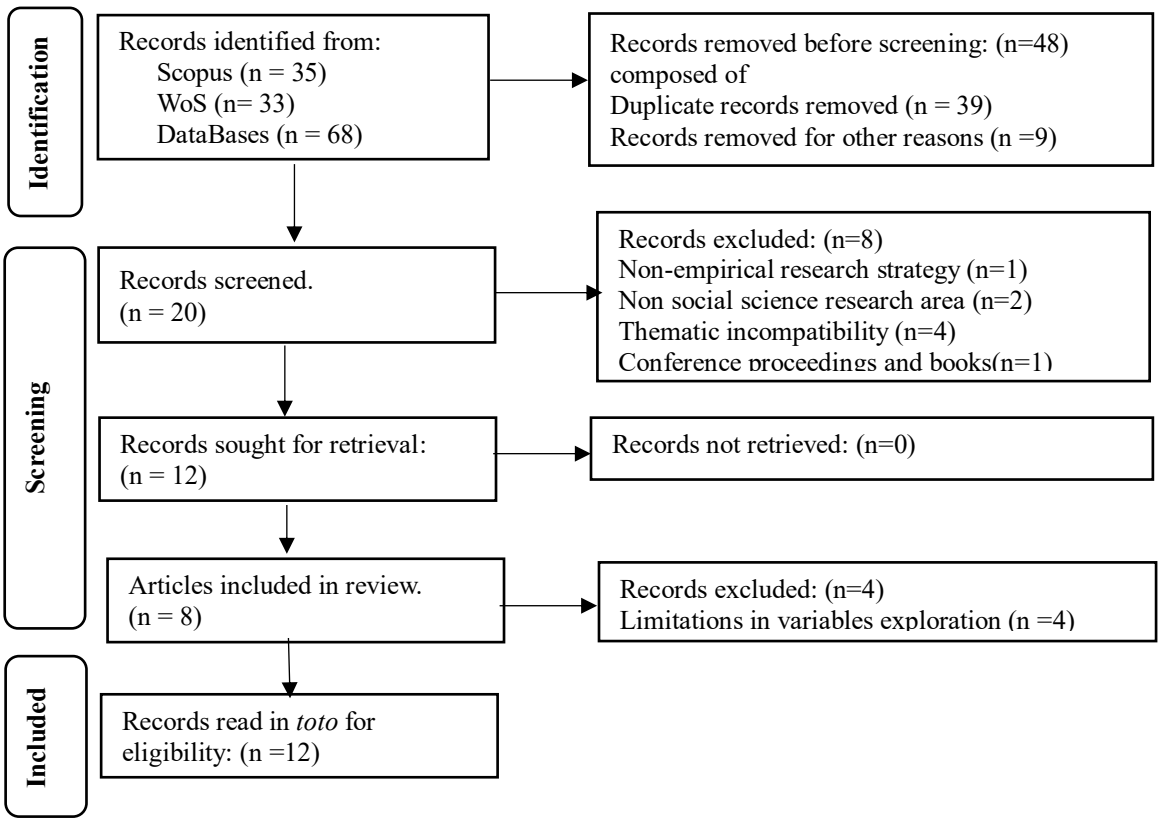
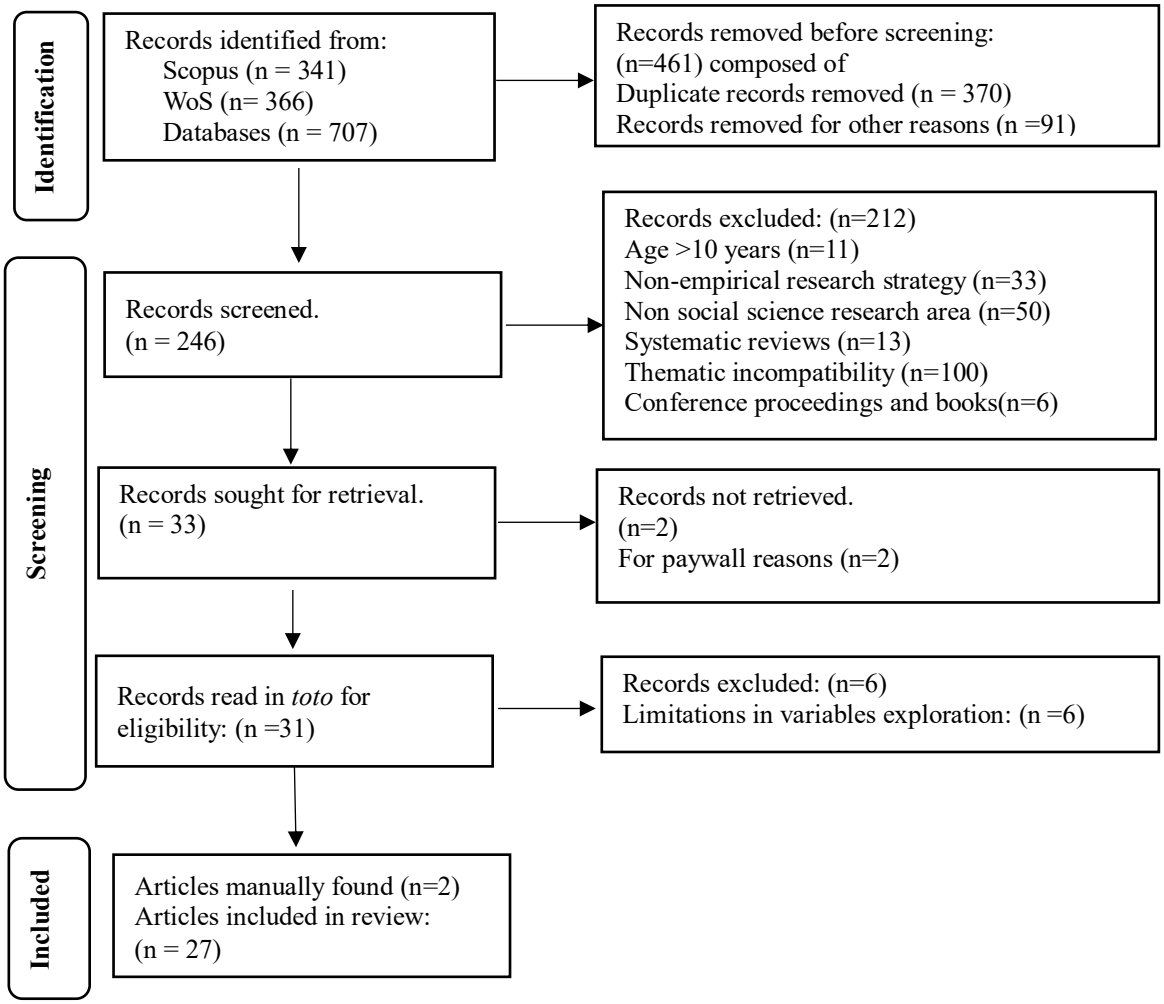


Fig 2: Prisma flow diagram for articles from 2013-2022.



Source Produced by the authors from Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. (Page et al., 2021).

Data Extraction and Study Characteristics:

Using a standardised form, the researcher extracted key characteristics and findings for each study: bibliographic details, location, design, sample, key variables, gender and adaptation findings, and author-noted limitations/strengths. The 35 studies spanned diverse geographic contexts: primarily East Africa (Kenya, Ethiopia, Tanzania), with cases from South Asia (India), West Africa (Gambia), Southern Africa (Namibia, South Africa), and the Andes (Peru). Most studies were community-level field research in rural agri-pastoralist or pastoralist settings, often using mixed methods. Some employed quantitative approaches, including a quasi-experimental evaluation (Grillos, 2018) and surveys analysing gender-

disaggregated vulnerability indices (Mtupile & Liwenga, 2017). The Study Characteristics Master File (Appendix Table S1) details each study's context, design, and focal variables. Common focal areas included gendered division of labour, differential access to resources (land, livestock, credit), participation in decision-making, and the role of indigenous/new knowledge in adaptation. These domains aligned with established gender relations dimensions and guided our synthesis structure

Quality Appraisal

The researcher appraised each study's methodological rigor and relevance for synthesis, without excluding any solely on quality. Qualitative studies were evaluated using Standards for Reporting Qualitative Research criteria (SRQR) while quantitative components were assessed for sampling bias, measurement validity, and control of confounders. Mixed-methods studies were examined for integration. The evidence base was contextually rich but limited by case-specific and cross-sectional designs, affecting generalisability and causality. Common limitations included small/non-representative samples, potential self-report/recall biases, and regional sampling bias potentially missing broader variability (e.g., studies on specific communities). One quasi-experimental study lacked complementary qualitative insights. Overall, the 35 studies provided valuable evidence on gender and adaptation.

Synthesis without Meta-Analysis Approach

The synthesis followed SWiM guidelines to organise and interpret findings across a methodologically diverse evidence base (Campbell et al., 2020). Aligned with PRISMA Item 14, the synthesis is organised around four recurring conceptual domains: labour, resources, decision-making, and knowledge enabling transparent grouping and comparison across studies. Within each domain, findings were recorded using a common descriptive format. For qualitative studies, thematic findings were summarised and aligned; for quantitative studies, vote-counting was used to capture the direction and significance of results. Vote-counting, in this context, refers to noting whether outcomes increased, decreased, or remained unchanged, and whether those patterns were supported by statistical significance or repeated across studies.

In keeping with PRISMA Item 21, the synthesis logic, grouping rationale, and prioritisation of findings are clearly documented to mitigate reporting bias. Findings supported by multiple studies or corroborated across methods were prioritised, while divergent cases were noted for contextual variation. No effect sizes or statistical heterogeneity metrics were reported due to the qualitative nature of most outcomes. The synthesis preserves the distinctiveness of study contexts while enabling a coherent narrative across studies.

Synthesis Process

The researcher coded each study's findings into the four domains, with studies often contributing to more than one. Within each domain, the evidence was organised by relevant sub-topics or outcome types (e.g., land rights, financial resources, or communal resources under "Access to Resources"). When findings differed across studies, the researcher explored potential reasons by comparing study contexts (geography, socio-cultural setting). This narrative exploration of heterogeneity is reported alongside the results for each domain. Due to the mostly qualitative nature of the outcomes, the researcher did not quantitatively analyse heterogeneity but instead qualitatively described patterns and outliers.

Prioritisation of Results

In reporting the synthesis, findings supported by multiple studies or higher trustworthiness (e.g., mixed-method confirmation, cross-contextual observation) were prioritised. Divergent or unique findings offering important nuance were highlighted. While not relying on simple counting, frequency of similar findings indicated robustness. Novel findings addressing gaps or complementing common patterns were noted, even if from a single study. All included studies are referenced for transparency.

Data Presentation

To enhance transparency and traceability of evidence, summary SWiM tables are presented for each domain. These tables list each study with its context, design, key findings related to the domain, and notable limitations. This format allows for side-by-side comparison of studies, highlighting consistency or variability in findings and quality caveats. The tables clarify the evidence source, distinguishing between, for example, small-N ethnographies and larger surveys. We also indicate the number of studies observing a given pattern (e.g., "in

most studies, women's workload increased…"). No formal summary effect size or confidence interval is reported, as no meta-analysis was conducted, but evidence consistency is described qualitatively (e.g., "widely reported," "few studies," etc). The researcher aimed for a rigorous synthesis that transparently shows how conclusions were drawn, in line with SWiM guidance for honest and clear reporting (Campbell et al., 2020).

Results

Overview of Included Studies

This synthesis draws on 35 studies published between 2013 and 2025, examining gendered dimensions of climate change adaptation in pastoralist and agro-pastoralist contexts across Africa, Asia, and Latin America. Table S1 (Appendix) summarises each study's key features. Of the included studies, 14 employed mixed-methods designs, 8 were qualitative (e.g. ethnographic or case study), 4 used quantitative approaches (e.g. survey-based or quasi-experimental), and 1 was a longitudinal panel study. Field sites ranged from East African pastoralist regions (e.g. northern Kenya, southern Ethiopia) to agrarian settings in South Asia and the Andes.

Despite contextual variation, the studies converge around four thematic domains that reflect key dimensions of gender relations that shape adaptive capacity. Domains are interlinked, therefore for clarity, findings are synthesised within each domain, with cross-cutting insights discussed thereafter. Each domain is presented with a narrative synthesis and a corresponding table (Tables 1-4). Two additional studies that assessed broader vulnerability and well-being across multiple domains are summarised at the end.

Synthesis Across Thematic Domains

Findings from the 35 studies were synthesised across the four domains. Each study was coded into one or more domains based on reported outcomes. To manage heterogeneity, SWiM-guided techniques were applied, including vote counting by direction of effect and thematic grouping. Quantitative findings were tallied by directional trend; qualitative themes were aligned across comparable indicators. Divergent findings were retained and interpreted considering contextual factors. Studies with convergent evidence across settings were

prioritised, while distinctive cases were included where analytically relevant. Results are presented narratively and supported by summary tables for study-level transparency.

Labour and Work Roles

This domain draws on studies coded for gendered shifts in labour allocation, synthesised through SWiM-aligned thematic grouping. Findings incorporate qualitative narratives and vote-counted patterns in workload redistribution under climate stress.

Climate adaptation is altering labour distribution in pastoralist socio-ecological systems (SES), with women increasingly absorbing both productive and reproductive tasks. Studies report that climate-related stressors such as drought, livelihood diversification, and male out-migration have pushed women to take on new roles including herding, water collection, and income generation, often without relief from existing domestic duties (Galwab et al., 2024; Sangeda et al., 2013; Walker et al., 2022; Wangui & Smucker, 2018).

A recurring trend links male out-migration to shifts in household labour. In response to environmental shocks, men often leave for wage labour, leaving women and older children to manage livestock and agricultural production (Rao, 2019). In northern Kenya, Peru, and the Gambia, this has meant women assuming full responsibility for herding while maintaining unpaid care work at home (Caine, 2021; Olaniyan, 2017; Opiyo et al., 2016)). These shifts have rarely been accompanied by increased decision-making power or control over resources (Anbacha & Kjosavik, 2019; Dimon et al., 2025) The expansion of women's labour has brought physical and social costs, including heightened stress, adverse health impacts, and curtailed education, particularly for adolescent girls (Zecca & Saima, 2025) In Ethiopia and Kyrgyzstan, girls were frequently withdrawn from school during environmental crises to assist with household tasks, compromising their long-term autonomy (Azarov et al., 2025; Presler-Marshall et al., 2022). These patterns illustrate how gender relations mediate adaptation, often increasing burdens without shifting underlying authority structures.

Some studies point to localised shifts suggesting that adaptation does not invariably reinforce existing hierarchies. In India, collective water harvesting among lower-caste groups involved shared responsibilities between men and women, fostering more equitable responses to scarcity (Rao et al., 2020). Within households, limited evidence shows men performing

traditionally female tasks during crises. In Kenya, some men took on childcare and food preparation during periods of hardship, although these efforts were temporary and insufficient to offset women's expanding workload (Emongor et al., 2017). Such examples challenge assumptions that adaptation naturally promotes gender equity, revealing the persistence of entrenched norms and unequal power even in the face of environmental strain.

Traditional roles largely remain intact, even as total labour demands increase. In Tanzania and Ethiopia, men pursued wage labour or managed livestock mobility, while women added fuel and water collection to their duties (Anbacha & Kjosavik, 2019; Sangeda et al., 2013) This asymmetrical redistribution of labour often occurs without institutional recognition or support. However, not all shifts have been detrimental. Some studies document pathways that expand women's economic engagement. In India, women participating in dairy cooperatives and small businesses gained income and community visibility, although this also extended their work hours (Venkatasubramanian & Ramnarain, 2018) In Namibia, women created informal goat markets to boost earnings (Hazel et al., 2021). In Benin and northern Kenya, they mobilised cooperative farming and small livestock ventures, blending informal networks with entrepreneurial tactics that supported household resilience but remained undervalued(Dimon et al., 2025; Galwab et al., 2024) These cases show that adaptation can open space for negotiated agency while imposing new pressures, shaped by social and institutional context.

Throughout the reviewed literature, there is a clear consensus that women's labour has expanded in scope and intensity under climate adaptation. This has occurred with limited reallocation of other duties or enhancement of decision-making power. While women adapt actively through diversified roles and informal support systems, these efforts are largely constrained by unequal structures that limit the potential for transformative outcomes. Table 1 provides a summary of study-level findings on labour and adaptation.

Table 1. Labour and Work Roles.

Study	Region	Knowledge Domain	Gendered Findings
Nunow et al. (2019)	Kenya	Shifting gender roles in adaptation	Male out-migration increased women's labour responsibilities,

Study	Region	Knowledge Domain	Gendered Findings
			including herding and income generation.
Presler-Marshall et al. (2022)	Ethiopia	Labour burdens among adolescents	Girls were withdrawn from school to help with domestic tasks during climate stress.
Rao et al. (2020)	India	Gendered labour and caste	Women engaged in labour-intensive adaptation while control remained with dominant caste men.
Omolo & Mafongoya (2019)	Kenya	Kinship-based labour reallocation	Women relied on informal work-sharing in droughts, assuming additional roles in household provisioning.
Wangui & Smucker (2017)	Tanzania	Gendered adaptation practices	Adaptation increased women's work through collective and household responses.
Anbacha & Kjosavik (2019)	Ethiopia	Labour divisions in Borana households	Women managed daily livestock care but had limited influence in high-level adaptation decisions.
Olaniyan (2017)	Gambia	Youth climate innovation and roles	Young women took leadership roles in climate innovation but remained underrepresented in formal bodies.
Grillos (2018)	Kenya	Environmental committees and gender	Women attended more meetings but decision authority remained with men.
Emongor et al. (2017)	Kenya	Household burden redistribution	Men sometimes assisted with food preparation, but domestic burdens stayed with women.

Study	Region	Knowledge Domain	Gendered Findings
Sangeda et al. (2013)	Tanzania	Adaptation pressures on work roles	Women collected water and fuelwood over longer distances under stress.
Walker et al. (2022)	Multi-country	Global review of pastoral labour	women's labour increased globally without corresponding decision-making authority.
Mtupile & Liwenga (2017)	Tanzania	Drought responses and household roles	Climate shocks altered intra-household labour responsibilities, disproportionately affecting women.
Venkatasubramanian & Ramnarain (2018)	India	Livelihood transitions and gender	Women entered cooperatives, increasing income but extending labour hours.
Hazel et al. (2021)	Namibia	Goat markets and informal economies	Women established covert markets, increasing agency within informal systems.
Dimon et al. (2025)	Benin	Labour in climate-impacted farming	women's labour intensified as livestock farming became less viable.
Galwab et al. (2024)	Kenya	Rainfall decline and work roles	Women took on new roles in forage and water acquisition as rainfall declined.
Najjar & Baruah (2024)	Tunisia	Labour shifts and environmental interventions	women's roles expanded in response to ecological restoration efforts.
Zecca & Saima (2025)	Ethiopia	Participatory work roles	Women participated in participatory research but lacked implementation authority.

Access to and Control Over Resources

Access to and control over land, water, livestock, and financial assets remain deeply gendered, a pattern reinforced across the reviewed literature. Climatic stress has often deepened these disparities. In northern Kenya, Galwab et al. (2024) report that declining rainfall has increased women's burden in sourcing water, requiring longer travel for household use. This labour reflects both entrenched roles and limited access to alternatives such as motorised transport or private wells, which are generally controlled by men or wealthier households (Anbacha & Kjosavik, 2019). Women's access to critical resources is frequently mediated through male relatives and shaped by patrilineal inheritance and male-dominated governance structures (Ng'ang'a & Crane, 2020; Sandstrom & Strapasson, 2017) These norms constrain women's capacity to respond autonomously to climate stress, especially in prolonged or acute crises (Galwab et al., 2024).

Findings from Tunisia reinforce the pattern of male dominance over high-value productive resources, despite women's increasing involvement in agriculture and livestock management. Najjar and Baruah (2024) observe that land and livestock such as camels remain under male control. Even where formal joint ownership exists, men typically retain decision-making authority, reflecting persistent hierarchies (Grillos, 2018). In Ethiopia's Borana region, similar structures prevail, with men controlling livestock and rangelands while women's access remains indirect (Anbacha & Kjosavik, 2019). This lack of control undermines women's bargaining position, despite their central role in sustaining livelihoods (Emongor et al., 2017). Some women navigate these constraints by leveraging kinship ties or negotiating within marriage to gain access during periods of stress (Omolo & Mafongoya, 2019; Rao, 2019). However, such strategies remain precarious and have become harder to sustain under formal land registration regimes and escalating climate risks (Archambault, 2016).

Climate-induced scarcities further restrict women's access due to their gendered responsibilities in pastoralist socio-ecological systems. In Benin, Dimon et al. (2025) found that women small-ruminant farmers faced erratic rainfall and pasture degradation, which compromised livestock health and household resilience. In Gujarat and Tanzania, repeated droughts reduced the availability of water and fuel, increasing women's workload and exposure to health hazards (Mtupile & Liwenga, 2017; Venkatasubramanian & Ramnarain,

2018). Lacking secure land tenure, mobility, or financial services, women struggled to implement adaptive strategies and remained largely excluded from formal climate responses.

Some adaptation initiatives have unintentionally reinforced gendered exclusions. In Tunisia, erosion-control efforts that prioritised olive tree planting reduced communal rangelands, forcing households to purchase fodder. This benefitted men through wage labour while intensifying domestic burdens for women (Najjar & Baruah, 2024) In Kyrgyzstan, shrinking pastures led men to adopt longer transhumance routes, while women spent more time sourcing fodder near settlements (Azarov et al., 2025). In India, Dalit women face intersecting constraints of caste, class, and gender that limit their engagement in adaptation programmes (Rao et al., 2020). In Kenya, male leaders continue to mediate drought relief access, compelling women to rely on kinship networks (Omolo & Mafongoya, 2019). Land titling initiatives have often displaced women, although some matrilineal systems offer limited protections (Archambault, 2016) Even targeted tools such as quotas and microfinance have delivered limited structural change (Grillos, 2018; Mihiretu et al., 2019)

In summary, gendered disparities in resource access and control remain entrenched and risk deepening under climate stress. Women pastoralists remain disadvantaged in securing key assets, which curtails their adaptive capacity. Addressing these inequalities requires institutional reform and governance changes that go beyond technical interventions. Table 2 presents the study-level findings.

Table 2. Access and Control of Resources.

Study	**Region**	**Knowledge Domain**	**Gendered Findings**
Nunow et al. (2019)	Kenya	Land access disparities	Land access disparities, labour divisions, historical empowerment
Rao et al. (2020)	India	Caste-mediated resource access	Caste-mediated resource access, intra-household conflicts, collective labour

Study	Region	Knowledge Domain	Gendered Findings
Omolo & Mafongoya (2019)	Kenya	Kinship networks	Kinship networks, gendered resource sharing, drought coping strategies
Mihiretu et al. (2019)	Ethiopia	Land tenure insecurity	Land tenure insecurity, microfinance impacts, gendered vulnerability
Rao (2019)	Kenya	Marital instability	Marital instability, generational resource conflicts, women's collectives
Archambault (2016)	Kenya	Enclosure impacts	Enclosure impacts, women's networks, land privatization effects
Hazel et al. (2021)	Namibia	Covert networks	Covert networks, market strategies, gendered livestock management
Anbacha & Kjosavik (2019).	Ethiopia	Gender roles	Gender roles, resource access, decision-making power, drought perceptions
Sandstrom & Strapasson (2017)	Tanzania	Gender inequalities in resource access	Gender inequalities in resource access, climate information utilization
Ng'ang'a & Crane (2020)	Kenya	Social differentiation	Social differentiation, adaptation pathways, land tenure
Zecca & Saima (2025).	Ethiopia	Gendered resource access	Gendered resource access, market strategies, climate impacts
Najjar & Baruah (2024)	Tunisia	Gendered labour	Gendered labour, resource access, adaptation strategies
Azarov et al. (2023)	Kyrgyzstan	Gendered resource access	Gendered resource access, pasture degradation

Study	Region	Knowledge Domain	Gendered Findings
Grillos (2018)	Kenya	Community resource governance	Quotas increased women's committee presence but did not change decision-making power over key allocations.
Rao et al. (2020)	India	Caste-based land access	Dalit women used matrilineal entitlements to access communal land despite intersecting caste and gender barriers.
Dimon et al. (2025)	Benin	Perceived climate risk and adaptive capacity	Women smallholders recognised climate risks but lacked mobility and secure land access to adapt effectively.
Mtupile & Liwenga (2017)	Tanzania	Resource scarcity and gender roles	Climate-induced drought reduced water and fuel access, intensifying women's domestic burdens and limiting mobility.

Decision-Making Power

This domain examines authority over adaptation-related decisions at household and community levels. Across the 35 studies synthesised, decision-making power is structured by gendered hierarchies, institutional arrangements, and intersecting social categories. Although women's roles in adaptation have expanded, particularly in labour and resource management, their authority over decisions remains constrained. However, some contexts suggest partial shifts, reflecting broader changes in gender norms and institutional participation.

At the household level, men often retain control over decisions related to resource use, migration, and livelihood diversification, even when women contribute significantly to adaptation strategies. In Ethiopia's Borana region, Anbacha and Kjosavik (2019) found that men directed livestock mobility while women managed domestic finances. In Marsabit,

Kenya, Galwab et al. (2024) reported that 63 percent of male respondents identified themselves as primary decision-makers, whereas women were seen as domestic managers. In Tunisia, men held control over high-value livestock decisions, while women's input remained limited to minor tasks (Najjar & Baruah, 2024). Although some households described joint decision-making, women's roles were typically consultative rather than authoritative (Emongor et al., 2017; Nunow et al., 2019).

A few studies suggest that climate stress has unsettled dominant masculinities, prompting limited shifts in household roles. In Uganda, Ayub et al. (2023) and Catley et al. (2023) documented that livestock loss led some men to take on childcare and household provisioning, responsibilities usually associated with women. These changes challenged masculinities tied to cattle ownership and provider roles. Men described feelings of social displacement and reduced standing in the community. In such cases, participation in reproductive work was framed as necessity rather than choice, signalling constrained agency under pressure (Rao, 2019). These role reversals were often temporary and situational, but they reveal how gendered authority can be contested during climate crises.

At the community level, adaptation governance continues to be led by men. In Ethiopia's Afar region, Balehey et al. (2018) found that resource allocation decisions were made by male elders, despite women's substantial role in coping strategies. In Peru, Caine (2021) noted that male leaders were treated as adaptation experts, marginalising women's knowledge. In Tunisia, women's representation in rangeland groups was often symbolic (Najjar & Baruah, 2024) These findings align with Presler-Marshall et al. (2022) who observed that adolescent girls were excluded from community dialogues in Ethiopia. In India, caste and class further reinforced structural exclusions. Rao et al. (2020) found that Dalit men and women were routinely barred from formal decision-making platforms.

Even so, some studies document more enabling institutional contexts. In Colombia, Forero et al. (2023) found that matrilineal inheritance among the Wayuu facilitated women's participation in herd management. Hazel et al. (2021) reported that women in Namibia shaped livestock marketing through informal coalitions. Grillos (2018) found that gender quotas in Kenya improved women's visibility in local environmental committees, although formal authority often remained with men. In Kenyan communities, matrilineal tenure enabled greater female influence in land allocation during droughts (Archambault, 2016). Olaniyan

(2017) noted that youth-led initiatives in the Gambia opened space for young women to lead adaptation efforts. While these settings permitted greater inclusion, tokenism, entrenched norms, and gendered asset hierarchies continued to limit deeper shifts in authority.

Some interventions have attempted to correct decision-making inequalities but with mixed outcomes. In Tunisia, Najjar and Baruah (2024) found that participatory roles often added to women's workload without expanding their authority. In Ethiopia, Mihiretu et al. (2019) reported that microfinance increased women's financial capacity but did not change decision-making patterns within households. Even when women enter forums, influence is frequently undermined by symbolic participation or persistent social norms. These findings point to a gap between procedural inclusion and substantive authority.

In sum, most studies found that women's decision-making power remains more limited than men's, both within households and in community institutions. While interventions such as quotas and informal coalitions offer promise, they have yet to drive transformative shifts in power relations. Exclusion is not uniform; it intersects with age, class, and cultural structures. Some men also experience reduced authority as climate pressures reconfigure livelihood roles.

Table 3: Gendered Authority for Decision-Making Power.

Study	Region	Knowledge Domain	Gendered Findings
Nunow et al. (2019)	Kenya	Land access disparities	Land access disparities, labour divisions, historical empowerment
Presler-Marshall et al. (2022)	Ethiopia	Youth agency	Youth agency, gendered labour burdens, digital innovation
Olaniyan (2017)	Gambia	Male migration patterns	Male migration patterns, women's leadership, digital adaptation tools
Camfield et al. (2020)	Ethiopia	Migration	Migration, household splitting, intra-household dynamics

Study	Region	Knowledge Domain	Gendered Findings
Hazel et al. (2021)	Namibia	Covert networks	Covert networks, market strategies, gendered livestock management
Ebhuoma et al. (2020)	South Africa	Social differences	Social differences, power relations, drought vulnerability
Anbacha & Kjosavik (2019)	Ethiopia	Gender roles	Gender roles, resource access, decision-making power, drought perceptions
Balehey et al. (2021)	Ethiopia	Gender-differentiated vulnerability	Gender-differentiated vulnerability, adaptation capacity, traditional governance
Grillos (2018)	Kenya	Women's empowerment	Women's empowerment, drought preparedness, decision-making outcomes
Caine (2021)	Peru	Gendered herding labour	Gendered herding labour, relational networks, exclusion from decision-making processes
Forero et al. (2023)	Colombia	Transmittance	Transmittance, political devolution, cultural rituals
Ayub et al. (2023)	Uganda	Ethnicity	Ethnicity, labour division, marital stress
Catley et al. (2021)	Uganda	Seasonality of malnutrition	Seasonality of malnutrition, women's workload

Knowledge Systems and Networks

This section examines the role of indigenous and local knowledge systems (IKS) in shaping climate adaptation in pastoralist socio-ecological systems, based on evidence from 18 of the 35 studies. SWiM-consistent thematic coding was used to analyse gendered patterns of knowledge holding, transmission, and recognition. IKS includes traditional ecological knowledge, informal learning, and adaptive practices related to rangeland monitoring, livestock care, and seasonal mobility (Aregu et al., 2016; Catley et al., 2023; Opiyo et al., 2016). These systems are shaped by gender, age, and cultural norms, and circulate through networks that vary in legitimacy and accessibility.

Across regions, women demonstrated deep environmental expertise grounded in daily interaction with local ecologies. In Kenya, Ethiopia, and Namibia, women tracked forage availability, monitored livestock health, and used oral seasonal calendars to anticipate drought (Dimon et al., 2025; Galwab et al., 2024; Hazel et al., 2021). In Karamoja, Uganda, women classified malnutrition and linked climatic events to health outcomes (Catley et al., 2023). In India, women specialised in seed preservation and soil fertility, while men focused on weather forecasting and commercial crops (Bhadwal et al., 2019). Despite these complementary domains, women's knowledge often remained excluded from formal adaptation planning. In Peru and Tunisia, institutions privileged the expertise of male leaders, disregarding women's practical contributions to grazing and herd care (Caine, 2021; Najjar & Baruah, 2024) This epistemic exclusion limits the scope and depth of adaptation interventions.

Institutional structures further entrenched these exclusions. In Ethiopia and Kyrgyzstan, male-dominated governance platforms restricted women's access to training and decision-making spaces (Aregu et al., 2016; Azarov et al., 2025). However, matrilineal configurations offered alternative pathways. Among the Wayuu in Colombia, women managed herd movements and passed knowledge across generations (Forero et al., 2023). In matrifocal households in Kenya, women led drought-response practices including livestock culling and seed selection (Nunow et al., 2019). In India, lower-caste matrilineal groups used lineage-based entitlements to secure access to land (Rao et al., 2020). These examples show that institutional arrangements can expand women's epistemic authority, although such protective effects remain highly context-specific.

In the absence of formal recognition, women relied on informal networks to share adaptive knowledge. In Tanzania, women's savings groups functioned as sites of drought-related learning (Wangui & Smucker, 2018) In Turkana, knowledge of wild foods and water sources circulated through kinship ties during crises (Omolo & Mafongoya, 2019). In Namibia, women used covert channels to exchange livestock market information, navigating male-controlled trading systems (Hazel et al., 2021). In Ethiopia, adolescent girls turned to peer learning due to limited digital access, unlike boys who accessed online climate tools (Presler-Marshall et al., 2022). In Gambia, inclusive training reduced this gap and improved women's access to adaptation knowledge (Olaniyan, 2017). These networks help compensate for exclusion but remain unrecognised in formal frameworks.

Some cases showed promising integration between IKS and scientific knowledge systems. In Kenya, participatory epidemiology used women's insights into seasonal animal nutrition to improve veterinary service outcomes (Catley et al., 2023). In Tanzania, local forecasting was incorporated into formal adaptation planning via deliberative forums (Mtupile & Liwenga, 2017). These examples demonstrate that inclusive, co-produced adaptation is possible when institutions acknowledge diverse knowledges. However, such instances were rare and often fragile. Without consistent policy support, integration efforts risk reverting to technocratic norms. When gendered knowledges are excluded, adaptation strategies remain partial, and opportunities to enhance resilience are missed.

In conclusion, both women and men contribute distinct ecological and cultural knowledge to pastoralist adaptation. Women's expertise in household resource use, forage monitoring, and animal care remains undervalued, while men typically control formal knowledge systems. This gendered asymmetry in epistemic authority reduces the inclusiveness and effectiveness of adaptation planning. Broader institutional factors such as inheritance regimes, governance norms, and matrilineal systems further shape whose knowledge counts. Table 4 presents study-level findings on this theme.

Table 4. Indigenous and Local Knowledge Systems.

Study	Region	Knowledge Domain	Gendered Findings
Aregu et al. (2016)	Ethiopia	Watershed and adaptation training	Male-dominated learning groups limited women's participation
Catley et al. (2023)	Uganda	Child malnutrition, seasonal knowledge	Women used nuanced indigenous classifications and causal reasoning
Opiyo et al. (2016)	Kenya	Weather forecasting, herd mobility	Elder men dominate forecasting; women contribute to food storage knowledge
Bhadwal et al. (2019)	India	Seed saving, soil conservation	Women manage seed and soil conservation; male knowledge prioritised in formal systems
Caine (2021)	Peru	Forage knowledge, institutional exclusion	Male leaders consulted, sidelining women’s expertise
Azarov et al. (2025)	Kyrgyzstan	Pasture use, governance participation	Women and youth excluded from pasture decision spaces
Forero et al. (2023)	Colombia	Herd migration, cultural knowledge	Women maintain kinship-based adaptation and knowledge transmission
Galwab et al. (2024)	Kenya	Rainfall perception, forage tracking	Women engage in observational monitoring, but excluded from early warning systems
Dimon et al. (2025)	Benin	Climate risk perception	All women recognised climate shifts, but not consulted in planning
Wangui & Smucker (2018)	Tanzania	Informal adaptation networks	Women exchanged drought knowledge through local groups

Study	Region	Knowledge Domain	Gendered Findings
Omolo & Mafongoya (2019)	Kenya	Crisis-based food and water knowledge	Kin-based systems supported informal knowledge sharing
Hazel et al. (2021)	Namibia	Market intelligence sharing	Women used covert channels to circulate livestock pricing data
Presler-Marshall et al. (2022)	Ethiopia	Youth digital access	Boys accessed information digitally; girls relied on social networks
Olaniyan (2017)	Gambia	Youth innovation programme	Programme expanded girls' and boys' climate knowledge and digital inclusion
Mtupile & Liwenga (2017)	Tanzania	Local forecasting and planning	Combined local and formal climate knowledge through dialogues
Aregu et al. (2016)	Ethiopia	Watershed and adaptation training	Male-dominated learning groups limited women's participation
Catley et al. (2023)	Uganda	Child malnutrition, seasonal knowledge	Women used nuanced indigenous classifications and causal reasoning
Opiyo et al. (2016)	Kenya	Weather forecasting, herd mobility	Elder men dominate forecasting; women contribute to food storage knowledge
Najjar & Baruah (2024)	Tunisia	Rangeland and livestock decision-making	Women's participation in communal rangeland committees was limited and often tokenistic.
Mihiretu et al. (2019)	Ethiopia	Microfinance and household investment	Microfinance improved women's liquidity but did not shift intra-household decision-making.
Archambault (2016)	Kenya	Land tenure and customary authority	Matrilineal households retained female land decision roles; formalisation displaced many women.

Study	Region	Knowledge Domain	Gendered Findings
Rao et al. (2020)	India	Caste and adaptation planning	Dalit women excluded from adaptation forums due to caste and gender.
Rao (2019)	Kenya	Marital negotiations and adaptation	Women used marital strategies to influence household adaptation decisions.
Galwab et al. (2024)	Kenya	Household adaptation strategies	Men dominated decision-making; women executed but did not steer strategy.

Ultimately, the four thematic domains show that adaptation in pastoralist socio-ecological systems is shaped by gendered patterns of labour, authority, access, and epistemic recognition. Women often take on expanded roles in response to climate stress, while some men face reduced authority as livelihoods shift. Yet these redistributions rarely alter underlying power relations. Institutional arrangements such as matriliny and informal coalitions can create openings, but broader exclusions persist, particularly where adaptation initiatives rely on formal systems that sideline diverse knowledges and entrench existing hierarchies. Rather than a simple story of disadvantage, the findings point to negotiated and uneven forms of agency shaped by social location, governance structures, and historical legacies.

Strengths, Limitations, and Research Gaps

This review's strength lies in its use of the PRISMA framework and SWiM approach to synthesise a heterogeneous body of literature on gender and climate adaptation in pastoralist socio-ecological systems. Grouping findings across four domains enabled structured thematic synthesis, while vote-counting and narrative comparison enhanced transparency. The inclusion of diverse study designs: qualitative, quantitative, and mixed-methods allowed triangulation of patterns across methodological approaches. Where available, intersectional data (e.g. age, caste) enriched the analysis, though only a minority of studies explicitly adopted intersectional frameworks.

Nonetheless, several limitations merit attention. Regional concentration in East Africa and South Asia, along with exclusion of non-English sources, constrains broader applicability. Most included studies were descriptive case studies, limiting causal claims. While SWiM supports transparent grouping, it does not assess effect size and may overrepresent frequently reported findings. The domain structure, while analytically useful, is also a simplification of overlapping processes.

Three key research gaps emerge. First, intersectionality remains under-theorised, with limited attention to how gender intersects with age, marital status, or class in shaping adaptation. Second, longitudinal evidence is scarce, hindering understanding of how gendered adaptation trajectories evolve over time. Third, few studies evaluate the outcomes of gender-responsive interventions. Further research should address how gender contracts evolve under climate stress, how masculinities influence adaptation strategies, and how financial flows reshape authority within households. These questions are critical to understanding how adaptive capacity is produced and contested over time. Additionally, research would benefit from comparative designs, attention to change processes, and robust evaluations of interventions aiming to shift structural inequalities in adaptation contexts.

Discussion

This systematic review, conducted using the PRISMA framework and SWiM approach, synthesises evidence from 35 empirical studies to expose how gendered power relations shape adaptation processes in pastoralist socio-ecological systems (SES). The findings disrupt simplistic narratives of vulnerability and resilience, revealing adaptation as a socially negotiated process structured by institutionalised inequality and shaped through context-specific agency. This discussion engages critically with Carr's (2020) resilience theory and Crenshaw’s (1989) intersectionality to develop a relational understanding of adaptive capacity.

The feminisation of pastoral labour, evidenced by women’s expanded roles in livestock management, agro-pastoral farming, and household provisioning (Anbacha & Kjosavik, 2019; Walker et al., 2022) initially appears congruent with Carr’s conceptualisation of resilience as systemic reorganisation. However, closer analysis reveals this labour shift operates within structural constraints that Carr's framework inadequately theorises. Despite increased

responsibilities, women's control over critical assets remains restricted by customary tenure systems and state policies privileging male ownership (Rao, 2019). Microfinance schemes and climate-smart agriculture programs often instrumentalize women's labour without addressing underlying tenure inequalities, exemplifying what Rao et al. (2020) term “adaptation patriarchy”. These findings challenge Carr’s apolitical resilience models (Carr, 2019, 2020; Carr & Thompson, 2014) by demonstrating that labour reorganisation does not inherently enhance systemic resilience when divorced from institutional reform.

Knowledge systems reflect similar inequalities. Women possess vital ecological expertise, particularly in forage management and seed selection. Yet formal adaptation processes frequently privilege external technical expertise and male voices, excluding women from forecasting trainings and climate planning (Caine, 2021; Opiyo et al., 2016). These exclusions reflect what Crenshaw (1989) terms structural intersectionality, where knowledge hierarchies are shaped not only by gender, but also by age, caste, and class. Informal networks, such as maternal storytelling and women’s seed exchanges, continue to play a crucial but unrecognised role in adaptation (Hazel et al., 2021; Omolo & Mafongoya, 2019). Crenshaw’s framework enables analysis of how power circulates through knowledge regimes, determining who participates in shaping adaptive responses

The findings also unsettle binary framings of gender. Intersectional exclusions were observed not only among women, but also among lower-caste men, unmarried youth, and others marginalised in elder-dominated structures (Olaniyan, 2017). At the same time, matrilineal counter-narratives, such as in Kenya’s Samburu communities where women manage land allocation, illustrate that authority is shaped by institutional variation rather than biological destiny (Archambault, 2016). These patterns invite a synthesis of Crenshaw’s intersectionality with Adger’s (2003) agency-vulnerability framing to analyse how overlapping forms of disadvantage mediate adaptive outcomes.

The findings call for a theoretical approach that does not treat resilience and intersectionality as separate paradigms but instead understands adaptive capacity as a product of their interaction. This article proposes a relational formulation: adaptive capacity emerges through the interplay of gendered power relations, institutional adaptability, and the recognition of situated knowledge systems. Rather than treating capacity as a fixed attribute, this model emphasises how structural position, governance mechanisms, and epistemic legitimacy shape

adaptive possibilities. Such a perspective requires substantive shifts in adaptation programming, including legal reforms to secure women's customary land rights, integration of care work into national adaptation plans, and the co-design of early warning systems with women's ecological monitoring networks (Presler-Marshall et al., 2022).

In conclusion, this review contributes to the climate adaptation literature in three ways. First, it reframes adaptation as a socially embedded process shaped by historical and institutional inequalities. Second, it positions intersectionality as essential for analysing how overlapping exclusions mediate adaptation outcomes. Third, it calls for rethinking resilience theory to centre questions of power and justice. In doing so, it moves beyond narratives of inclusion to demand transformation in the governance of adaptation in pastoralist systems. Rather than portraying women as passive victims, it recognises their role as adaptive agents navigating complex and unequal environments. These insights are vital for designing strategies that respond to the realities of climate change in diverse pastoralist contexts.

Conclusion

This review shows that gender relations in climate adaptation among pastoralist communities are neither static nor uniformly oppressive, but shaped through ongoing negotiations of labour, resource access, authority, and knowledge. While patriarchal structures continue to constrain formal inclusion, adaptation processes often rely on women's expanded roles, informal strategies, and ecological expertise. These contributions, although essential to household and community resilience, remain undervalued by formal governance systems. The synthesis reveals that adaptation reconfigures responsibilities more readily than it redistributes power, producing outcomes that are uneven, context-dependent, and mediated by intersecting structures such as age, class, and institutional form. Yet it also identifies spaces of possibility: where matrilineal tenure, collective action, or knowledge-sharing networks are in place, women negotiate new forms of influence that challenge simplistic binaries of vulnerability and agency. Indigenous knowledge emerges as both a vital resource and a contested terrain, with gender shaping whose expertise is legitimised and whose is ignored. Rather than relying on instrumental fixes such as quotas or titling schemes, effective adaptation must engage more seriously with the social foundations of resilience. This requires embedding gendered labour, local knowledge systems, and care work into adaptation design, while recognising the differentiated constraints faced by younger generations and marginalised subgroups.

Ultimately, gender is not an add-on to adaptation but a structuring force within pastoralist socio-ecological systems. A more just and grounded response to climate change must therefore begin by asking not only who adapts, but who decides, who is recognised, and on what terms.

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